

A Review of AI Based Decision Support Systems in Smart and Precision Agriculture

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Abstract--The paper is a review of intelligent decision support systems that are created to serve smart agriculture, especially the agentic AI-based advisory systems. The currently used methods, which assist in crop selection, market awareness, weather forecasting, and resource planning, are discussed in a systematic way. This analysis shows that the study has discovered the limitations of prediction-centric models that are becoming more critical and the growing necessity of real-time data aggregation, comparative intelligence, and contextual reasoning. These are needed to provide dynamic agricultural and market conditions with adaptive, practical, and farmer-centric decision support.

I. INTRODUCTION

The process of agricultural decision-making functions under a very dynamic and uncertain environment whilst results are determined by the interplay of the various factors like the climate variability, soil characteristics, specific requirements of the crops and ever changing market dynamics. These problems are compounded by scattered information in India, lack of access to timely advisories and reliance on experience driven practices, which mostly lead to suboptimal or delayed decision making.

Over the past few years, smart agricultural innovation has greatly enhanced access to agricultural information in terms of weather forecasting, soil and crop sensors, remote sensor and digital agricultural marketplace. Alongside, machine learning, data analytics, Internet of Things (IoT), and artificial intelligence methods are starting to be considered to facilitate planning, forecasting, and risk management in farming systems. But, limited is the translation of these technological advancements into unified and functional decision support.

The available agricultural decision support systems are most often concerned with the particular activities of crop selection, irrigation control, crop yield prediction, pest control, or market prices prediction. Despite the fact that such systems can deliver successful outcomes to very specific goals, they are typically in silos and are not designed to be cross-domain integrated, responsive in real-time, and aware of the situation. These constraints minimize their usefulness in practical field applications in agriculture, particularly in the Indian environment which is diverse with regards to the agro-climatic environments and resource endowment.

Considering the booming nature of intelligent agricultural advisory systems and the absence of coherent analytical evaluations, there is a definite necessity of systematic review of intelligent decision support systems. Such an overview will be able to judge

existing methodologies, data use plans, and architecture designs, and specify unresolved issues associated with scalability, flexibility, and user-oriented implementation.

In this light, the paper is a systematic review of smart agricultural intelligent decision support systems, specifically agentic AI inspired and data-oriented systems. Systems in place are categorized in terms of functional purposes, sources of data and decision making. The discussion identifies the existing weakness and provides a path forward to the creation of dependable integrated, real-time, and farmer-focused advisory measures. The rest of the paper will be structured in the following way- Section II will contain the background concepts, Section III will contain related work survey, and the comparison will be done, research gaps will be identified, and the research directions will be discussed.

II. BACKGROUND AND CORE CONCEPTS

Smart agriculture is the use of data-driven technologies to streamline the processes in agriculture by making informed decisions. It combines the heterogeneous sources of data like weather predictions, soil properties, crop traits and market data to tackle the uncertainties that prevail in the farming conditions.

Decision Support Systems (DSS) offer a systematic approach to the analysis of complex data and the creation of recommendations to be taken. DSS is especially useful in agriculture because the interdependence between climatic, biological, and economic aspects is dynamic. Intelligent Decision Support Systems can be seen as an extension of traditional DSS systems, where machines develop machine-learning and prediction capabilities to provide recommendations that are adaptive and context-specific according to the changes in data trends.

III. REVIEW METHODOLOGY

The review uses an analytical approach that aims at assessing the intelligent decision support systems in smart agriculture with special interest in the agentic and decision-oriented architectures. The systems that are analysed are those that can autonomously acquire information, synthesize data in real-time and reason based on the context to facilitate adaptive agricultural decisions.

The reviewed literature was analysed on the main functional dimensions, including the capacity to acquire and combine real time data between diverse heterogeneous sources, such as agricultural markets, weather services, and agronomic knowledge bases. Specific focus was on the systems that can be used to carry out comparative analysis among a multiplicity of options such that informed decisions can be made regarding the choice of crops, entry into the market and planning of resources as opposed to the use of predictions that are not dynamic or based on the past.

