Mission and Vision of Artificial Intelligence in Agriculture: Addressing Transparency, Scalability, and Security Issues, and Future Directions

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ABSTRACT
AI-induced era is currently progressing. We are seeing phenomenal AI advancements. In front of our eyes, many things are becoming automated, and AI could significantly impact agriculture, the field that feeds and nourishes us every day. We envision various applications such as optimizing supply chains, weather predictions, adapting to climate change, automating physical processes with robotics, making precise decisions, saving resources as side effects of the economy get improved, and more competition in the field.It brings positive changes, yet there are specific challenges regarding scalability, security, the way it is adapted, improper AI training that can lead to disastrous results, educating farmers on this new technology, making more people aware of it, financial challenges, commercialization, etc.There are advantages and disadvantages, like higher computing costs, training time, and a lack of high-quality datasets. Considering all these challenges, adaptation takes time, money, patience, and effort. All these are present possibilities; there can be more possibilities yet to be discovered. We present them as future projections, and the sheer data doesn't make an AI model work; it's the algorithms that make AI predict, think, understand, and produce solutions that are compliant with the norms and ethical rules of conduct.

Keywords: Artificial Intelligence, Precision Agriculture, Autonomous farming, Urban Agriculture, Supply chain optimization, Crop management, Weather Forecasting.

1. INTRODUCTION

Millions of Megabytes of data are being generated, stored, and processed. This data tells us a lot, and we found a way to make this data talk with us, i.e., Artificial intelligence. Basing this AI model on AI algorithms that are focused on agriculture will open many doors of opportunity and economic rise, etc [1-2].

The Rise in Precision Agriculture: The most significant use for AI is precise decision-making backed up with extensive, verified data. Hence, farmers leverage this power within their practice and make their methods more precise, saving resources and increasing yields, which in turn gives them more profit.

Autonomous Farming with Robotics: With the help of mechanical robots integrated with advanced AI models, it is now possible to automate a wide range of farming practices, including automatic irrigation, weed picking, harvesting, and real-time protection protocols against sudden weather changes.

Supply chain Optimization: The transport routes, deadlines, food expiration, physical damage to produce, unexpected accidents, sudden recalls, mismatched orders, payment delays, and many more

factors will determine how the farmer's economy operates; introducing AI will not only optimize this chain but can even enhance it by updating routes Realtime, predictions on physical damage to food, etc.
With this information, a basic idea has been represented; however, there's still more to it, including the vision for agriculture and the mission for AI in agriculture roles, opportunities, issues, advantages, and disadvantages, as well as future projections.
The following are the objectives of this work:

1. How can artificial intelligence be helpful in the agriculture sector?
2. What changes can it bring?
3. What conveniences will it offer?
4. How can it make agriculture techniques smoother?

The rest of the paper is organized as follows: Section 2discussed vision and mission of the paper, Section 3 covers the roles it will take in agriculture, Section 4 explains what opportunities it will offer, Section 5 outlines the challenges, Sections 6,7,8 discussed issues with transparency, scalability, security and their potential remedies. Sections 9, 10, 11, 12 discussed advantages&disadvantages, applications, future directions, and algorithms. Section 13 concludes with conclusion.

2. Mission & Vision

2.1. Mission

Ensuring long-term sustainability: To ensure its long-term survival, the AI model should be able to promote environmental sustainability, generate creative methods for building resilience to climate change, and ultimately ensure that consumers use artificial intelligence ethically and responsibly.
Monitoring and Evaluation: Monitoring AI and evaluating its tokens of replies need newer and clearer metrics and monitoring frameworks. These will provide better ways to measure AI's impact in the agriculture sector and then lead to improvements in AI, providing more optimized solutions to create real impact.
Fostering collaboration and knowledge sharing: "Engaging with stakeholders" means engaging farmers, agricultural researchers, policymakers, and other services that aid in agriculture. These must engage in community-wide meetings to create innovative solutions and lead to more open-sourced solutions; this will encourage more people around the globe to create their solutions using these Open-Sourced models as a base.
Minimizing Biases: When it comes to farming, there is no shortage of biases because everyone's situation is different, resulting in more belief toward bias. To prevent this, we will feed the model the peer-reviewed data authorized by various trustable organizations with valid proof [3-5].

