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OPTIMIZATION OF SWEET CORN PRODUCTION USING ARTIFICIAL INTELLIGENCE

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Abstract. *The integration of artificial intelligence (AI) technologies in sweet corn cultivation (Zea mays saccharata) holds significant potential for enhancing production efficiency and resource management. This study explores the application of AI in various agricultural processes, including the use of computer vision and multispectral imaging for continuous crop monitoring, machine learning algorithms for yield prediction, precision agriculture for resource optimization, and autonomous systems to increase operational efficiency. The results demonstrate that AI enables early detection of crop stress, diseases, and pests, facilitating targeted interventions that improve crop quality and reduce costs. Moreover, AI-driven predictive analytics help mitigate climate-related risks, while decision support systems provide customized recommendations for optimizing agricultural practices. The widespread adoption of AI in sweet corn cultivation represents a strategic opportunity to increase the sustainability and competitiveness of this sector.*

Keywords: artificial intelligence, sweet corn, precision agriculture, crop monitoring, yield prediction.

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1. Introduction

Agricultural production is one of the essential economic sectors globally, playing a crucial role in ensuring food security. In this context, sweet corn (*Zea mays saccharata*) represents a crop of significant interest, both due to its nutritional value and the growing demand in the food product market. Given demographic trends and the need to meet increasingly high consumer demands, optimizing sweet corn production has become a strategic priority for both farmers and researchers.

In traditional sweet corn production, farmers face multiple challenges. Unpredictable climatic factors, the necessity for efficient resource management (such as water, fertilizers, and pesticides), and pest and disease control are just some of the variables that can negatively impact yield and crop quality.

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Additionally, agricultural market fluctuations and economic pressures require the adoption of innovative solutions to maximize productivity and minimize risks.

In recent years, technological advances have opened new horizons for optimizing agricultural production, and artificial intelligence (AI) has become a valuable tool in this regard. AI encompasses a set of technologies that enable machines to learn from data, recognize complex patterns, and make automated or semi-automated decisions. In agriculture, AI can be applied in numerous areas, from weather condition prediction and plant health monitoring to resource optimization and harvest process automation.

This article aims to explore the potential of using artificial intelligence technologies to optimize sweet corn production. Finally, the article will highlight AI's contributions to improving the efficiency and sustainability of sweet corn production.

2. Materials and methods

2.1 The use of artificial vision and multispectral imaging in crop monitoring

An essential aspect in optimizing sweet corn production is the continuous monitoring of plant health and growth conditions. Artificial vision tools, based on multispectral and hyperspectral images, can be used to detect plant stress, diseases, and pests. Figure 1.1 illustrates computer vision.

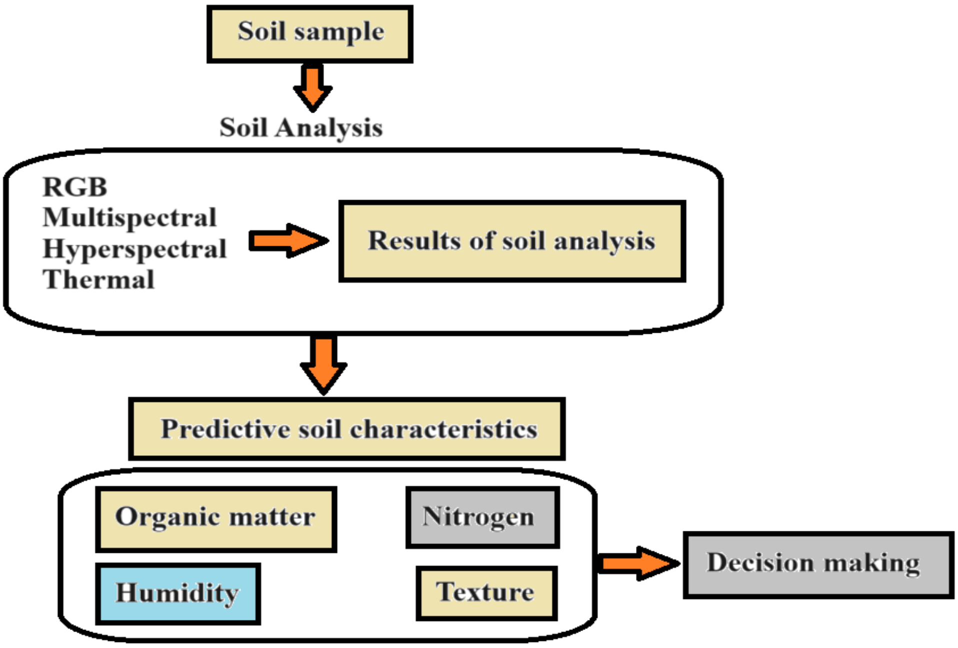

Figure 1.1 Computer vision (adapted after Ghazal, S., et al, 2024) [7].

