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Advance agriculture system using artificial intelligence: Way towards future farming

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Abstract

This study explores the revolutionary field of advanced AI-driven agriculture, integrating cutting-edge technologies to improve farming methods. First, electromagnetic waves are used to control and repel insects in an environmentally benign manner. Second, a cutting-edge strategy uses a wind blower mechanism to successfully attack pests. Thirdly, a voice-activated, remote-controlled, autonomous smart solar-powered 4-wheel drive vehicle revolutionizes farming operations such as seeding, watering, applying fertilizer, and labouring on the field. Last but not least, a solar-powered grass cutter that can be used in voice, remote, and autonomous modes improve the effectiveness of maintaining the lawn. The precision, sustainability, and productivity that AI enables in agriculture are highlighted by these combined developments. This holistic strategy leads to an adaptive and responsive agricultural ecosystem, ready to fulfil global food demands, through the convergence of AI and technology.

Keywords: Artificial intelligence, advanced farming, remote control, solar power

Introduction

It is a critical challenge to address the growing demand for food while also ensuring sustainability and minimizing environmental impact. Both options you mentioned, expanding agricultural land and leveraging technology for increased productivity, have their merits and drawbacks. Expanding agricultural land can lead to deforestation and habitat destruction, exacerbating climate change and biodiversity loss. On the other hand, using technology to enhance productivity on existing farmland can help mitigate these issues by maximizing the efficiency of land use (Gandhi *et al.*, 2020; Ahir *et al.*, 2020) ^[4, 5]. Technologies like precision agriculture, drones, sensors, and AI-driven analytics offer promising solutions to optimize resource allocation, minimize waste, and improve crop yields. However, you're right that adoption rates of these technologies vary among farmers and agribusinesses. Factors such as cost, access to technology, knowledge gaps, and infrastructure limitations can hinder widespread adoption. Efforts to bridge these gaps through education, training, and incentivizing technology adoption are essential to ensure that all farmers can benefit from the latest advancements. Moreover, it's crucial to develop AI solutions tailored to the specific needs and challenges of agriculture, taking into account factors like local climate, soil conditions, and crop types. Collaborative efforts between researchers, technology developers, policymakers, and agricultural stakeholders are necessary to drive innovation and promote sustainable practices in modern agriculture (Puri *et al.*, 2017) ^[3].

Role of AI in Agriculture

Sustainable agriculture is a complex issue that requires a

multifaceted approach. Balancing the need to increase food production with environmental conservation is crucial for the long-term health of our planet. By emphasizing the use of technology to improve productivity on existing farmland, we can minimize the pressure to expand into natural habitats. Precision agriculture, for example, allows farmers to optimize inputs such as water, fertilizers, and pesticides, reducing waste and environmental impact. Drones and sensors can provide valuable data on soil health, crop growth, and pest infestations, enabling farmers to make informed decisions in real time. However, as you mentioned, addressing barriers to technology adoption is essential to ensure that these tools reach their full potential. Investing in education and training programs can empower farmers to effectively utilize new technologies, while policies that incentivize sustainable practices can encourage widespread adoption. Furthermore, developing AI solutions tailored to the specific needs of agriculture holds great promise for addressing challenges such as climate change and soil degradation. By harnessing the power of AI-driven analytics, farmers can gain insights into complex agricultural systems and make data-driven decisions to improve efficiency and sustainability.

Overall, collaboration among various stakeholders is key to driving innovation and promoting sustainable practices in modern agriculture. By working together, we can develop solutions that meet the growing demand for food while safeguarding the environment for future generations.

Challenges faced by farmers using traditional methods

Farmers using traditional methods of farming face a multitude of challenges, many of which can impact their livelihoods and the sustainability of their operations. Some

of these challenges include:

- a) **Low Productivity:** Traditional farming methods often rely on manual labor and outdated techniques, resulting in lower yields compared to modern agricultural practices. This can limit farmers' ability to meet the increasing demand for food.
- b) **Limited Access to Resources:** Traditional farmers may have limited access to essential resources such as improved seeds, fertilizers, and irrigation systems. This can restrict their ability to maximize crop yields and adapt to changing environmental conditions.
- c) **Vulnerability to Climate Change:** Traditional farming practices are often more susceptible to the impacts of climate change, such as droughts, floods, and extreme weather events. Without access to technology and resources to mitigate these risks, farmers may struggle to maintain consistent yields.
- d) **Soil Degradation:** Continuous use of traditional farming methods without proper soil management practices can lead to soil degradation, loss of fertility, and erosion. This not only reduces crop yields but also contributes to environmental degradation.
- e) **Pest and Disease Management:** Traditional farming methods may lack effective pest and disease management strategies, leading to crop losses and decreased profitability. Without access to modern pesticides and disease-resistant crop varieties, farmers may struggle to protect their crops.
- f) **Market Access and Pricing:** Traditional farmers often face challenges in accessing markets and obtaining fair prices for their produce. Lack of transportation infrastructure, market information, and bargaining power can hinder their ability to sell their products profitably.
- g) **Labor Intensiveness:** Traditional farming methods typically require a significant amount of manual labour, which can be physically demanding and time-consuming. As labor becomes scarcer and more expensive, this can further exacerbate the challenges faced by traditional farmers.
- h) **Lack of Knowledge and Training:** Many traditional farmers lack access to formal education and training opportunities, which can prevent them from adopting more sustainable and efficient farming practices. Improving access to extension services and agricultural training can help address this challenge.

Addressing these challenges requires a holistic approach that combines technological innovation, access to resources and markets, capacity building, and policy support. By empowering traditional farmers with the tools and knowledge they need, we can help ensure the sustainability and resilience of agricultural systems worldwide.

Applications of Artificial Intelligence in Agriculture

AI-powered technologies such as drones, satellite imagery, and sensors enable farmers to collect detailed data on soil conditions, crop health, and weather patterns. This data can be analyzed to optimize inputs like water, fertilizers, and pesticides, leading to more targeted and efficient farming practices.

Weather forecasting: Improved Accuracy: AI algorithms analyze vast amounts of historical weather data, satellite imagery, and atmospheric models to generate highly accurate forecasts. These forecasts take into account local microclimates and topographical features, providing farmers with precise information about weather conditions in their specific location.

1. **Advanced Predictive Models:** AI techniques such as machine learning enable the development of advanced predictive models that can forecast weather patterns days or even weeks in advance. This long-range forecasting helps farmers plan their planting and harvesting schedules, mitigate the risk of weather-related disasters, and optimize resource allocation.
2. **Customized Recommendations:** AI-powered weather forecasting platforms can provide customized recommendations based on the specific needs of each farm. Farmers can input parameters such as crop type, soil type, and irrigation practices, allowing the system to tailor its forecasts and recommendations accordingly.
3. **Real-Time Monitoring:** AI algorithms continuously analyze incoming weather data in real time, providing farmers with up-to-the-minute updates on changing weather conditions. This real-time monitoring allows farmers to respond quickly to sudden changes in weather, such as storms or temperature fluctuations, minimizing the impact on crops.
4. **Risk Management:** By leveraging AI-powered weather forecasting, farmers can better manage risks associated with climate variability and extreme weather events. For example, they can adjust planting dates or switch to more resilient crop varieties in response to forecasted droughts or floods, reducing the likelihood of crop failures.
5. **Optimized Resource Use:** Accurate weather forecasts enable farmers to optimize the use of resources such as water, fertilizers, and pesticides. By aligning irrigation schedules with forecasted rainfall and adjusting fertilizer applications based on expected temperature and humidity levels, farmers can minimize waste and maximize crop yields.

Analyzing Crop Health by Drones: Drone-based aerial imaging solutions represent a significant advancement in precision agriculture, offering farmers valuable insights into crop health and enabling timely interventions to optimize yields and minimize losses

Data Capture: Drones equipped with high-resolution cameras capture aerial imagery of the fields, providing detailed visual information about crop health, growth patterns, and potential stressors such as pests, diseases, or nutrient deficiencies.

Data Analysis: The captured imagery is then transferred from the drone to a computer, where sophisticated algorithms developed by SkySquirrel Technologies analyze the data. These algorithms use machine learning techniques to identify and quantify various indicators of crop health, such as leaf color, canopy density, and vegetation indices.

i. Detailed Reports: Based on the analysis, SkySquirrel Technologies generates detailed reports that provide farmers with actionable insights into the current health status of their crops. These reports may include recommendations for pest control measures, irrigation scheduling, nutrient management, and other agronomic practices tailored to the specific needs of each farm.