2.2. Vision

Cultural Preservation: Loading cultural methods and information into an AI model will not only preserve it but also utilize and educate it to other farmers. Experienced farmers who used ancient methods can now utilize them with modern technology.
Climate resilience and adaptation: Climate change is a well-known problem that’s ongoing. The solution for it might exist in the possible future, but right now, we can implement a proper system with AI to resist and adapt crops to climate change by enhancing them biologically or making changes in farming techniques, etc.
Rural economic growth: Implementing AI in agriculture will bring in more innovative ideas around the globe. This opens an opportunity for the rural economy to participate in developing solutions and commercializing them, ultimately leading to growth in the rural economy.
Urban agriculture: By leveraging AI-driven algorithms, growing crops in an indoor set can now be optimized to max factors like LED lighting, hydroponic nutrient management, and indoor climate control; this will maximize yields and minimize resource utilization, contributing to urban sustainability [6-9].

3. Roles

Better Data Analysis: Sensors, satellites, forecasts, and more are necessary factors for a farmer to yield a good harvest. At the end of the term, well-advanced AI algorithms can do that in mere seconds, hence fulfilling a Role in better agriculture.
Market Analysis: Since farming isn't only to feed all of us, it's one way to make a living. Analyzing trends, prices, and consumer demands will give the farmer an idea of what crop will be much more profitable and beneficial. Then, they can make a good decision, and it can be personalized.
Soil Health Monitoring: Soil is one of the tricky factors to get right because, with changing weather conditions and other factors, the nature of the soil can change. Keeping track of this is tricky; with AI, we can constantly check the soil, determining what crops suit that soil's nature.

Selective Harvest: Harvesting is one of the best parts of farming yet weeds, uneven produce can be filtered out with AI-powered Robots while harvesting. Scanning for weeds, picking out the weeds, and similar patterns for uneven produce happen simultaneously and seamlessly, reducing time and effort [3-4].

4. Opportunities

Increased productivity and profitability: With AI, farmers can optimize their schedule and the suitable crop type according to field conditions and the aftermath of plantation till harvest. With extensive, verified data, they can experiment with various combinations and know what is more profitable.
Improved Resource Management: Resource managing is a hectic task since the growth of the farmer's produce increases and storage space gets bigger and bigger; even though there is a system that's applied to manage, introducing AI in this system can make things like detecting rotted produce, segregating weeds, sends alerts when a produce is about to reach its expiration date and could provide suggestions on what to do.
Empowering smallholder farmers: Not every farmer is more experienced in growing crops; with a Large Language Model at their hands, farmers can learn more about certain crops and methods to produce them; it will be much more helpful for smallholder farmers even though they have minor produce and place AI algorithms can help in optimizing with what they have now.
Streamlining the food supply chains: Plantation, harvesting, storing, and then transporting the produce so that farmers can make a living out of their work with current supply chains and mass demands achieved daily. Introducing AI into this will optimize the supply chain by implementing a better schedule, monitoring traffic, keeping track of expiration dates, and many more; with this, more demands could fulfil, and the quality of produce would increase. [5] [10]

5. Challenges

Financial Constraints: Deploying AI sometimes means spending large amounts of money on hardware, software, and expert training personnel to train and maintain the AI. The development of agricultural technologies and farming methods may appear to be an obstacle, particularly to small-scale farmers and those in developing areas characterized by limited resources.
Data Challenges: Data-driven boosts AI. Although producing good-quality agricultural data is quite complex, significant improvements can be made over time. Data might be location-specific or odd due to inherent discrepancies such as changes in weather, soil conditions, and farming methods across different locations.

Fig 1. Challenges of Artificial Intelligence in Agriculture

Artificial Intelligence in Agriculture is a remarkable achievement. However, we face many challenges, as described in **Fig-1**.
Acceptance and Adoption: Shifting mindsets and significantly translating services into new agricultural methodologies can be painstaking. Consequently, farmers who are suspicious of AI might refrain from implementing it due to their lack of experience with the technology or job security concerns.

Infrastructure Limitations: AI systems depend on a solid network connection to operate well and utilize the latest technological technology. However, in the case of areas that are isolated and not well connected to the internet and computation, it may raise a problem.

Ethical Considerations: Privacy and ownership of the data can be essential components of data. AI in agribusiness sees immense data gathered and analyzed from farms. So, it is essential to formulate a perfect data governance scheme and take care of possible privacy-related issues [11].