Data is collected using drones or satellites equipped with specialized cameras, which capture images in the visible spectrum and beyond (infrared, ultraviolet). Analyzing these images allows for the early identification of issues and the application of precise treatments [7].

According to the article 'Computer vision in smart agriculture and precision farming: Techniques and applications' by Sumaira Ghazal, Arslan Munir, and Waqar S. Qureshi, computer vision can enhance sweet corn production through continuous monitoring of crop conditions, enabling early detection of stress, diseases, and pests. This allows for rapid and precise interventions, contributing to increased yield and crop quality [7].

The article emphasizes that using computer vision in smart agriculture enables the capture of detailed images that, when analyzed with AI technologies, help optimize treatment application processes, thereby reducing costs and environmental impact. Figure 1.2 illustrates a multispectral drone.
With the help of an agricultural drone, the farmer has the opportunity to spray 160 hectares in one day [2].

Figure 1.2 Multispectral vision drone
Source: Original photo.

2.2 Implementing Machine Learning algorithms for yield prediction

Machine learning algorithms are particularly valuable in agriculture due to their ability to learn from complex data and make precise predictions [1].
In the context of sweet corn cultivation, these algorithms can be trained on datasets that include information about climate conditions, soil type, resource management, and farming practices.

Based on insights from the article 'A proposed framework for crop yield prediction using hybrid feature selection approach and optimized machine learning' by Mahmoud Abdel-salam, Neeraj Kumar, and Shubham Mahajan, implementing artificial intelligence (AI) technologies in sweet corn production could bring multiple benefits, such as:

-Yield Prediction: Using an advanced yield prediction framework based on hybrid feature selection and optimized machine learning algorithms can improve the accuracy of sweet corn production estimates. This enables farmers to make more informed decisions on crop management by adjusting irrigation, fertilization, and pest control methods according to detailed forecasts [1].

-Optimized Feature Selection: Another benefit lies in the use of feature selection methods that remove redundant information from the agricultural dataset. This leads to a more efficient and accurate prediction model, which can support farmers in maximizing yield and reducing losses in sweet corn production [1].
Thus, the application of AI in agriculture, especially through the optimization of prediction models, can significantly contribute to improving production and resource management in sweet corn cultivation.

Based on this data, machine learning models can predict crop yield, allowing farmers to make informed decisions on the optimal timing for planting, irrigation, and harvesting.

2.3 Precision agriculture and resource optimization through artificial intelligence

Precision agriculture involves the application of resources (water, fertilizers, pesticides) based on the exact needs of the plants, identified through AI. Sensors placed in the soil and at the plant level collect data on moisture, nutrient levels, and other environmental conditions [9]. This data is processed by AI algorithms that generate variable rate application maps (Variable Rate Technology - VRT), accurately indicating where and in what quantity resources should be applied [6].

This method reduces waste, costs, and negative environmental impact while increasing the yield and quality of sweet corn [8]. Figure 1.3 illustrates precision agriculture with AI .

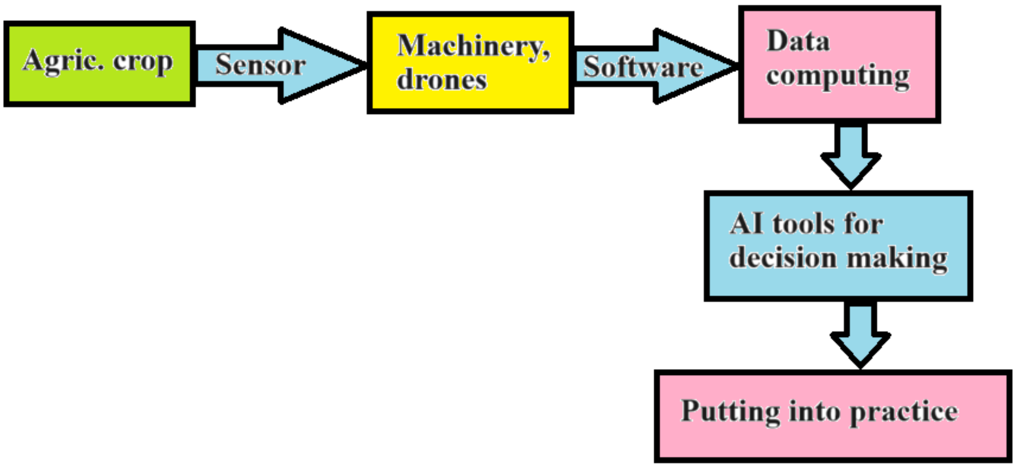

Figura 1.3 Precision agriculture with AI (adapted after Raman et al, 2024) [9].