Timely Interventions: By providing timely information about potential threats to crop health, such as pest infestations or disease outbreaks, SkySquirrel's drone-based imaging solutions enable farmers to take proactive measures to mitigate risks and protect their crops. This may involve targeted application of pesticides or biological control agents, adjusting irrigation levels, or implementing cultural practices to improve crop resilience.

Precision Farming and Predictive Analytics

i. Water Management: AI-enabled systems analyze data from sensors, satellites, and weather forecasts to provide real-time information on soil moisture levels and crop water requirements. This allows farmers to optimize irrigation scheduling, reduce water usage, and mitigate the risk of water stress in crops.

ii. Crop Rotation and Management: AI algorithms analyze historical data on crop performance, soil health, and environmental conditions to recommend optimal crop rotation strategies. By rotating crops strategically, farmers can improve soil fertility, reduce pest and disease pressure, and increase overall farm productivity.

iii. Timely Harvesting and Planting: AI-driven predictive analytics utilize historical weather data and machine learning algorithms to forecast optimal planting and harvesting times. By timing planting and harvesting activities more accurately, farmers can maximize crop yields and quality while minimizing losses due to weather-related risks.

iv. Pest and Disease Management: AI-powered image analysis tools, combined with data from drones and satellites, can detect early signs of pest infestations, diseases, and nutrient deficiencies in crops. By identifying these issues early, farmers can take timely action to mitigate their impact, whether through targeted pesticide applications, crop rotation, or other management practices.

v. Nutrition Management: AI algorithms analyze soil and plant data to provide personalized recommendations for nutrient management, including fertilizer application rates and timing. By optimizing nutrient inputs based on crop needs and soil conditions, farmers can improve crop health, reduce nutrient runoff, and enhance overall farm sustainability.

vi. Weather Prediction and Risk Assessment: AI-driven weather forecasting models analyze data from satellites, weather stations, and historical weather patterns to predict future weather conditions with greater accuracy. These forecasts help farmers anticipate risks such as droughts, floods, or extreme temperatures, allowing them to

implement proactive measures to protect their crops and minimize losses.

By harnessing the power of AI and predictive analytics, farmers can make more informed decisions, optimize resource use, and improve overall farm productivity and sustainability. As these technologies continue to evolve and become more accessible, they have the potential to revolutionize agriculture and help feed a growing global population while minimizing environmental impact.

Agricultural robotics

Agricultural robotics represents a significant advancement in modern farming practices, offering automation and efficiency in various tasks traditionally performed by humans. Here's how AI-powered robots are transforming agriculture:

i. Weed Control: AI-driven robots equipped with cameras and sensors can identify and target weeds with precision, allowing for targeted herbicide application or mechanical removal (Tang *et al.*, 2000) [2]. By selectively targeting weeds while minimizing damage to crops, these robots help reduce the need for herbicides and manual labor, improving overall farm sustainability.

ii. Crop Harvesting: AI-enabled robots are capable of harvesting crops with speed and accuracy, reducing reliance on manual labor and addressing labor shortages in the agricultural sector. These robots use computer vision and machine learning algorithms to identify ripe produce, pick them gently without damaging the crops, and pack them for transportation.

iii. Crop Quality Assessment: Robots equipped with advanced sensors and AI algorithms can assess the quality of crops by analyzing factors such as size, color, and ripeness. By automating quality assessment tasks, these robots help ensure consistent product quality and reduce waste in the supply chain.

iv. Multi-Tasking Capabilities: Some agricultural robots are designed to perform multiple tasks simultaneously, such as weed detection, harvesting, and packing. By integrating various functionalities into a single robotic platform, farmers can streamline operations, reduce equipment costs, and increase overall efficiency.

v. Labor Force Challenges: Agricultural robots help address challenges related to labor availability and cost by automating repetitive and physically demanding tasks. With the global agricultural workforce shrinking and labor costs rising, robots offer a viable solution to maintain productivity and competitiveness in the industry.

vi. Adaptability and Scalability: AI-powered robots can adapt to different crops, field conditions, and farming practices, making them versatile tools for a wide range of agricultural applications. Whether it's row crops, orchards, or greenhouse operations, robotic systems can be customized and scaled to meet the specific needs of each farm.