6. Transparency Issues

1. Algorithm Bias:

- Besides, data bias may occur unintentionally during AI training, resulting in inappropriate practices such as unfair farm loans based on non-essential factors.
- Diversity of datasets and representation of agricultural activities and conditions. Arrange laws that promote data collectors' and model makers' transparency.

2. Lack of Explainability:

- The difficulty in understanding how AI algorithms arrive at decisions at the request of complex models is one of the factors. That explainability is necessary for farmers to challenge or adapt recommendations with trust and effectiveness.
- Create AI models with built-in explainability capabilities, allowing people to understand and experience reasons for the recommendations. Diversify research on post-hoc interpretability techniques for explaining complex AI decisions.

3. Data Ownership and Privacy:

- Along with AI agriculture accumulating much farm data, data control and possible misuse have become a serious concern. Farmers might restrict their data sharing out of worry about data privacy and unauthorized access to their data by somebody else.
- Establish transparent data ownership rights; farmers have the right to own their data. Develop rigorous data security procedures and standards for ethical and responsible data gathering and processing.

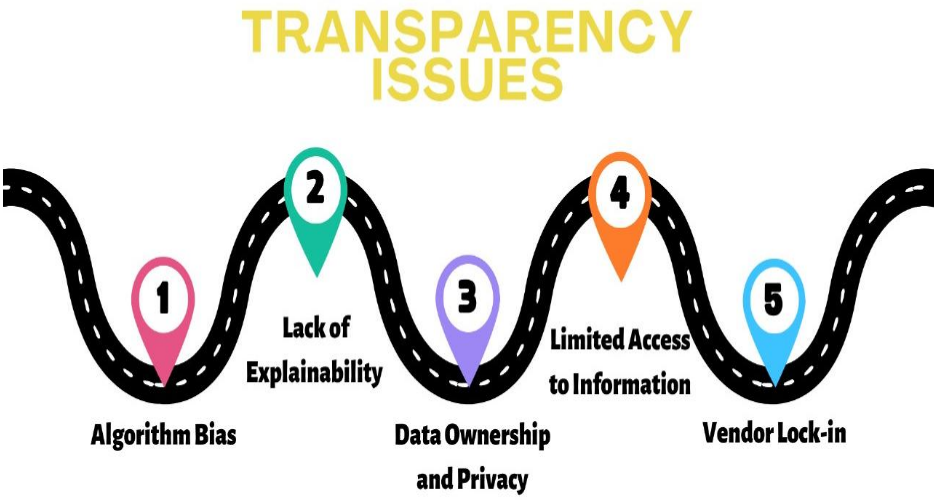

Fig 2. Transparency Issues of Artificial Intelligence in Agriculture

Fig-2, in short illustration, depicts bias in algorithms, vendor lock-in practices, limited access to databases and general information, and more generally considered transparency issues.

4. Limited Access to Information:

- Farmers, especially in developing countries, can have limited knowledge of AI models, working mechanisms, or the data sets they use. Such a knowledge gap can be a watershed to their abilities to make rational choices about technology employment.
- Through open communication and educational campaigns. It is essential to make available resources that explain AI applications in agriculture, including data practices, benefits, and drawbacks.

5. Vendor Lock-in:

- Too much dependence on particular AI vendors may limit farmers' options, resulting in huge prices and a scarcity of choices.

- Promote open-sourced AI solutions and let them communicate with each other easily. This results in a competitive market where the farmers have more power, quality, and quantitative options [12].