2.4 Use of robots and autonomous systems in crop management

Agricultural robots and autonomous systems controlled by AI can perform important tasks in sweet corn cultivation, such as planting, weeding, and harvesting. These robots are equipped with sensors and artificial vision systems that enable them to navigate fields and carry out precise operations [5].

Based on information from the article 'Recent Advancements in Agriculture Robots: Benefits and Challenges' by Chao Cheng, Jun Fu, Hang Su, and Luquan Ren, integrating artificial intelligence (AI) technologies in sweet corn production can significantly improve the efficiency and sustainability of this process. AI can be used for monitoring and managing resources, thereby reducing pesticide overuse and optimizing irrigation, leading to higher production with a reduced environmental impact. Additionally, AI facilitates yield prediction and climate risk management, helping farmers make more informed decisions and maximize crop yields under varying conditions. These applications contribute to the sustainability and competitiveness of sweet corn production [5].

For example, weeding robots use AI to identify and eliminate weeds without affecting corn plants, thus helping to maintain an optimal growing environment.

2.5 Predictive analytics for climate and environmental risk management

Another powerful tool of AI is predictive analytics, which utilizes climate models and weather data to anticipate environmental changes and plan proactive measures in advance [10].

Based on information from the article 'Precision Agriculture and Predictive Analytics' by Nafees Akhter Farooqui, Mohd. Haleem, Wasim Khan, and Mohammad Ishrat, sweet corn production can significantly benefit from the innovations brought by predictive analytics and precision agriculture. Predictive analytics can help farmers anticipate future sweet corn yields through machine learning procedures, enabling them to optimally adjust resource allocation. This not only helps reduce costs through the efficient use of water, fertilizers, and other resources but also contributes to increased profitability by maximizing yield.

At the same time, precision agriculture provides farmers with access to advanced technologies such as sensors, GPS mapping, and data analysis, which allow for optimal management of sweet corn crops. By continuously monitoring soil conditions, moisture, fertilizer levels, and weather patterns, farmers can tailor agricultural practices to the specific needs of each field. This customized approach to crop management not only improves resource use efficiency but also contributes to increased production and reduced negative environmental impact [10].

For sweet corn cultivation, this type of analysis can inform farmers about periods of drought or excessive rainfall, allowing them to adapt agricultural practices to minimize losses and maximize yield. Figure 1.4 illustrates predictive analytics.

Figure 1.4 Predictive analytics [adapted after 10].

2.6 Decision support systems based on artificial intelligence

Decision support systems are information platforms that integrate multiple data sources and use AI to provide personalized recommendations to farmers. In the case of sweet corn, these systems can suggest the best times for applying treatments, the optimal time for harvesting, and can generate crop management scenarios based on predictive analyses of climate and soil conditions [3].

Based on information from the article 'Artificial intelligence-based decision support systems in smart agriculture: Bibliometric analysis for operational insights and future directions' by Arslan Yousa, Vahid Kayvanfar, Annamaria Mazzoni, and Adel Elomri, sweet corn production can significantly benefit from the use of advanced technologies such as Smart Agriculture and Precision Agriculture, which include the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML). These technologies enable precise monitoring of soil conditions, moisture, and other essential variables, thereby optimizing the use of resources such as water and fertilizers. Additionally, through the application of predictive analytics, farmers can anticipate future crop yields and adjust resource management strategies to maximize production and minimize losses. Thus, the integration of these innovations in sweet corn production contributes to increased efficiency and sustainability, while also ensuring better adaptation to climatic variables and challenges related to global food supply [4].
Figure 1.5 represents a decision support system.