Overall, agricultural robotics powered by AI technology offer immense potential to revolutionize the way crops are grown, harvested, and managed. By increasing automation, efficiency, and precision in farming operations, these robots help farmers improve productivity, reduce labour costs, and promote sustainable agriculture practices. As technology continues to advance, we can expect to see even greater innovations in the field of agricultural robotics in the years to come.

AI based pest management

AI-enabled systems for pest detection are proving to be invaluable tools for farmers in the battle against crop pests. By leveraging satellite imagery, historical data, and advanced AI algorithms, these systems can accurately identify and monitor pest activity in agricultural fields. Here's how they work:

i. Satellite Imagery: AI systems utilize high-resolution satellite imagery to capture detailed images of agricultural fields. These images provide valuable information about crop health, growth patterns, and potential pest infestations.

ii. Data Analysis: AI algorithms analyze the satellite imagery, looking for signs of pest activity such as changes in crop color, texture, or patterns. By comparing current images with historical data, the system can detect anomalies and identify areas where pest infestations are likely to occur.

iii. Pest Identification: AI algorithms can classify pests based on their appearance and behavior, distinguishing between different types of insects such as locusts, grasshoppers, or aphids. By accurately identifying the type of pest present in the field, farmers can take targeted action to control their spread (Kakkad *et al.*, 2019) ^[1].

iv. Alert System: Once pests are detected, AI-enabled systems can send real-time alerts to farmers via their smartphones or other devices. These alerts provide farmers with timely information about the presence and severity of pest infestations, allowing them to take swift action to protect their crops.

v. Preventive Measures: Armed with information from AI-powered pest detection systems, farmers can implement preventive measures to minimize crop damage. This may include deploying traps, applying targeted pesticide treatments, or adjusting planting schedules to avoid peak pest activity periods.

vi. Integrated Pest Management: AI systems can also support integrated pest management (IPM) practices by providing farmers with data-driven insights into pest populations and trends over time. By combining chemical, biological, and cultural control methods, farmers can effectively manage pest populations while minimizing reliance on pesticides.

Overall, AI-enabled systems for pest detection offer farmers a powerful tool for proactive pest management, helping to reduce crop losses, minimize environmental impact, and improve overall farm productivity. As these technologies continue to evolve, we can expect to see even greater

advancements in the field of precision pest management in agriculture.

Conclusion

Artificial Intelligence (AI) is revolutionizing agriculture by enabling farmers to move towards precise and sustainable cultivation practices. By harnessing the power of AI, farmers can optimize resource use, increase crop yields, and improve overall farm productivity while minimizing environmental impact. AI technologies continue to evolve and become more accessible, we can expect to see further advancements in precision agriculture, leading to more efficient, sustainable, and resilient farming practices. By embracing AI, farmers and agricultural stakeholders can navigate the complexities of modern agriculture and contribute to a more food-secure future for all.

Reference

1. Kakkad V, Patel M, Shah M. Biometric authentication and image encryption for image security in cloud framework. *Multiscale and Multidiscip Model Exp and Des.* 2019;2:233-248. <https://doi.org/10.1007/s41939-019-00049-y>
2. Tang L, Tian L, Steward BL. Color image segmentation with genetic algorithm for in-field weed sensing. *Trans ASAE - Am Soc Agric Eng.* 2000;43:41019-41028.
3. Puri A, Nayyar L, Raja. Agriculture drones: a modern breakthrough in precision agriculture. *J Stat Manag Syst.* 2017;20(4):507-518.
4. Gandhi M, Kamdar J, Shah M. Preprocessing of non-symmetrical images for edge detection. *Augment Hum Res.* 2020;5:10. doi:10.1007/s41133-019-0030-5
5. Ahir K, Govani K, Gajera R, Shah M. Application on virtual reality for enhanced education learning, military training and sports. *Augment Hum Res.* 2020;5:7.
6. Tilman D, Balzer C, Hill J, Befort BL. Global food demand and the sustainable intensification of agriculture. *Proc Natl Acad Sci USA.* 2011;108(50):20260-20264.