7. Scalability Issues

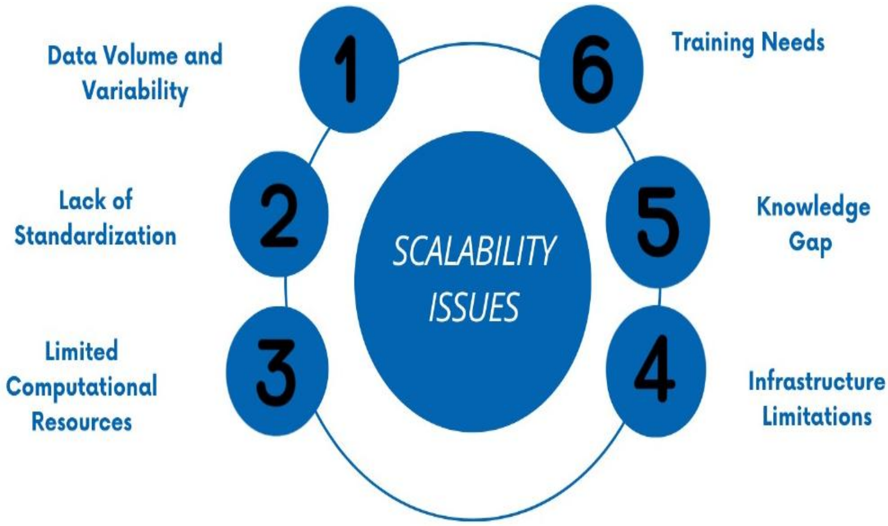

Fig 3. Scalability Issues of Artificial Intelligence in Agriculture

Scalability issues can arise in different scenarios as shown in figure 3. The following issues are scalability: Data volume and variability, lack of standardization, limited computational resources, infrastructure limitation, knowledge gap and required training.

1. Data Volume and Variability:

- The vastness and acknowledged variability of agricultural data create difficulties. Weather fluctuations, soil, and crop conditions generate massive data diversity among regions and even in farm fields.
- Create AI models capable of learning from smaller datasets and adjusting to local conditions. Apply transfer learning strategies, which involve fine-tuning pre-trained models on-farm data, thus minimizing the need for massive datasets.

2. Lack of Standardization:

- How data is collected frequently differs among farms, resulting in inconsistencies that affect the accuracy of machine-learning models designed for farm-scale deployment.
- Establish uniform data collection procedures and protocols. Support common databases and APIs for easy data sharing and use among farms and areas.

3. Limited Computational Resources:

- Complex AI algorithms consume a huge amount of computing power, which can be problematic for small farmers and those in regions with limited access to advanced computing facilities.
- Investigate cloud computing and edge computing modules for AI applications in agriculture. Cloud computing enables access to computer power resources without making huge on-farm infrastructure investments. With edge computing, data can be processed near its source rather than relying on a central server, leading to better optimization.

4. Infrastructure Limitations:

- The use of AI mostly depends on infrastructural strength, such as the availability of strong Internet connections and the latest technology, which is mostly lacking in remote areas.
- Spend on developing internet coverage and developing offline AI applications that do not require an internet connection. Perform studies about employing low-power and low-bandwidth AI models that can run on devices with limited resources.

5. Knowledge Gap and Training Needs:

- Assimilating the AI at the plot level, the digger men should have basic knowledge about the technology and its usage. A huge lack of knowledge and skills will prevent users from using AI systems effectively.
- Design courses for farmers and educate them on different farming areas, farming methods, and how to start a farm. Let farmers have knowledge, resources, and tools that enable them to understand how AI works in the agriculture sector and incorporate farming operations [11-12].

8. Security Issues

1. Cyberattacks and Data Breaches:

- It is important to realize that agricultural AI systems are heavily data-dependent, making them easily hackable. Hackers can cause a lot of trouble with this data, such as stealing sensitive information, interrupting operations, or even manipulating recommendation systems for malicious behavior.
- Establish powerful cyber security processes such as firewalls, data encryption, and regular security audits. Safe data deposit and access are very important to avoid unauthorized access.

2. Model Tampering and Manipulation:

- AI models can be at risk for manipulation by an attacker who can insert destructive code or tamper with the training data to bias the model's outputs. The results could affect the recommendations that farmers receive or even the manipulation of agricultural processes that would be to their own advantage.
- Employ techniques such as continuous monitoring and anomaly detection to detect any difference in model performance. Implementing secure programming principles and models' verification processes are the inseparable components of stopping hacking.

3. Insider Threats:

- Authorized malicious actors with access to an AI system can quite easily misuse their permissions, for example, to steal data, hinder operations, and mislead model outputs.
- Lay down robust access control rules and enforce the principle of least privilege; let users access the system only for tasks that they perform. The most important factor is the security awareness training for personnel that involves handling agronomic data.