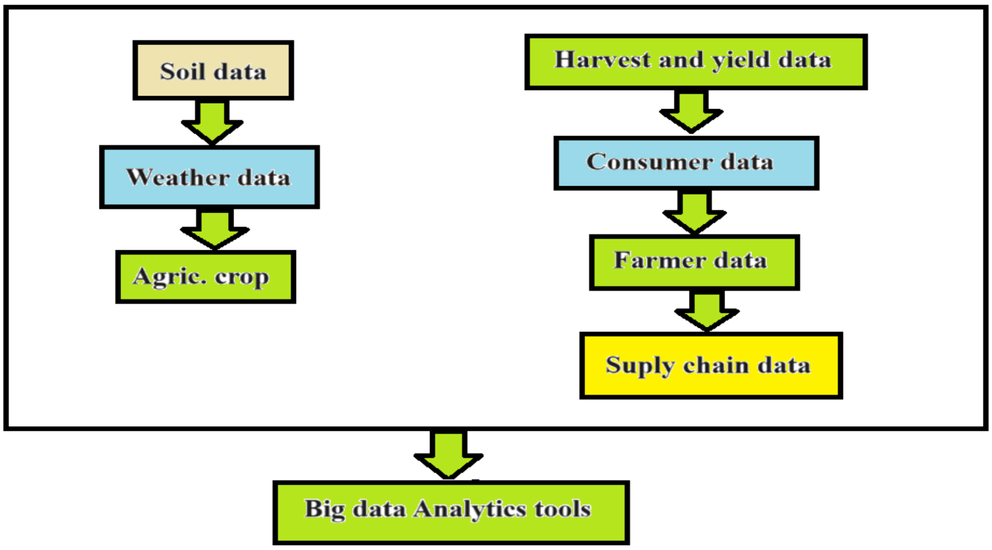

Figure 1.5 Decision support system (adapted after Bhat, 2021) [4].

3 Results and discussions

The implementation of artificial vision and multispectral imaging in monitoring sweet corn crops has demonstrated a significant impact on the ability to detect problems at early stages. By using drones and satellites to capture detailed images of fields, farmers have been able to intervene more quickly and effectively in addressing plant stress, diseases, and pest infestations. This approach has led to a reduction in losses and an increase in crop quality.

The use of machine learning algorithms for predicting sweet corn yields has shown high accuracy in forecasting outcomes under various environmental conditions. Predictive models have allowed farmers to adjust planting and resource management strategies based on climate forecasts and soil conditions.

The implementation of precision agriculture through AI technologies has resulted in a more efficient use of resources such as water, fertilizers, and pesticides. Sensors distributed across the fields have collected real-time data on soil moisture, nutrient levels, and other environmental conditions, and this data has been processed to generate variable rate application maps. This technology has enabled precise application of resources, avoiding overdosing and thereby reducing waste.
Agricultural robots and autonomous systems controlled by AI have demonstrated considerable potential in increasing the efficiency of agricultural operations. Planting and weeding robots have performed precise and repetitive tasks with minimal human intervention.

AI-based predictive analytics has played an important role in managing risks associated with climatic variability. The ability to anticipate unfavorable weather conditions has allowed farmers to implement protective and adaptive measures in advance.
AI-based decision support systems have shown the capacity to provide farmers with essential information for optimizing agricultural management. These platforms have integrated multiple data sources, including weather data, soil analyses, and plant health information, to offer personalized recommendations.

Conclusions

(1)The results obtained in this study demonstrate that the integration of artificial intelligence technologies in sweet corn cultivation can bring significant benefits, contributing to the optimization of production and the more efficient management of agricultural resources. The implementation of artificial vision and multispectral imaging has enabled precise and continuous monitoring of crop conditions, facilitating rapid and targeted interventions to combat stress, diseases, and pests, which has led to improved crop quality and reduced costs.

(2)The use of machine learning algorithms for yield prediction has demonstrated the capability of these technologies to guide farmers in making informed decisions by adjusting agricultural strategies based on weather and soil conditions. This has allowed for the minimization of losses and the optimization of yields, highlighting the effectiveness of AI in managing risks associated with climatic variability.

(3)Precision agriculture, supported by AI, has resulted in a more rational use of resources, reducing waste and the negative environmental impact, while agricultural robots and autonomous systems have increased the efficiency of agricultural operations by automating essential processes. Additionally, predictive analytics and AI-based decision support systems have provided farmers with valuable tools for proactive crop management, contributing to the maintenance of stability and productivity under variable conditions.

(4)In conclusion, the widespread adoption of AI technologies in sweet corn agriculture represents an important opportunity for increasing the sustainability and competitiveness of this sector.

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