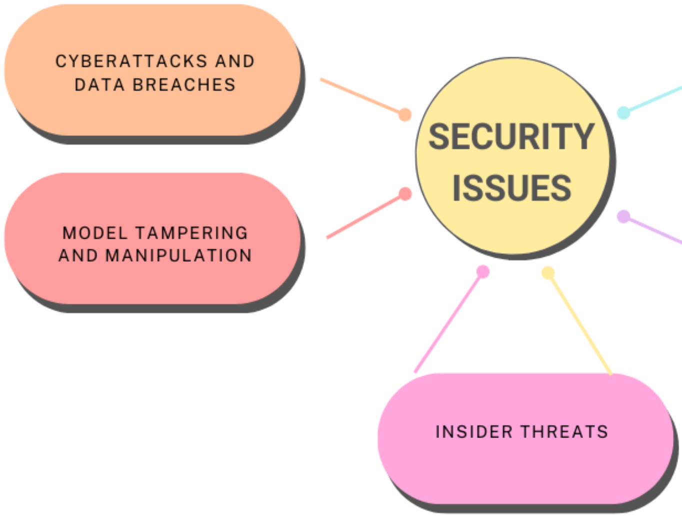

Fig 4. Security Issues of Artificial Intelligence in Agriculture

Fig-4 illustrates critical issues: cyber-attacks, Data breaches, physical security, model tampering, wrong manipulation, and new threats that can evolve as technology develops. Insider threats can also leave holes in the castle.

4. Physical Security of Sensors and Devices:

- AI in agriculture usually operates on a network of sensors and devices scattered across the fields. These physical modes could be susceptible to interference or altering, making the collected data unreliable and unsafe.
- Implement physical security measures like tamper-recognizable seals and restricted access controls for essential hardware components. Frequently evaluate sensors and devices for any indication of malicious intrusion or tampering.

5. Evolving Threat Landscape:

- Cybersecurity threats change constantly; hence, ongoing threat monitoring and adjustments are critical. Novel vulnerabilities could emerge, while the security measures in place now could become outdated over time.
- They stay informed about the newest cybersecurity threats and practice preventive security approaches. Frequently refresh software and firmware for AI apparatus and their associated devices. Invest in recurrent security assessment and penetration testing to identify possible weak points [12].

9. Advantages& Disadvantages

9.1. Advantages

1. **Precision in Farming:**
   AI allows farmers to maximize resource utilization by implementing precise and continuous monitoring of crops and thereby monitoring them at a constant rate. This makes it easier for farmers to screen and manage their availability of sources such as water, pesticides, fertilizers, seeds, and so forth. The precise decision-making capability of AI algorithms can make farmer-supportive and reliable decisions.
2. **Crop Health Monitoring:**
   Relentless work in fields and impromptu decisions regarding their livelihood make it hard for farmers to keep an eye on the plants and their conditions. This can be balanced by using AI-powered drones and sensors to detect many hard and time-bound tasks, such as crop diseases, pest control, and nutrient deficiency management, and taking in-time damage prevention measures.
3. **Yield Prediction:**
   Algorithms powered by artificial intelligence can predict the myriad metrics that affect crop yield. These algorithms can analyze various data inputs, such as changing weather conditions, historical data, soil nutrition levels, groundwater levels, etc., and predict crop yield based on the results. Regular changes in weather conditions, soil health, seasonal crops, and regional crops can also influence crop yield.
4. **Automation:**
   Farmers with larger areas face problems managing various aspects like labor, sowing seeds, de-weeding, planting, and more. AI-powered machinery and robots will automate such labor-intensive tasks, reducing labor costs and increasing efficiency. This will help farmers better manage and monitor their fields and progress for better profits and yields.
5. **Decision Support System:**
   AI systems can analyse vast data and make predictions that help farmers make decisions about support tools. These systems can provide farmers with real-time recommendations on plant scheduling, irrigation timings, crop management, pest control, yielding techniques, and patterns. In addition to prediction, they can also coordinate with the farmers' decisions.

9.2. Disadvantages

1. **Implementation Cost:**
   Implementing AI technology in agriculture requires considerable resources. Significant investments in infrastructure, equipment, training personnel, and integration with existing systems will be necessary. Therefore, obtaining additional funding is crucial to guaranteeing the successful implementation of this technology.
2. **Data Privacy and Security:**
   AI algorithms and systems use vast data to analyze and give results. This raises many privacy concerns regarding data security, potential misuse, and safety hazards. Since the data can include regional minerals present in the soil, historical data on agricultural fields, weather conditions, farmers' economics, and more, it can be useful for competitors and traders to use against farmers for their benefit.
3. **Dependency on Technology:**
   Highly reliant on AI technology may deprave traditional farming practices. Traditional farming knowledge and skills may be at stake for the overuse of AI-powered technology. Of course, using the latest tech to improve farming is a profitable task, but it may inflict a fatal blow on true and best agriculture.
4. **Regional Accessibility:**
   Despite Artificial Intelligence being the most widely used technology, accessing such advanced knowledge may be difficult for small-scale farmers and farmers living in rural areas where farming is the primary practice and with limited communication with global trading. Implementing AI technology in remote areas is difficult because of a lack of infrastructure, limited technical expertise, cost barriers, etc.
5. **Job Displacement and Ethical Concerns:**
   More implementation of AI in such sectors proves to farmers that it would be easier for them to use it more. This results in reduced human labor and fewer opportunities for farming-related activities. However, artificial intelligence can only sometimes be highly reliable. Unlike humans, farmers cannot

learn and understand AI's behaviour, which makes farmers choose between humans and artificial intelligence.

10. Applications

1. **Crop Management and Monitoring:**
   Artificial Intelligence has motivated many domains. It is being implemented in various sectors, creating drones, satellites, sensors, and such advanced machinery that helps in agricultural automation. These tech tools can continuously monitor the plants and predict their health, growth rate, and yield. A system presented to improve the profit rates in such fields, i.e., Precision Crop Management (PCM), which helps increase agricultural production by optimizing practices and protecting the environment [13].
2. **Farmers' Guiders:**
   Artificial Intelligence can communicate with humans and possess human-like behavior. This is accomplished through a process known as Cognitive Modeling, where an AI model is created to behave like a human [14]. This way, the farmers can communicate with AI to seek suggestions and keep themselves updated using the AI-powered chatbot technology. These chatbots are also known as virtual assistants, which are trained by machine learning techniques for their better interaction with humans [15].
3. **Weather Forecasting:**
   Training AI models with the previous regional weather data enable it to make even more precise weather predictions, which helps the farmers make decisions regarding planting and harvesting dates. The best example would be Google's DeepMind AI model, where 32 computers were trained for nearly 4 weeks, using 40 years of historical weather data. This made an ideal AI mode for weather forecasting that could predict the weather 10 days prior [16-18].
4. **Supply Chain Optimisation:**
   Improving efficiency and reducing food wastage while managing inventory is easier if we use AI algorithms to analyze and optimize supply chain logistics among distributed trading systems. Integrating these algorithms with ML models and IoT hardware to make the work easier and highly automated is also possible.
5. **Humanoid Farming:**
   Many countries plan to implement robotic farming with better chances of producing higher profits. Farmers are made to work in the field, and they fight tooth and nail with the circumstances to get their desired yield, making them more exhausted and weaker daily. AI-powered tools such as drones and automated machines like tractors and harvesters can perform aerial monitoring and imaging, planting, and harvesting to simplify farming processes.

11. Future Directions

1. **Autonomous Farming Systems:**
   Implementing autonomous farming systems that are AI-driven will engage fully automated agricultural operations, covering everything from planting and harvesting to packaging and delivering. Robotic drones for pest and plant health monitoring are better examples of such systems. However, covering all the available agricultural geographical areas will take time.
2. **Sustainable Agriculture:**
   Using AI algorithms and models in agriculture will improve the prediction capabilities and ability to make quality suggestions regarding sustainable agricultural practices such as organic farming, regenerative farming, and agroecology. By this, human-friendly AI will have better chances to work alongside farmers in better crop yields.
3. **Resilient Climatic Analysis:**
   AI models efficiently specify the short-term future scope of agriculture by analyzing the weather. The future scope of artificial intelligence in weather prediction and climatic analysis is predicting future weather conditions by analyzing vast datasets of regional historical weather data, which is now under implementation.
4. **Personalized Farming Solutions:**
   Introducing personal AI assistants for farmers helps them get better recommendations based on various parameters, such as personal crop preferences, farmer's financial capacity, soil health conditions, geographical structure, regional climatic changes, and many others. The best implementation would be AI chatbots and automated machinery, such as drones.
5. **Integration and Collaboration:**

AI works well with the available technology. However, this makes it a non-collaborative technology, which will have many adverse effects on its usage and reliability. So, the current focus is on interoperability. This interoperability allows the AI system to perform collaborative operations, such as data sharing between multi-stakeholders, farmers, researchers, policymakers, and technology developers.

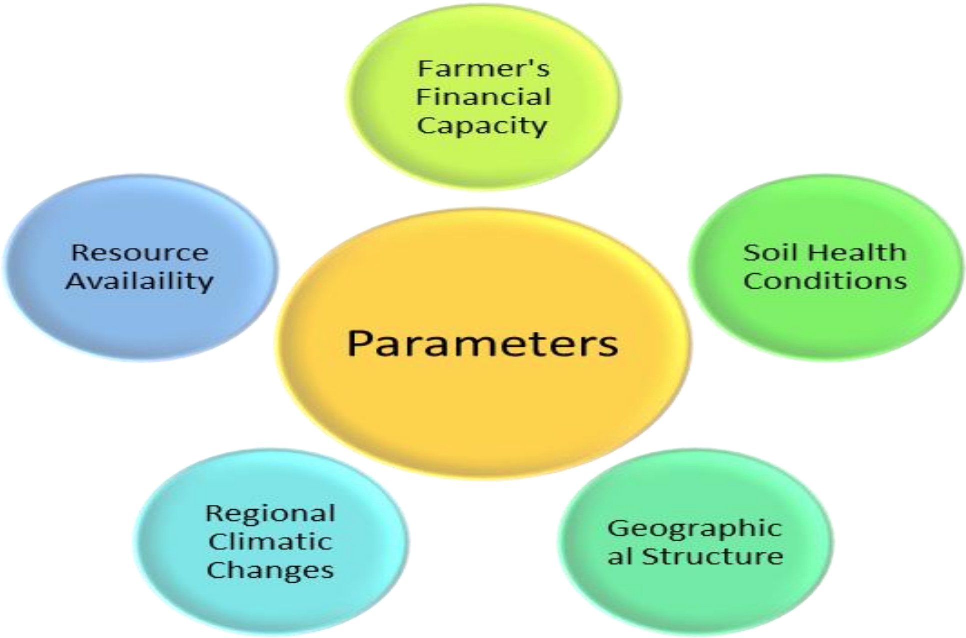

Fig 5. Parameters considered for personalized recommendations

Fig-5 demonstrates the parameters the AI models consider in training datasets to provide better recommendations for farmers and users. Since the AI assistant model analyses the scenario at hand and the various metrics involved in it, these recommendations will be personalized and specialized for the given situation.

12. Algorithms

We have discussed the algorithms of artificial intelligence in agriculture:

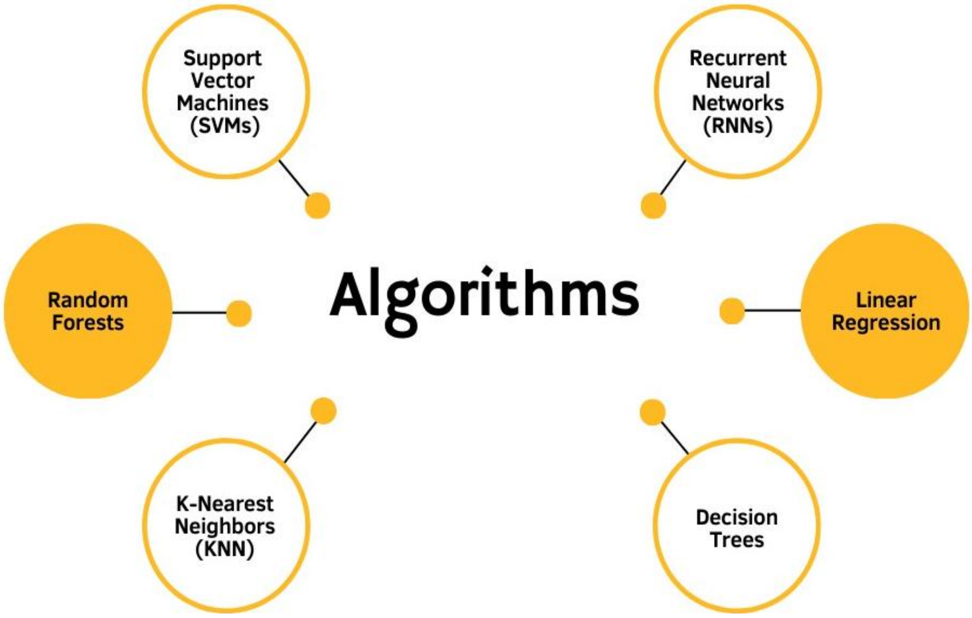

Fig 6. Algorithms of Artificial Intelligence in Agriculture

As artificial intelligence is mainly based on training and analysis, many algorithms are featured for that specific purpose. Fig. 6 specifies such algorithms. Table 1 elaborates on each algorithm specified in Fig. 6 and describes its various aspects.

Table 1. Algorithms of AI in Agriculture [19-21]

Algorithm: Support Vector Machines (SVMs)	
Description	This method combines different data sets by identifying the most accurate decision boundary that can effectively separate the interest categories.
Use cases	**Disease and Pest Detection:** SVM algorithms are good at building patterns from image data. These cultural media are used to spot diseases on crops by their visual attributes.
Real-Life Examples	**Plant Village:** The farmer can take images and send them to the open-source platform with SVMs. It will help the respective SVM classify various crop diseases that are occurring.
Algorithm: Random Forest	
Description	**Random Forest:** The ensemble approach is a combined decision tree method that improves accuracy and reduces overfitting.
Use cases	**Yield Prediction:** Random forests may be the ideal candidates for forecasting crop output, considering factors such as rainfall, soil conditions, and historical data.
Real-Life Examples	**The Climate Corporation:** Random Forests employs the platform to create personalized yield prediction models, enabling farmers, investors, and others similarly involved to lay a better road map of resource allocation.
Algorithm: K-Nearest Neighbors (KNN)	
Description	When data points are categorized based on a predefined number of immediate neighbors (K), they are cited as K-nearest neighbors.
Use cases	**Weed Identification and Control:** KNN algorithms rely on sensor data from the farmland's resources to determine weeds' locations. This type of spraying ensures resource conservation and makes the environment safe for animals, plants, and insects.
Real-Life Examples	**Precision Planting:** Uses knowledge about KNN sprays in its innovative sprayers for 90% chemical herbicide reduction.
Algorithm: Recurrent Neural Networks (RNNs)	
Description	A methodological procedure that can take data and reveal trends to us using a time coefficient.
Use cases	**Weather Prediction and Crop Yield Forecasting:** RNNs analyze historical weather data to predict how the weather pattern will change and its possible influence on crop yield.
Real-Life Examples	**IBM Research:** Attempts to use RNNs for data mining in historical weather, predict crop yields, make resource allocation plans, and reduce the risk that weather fluctuations may bring.
Algorithm: Linear Regression	
Description	Explains relationships in a linear manner (variables are linked).
Use cases	**Irrigation Management:** The linear regression models use sensor information, including factors like soil moisture and weather conditions, to plan the right irrigation schedules.
Real-Life Examples	**Granular.ai incorporates:** linear regression of farm data to instantly produce drip irrigation schedules that save water and improve crop health.
Algorithm: Decision Trees	
Description	Tree-structured type models conclude out of intent based on a line of decisions established in advance.
Use cases	**Crop Risk Assessment:** Decision trees fall into the category of models that can be designed to consider different factors to predict whether an extreme weather event will cause crop failure or not.
Real-Life Examples	**The World Bank** implemented a mechanism involving the use of decision trees, which helped determine areas likely to be affected by crop failure. Hence, the planning and implementation of localized interventions and programmers.

13. CONCLUSION

The integration of Artificial Intelligence with agriculture is a milestone in the culture of food production, which mainly aims to increase global food stocks while providing farmers with better yields and reasonable prices for the harvest. It has become the mission of many professional AI developers, and has made a clear vision of implementing it in distinct sectors. It is not only for multi-sector implementation but also to bring sustainable and eco-friendly agricultural practices while maintaining food security and shaping the future of agriculture.

Since artificial intelligence is one of the trending technologies, it paved its way and was entrusted with many roles by myriad people, consequently increasing its opportunities in multiple domains. Especially in agriculture, it possesses many opportunities in this sector. However, many challenges are involved in achieving the collaborative domain. Some such challenges are transparency issues and scalability issues. Transparency Issues deal with people's concerns about data privacy and its cybersecurity risks. In contrast, Scalability Issues deal with the metrics that are affected by the demand and usage of it.

By the way, this implementation involves both advantages and disadvantages. Advantages mainly support the users and farmers, while disadvantages concentrate on the general cons of artificial intelligence that need to be dealt with. The advantages and opportunities lead this AI to gain many applications in the agricultural sector, thereby increasing its future scope. The future scope of Artificial Intelligence in agriculture depends on the rapid rectification of its issues and disadvantages.

AI contains efficient algorithms developed by many scientists and research scholars to improve agriculture. Overall, it concludes that AI is a promising technology and building an interoperable hybrid system using it to improve agricultural practices while being useful for farmers and users. Utilizing the ultimate power of artificial intelligence in the agriculture sector enhances crop production and environmental stability.

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