In addition, the review will evaluate the extent of autonomy, interpretability, and farmer-centric design of the currently existing systems. System robustness, scalability and continuity of guidance in dynamic and uncertain agricultural conditions were also tested. Comparing both traditional prediction centric and the new agentic AI influenced advisory systems, the present work establishes the existing limitations and suggests the research directions, which are toward combined, real-time, and explainable decision support systems of smart agriculture.

IV. LITERATURE SURVEY

A. Intelligent System Pest and Situation Awareness.

Some research has discussed how machine learning and artificial intelligence methods can be used to improve pest related situational awareness in agriculture. Models which use ensemble techniques like the Random Forest and Decision Trees which use weather have proved to be effective in pattern recognition of pest outbreaks. Simultaneously, computer vision-based image-based pest surveillance systems that use camera traps have allowed the early detection and localized monitoring, which helped in the reduction of the use of pesticides. Even though these methods improve pest awareness, they are mainly independent analytical units and they do not promote autonomous decision-making and association with comprehensive agricultural decision-making activities.

B. Price Analysis and Agricultural Market Intelligence.

The field of agricultural market analysis has been largely dominated by studies on time-series modelling and deep learning algorithms to process the trend of crop prices in regional mandis. The use of LSTM-based methods has gained much popularity because of the capability to capture temporal trends in volatile agricultural markets. Though these systems can be useful to learn about the market, they rely mostly on historical information and do not include the ability to aggregate and compare data across markets and provide contextual reasoning needed to support dynamic decision-making.

C. Data-Intuitive Advisory Systems of Environment and Soils.

The parameters that are used in environmental and soil-based decision systems include the soil pH, nutrient composition, rainfall, and temperature to make decisions regarding crops and inputs. The common use of decision tree models and rule-based models is associated with their interpretability and easy deployment. These systems are usually used to run agronomic optimization, but

with fixed datasets, and concentrate on yield-related performance, but do not incorporate real-time environmental sensor data and economic optimization in a single advisory system.

D. Government and Regional Digital Agriculture Initiatives.

A number of government-based programs in India have shown how AI-based agricultural advisory systems could be implemented in practice. Image analytics and real-time surveillance have been used to support targeted interventions in other areas like Tamil Nadu that have used pest surveillance systems. On the same note, use of mobile based advisory applications that were launched in Maharashtra have made farmers to get information about crops and weather in time, leading to improved productivity. Although these efforts prove the efficiency of smart advisory systems, they are mostly independent systems and do not synthesise autonomously and compare decisions on various agricultural fields.

TABLE I
COMPARATIVE ANALYSIS OF EXISTING SMART AGRICULTURE DECISION SUPPORT SYSTEMS

Application Area	Techniques Used	Data Sources	Key Limitations
Pest Prediction	RF, Decision Trees	Weather data	No market or advisory integration
Market Price Forecasting	LSTM	Mandi price history	Limited real-time adaptability
Precision Agriculture	Decision Trees	Soil and climate data	Economic factors ignored
Pest Surveillance	Image-based AI	Camera images	Region-specific scalability
Crop Advisory Systems	Rule-based methods	Crop and weather data	Fragmented decision support

V. GAPS AND LIMITATIONS IN RESEARCH

Although there has been significant development in intelligent decision support systems in the field of smart agriculture, a number of important limitations arise based on the literature reviewed. The available solutions are more focused on solving agricultural problems separately, including pest identification, cereal advisory, yield projections or market price. The task-based and modular design restricts their capability to promote holistic and end-to-end agricultural decisions in practical farming conditions.

One of the biggest gaps is the inability to provide real-time flexibility and autonomous information integration. Most of the systems have a strong dependency on a static or historical dataset and fail to provide the ability of collecting and integrating the current information that can be fed through multiple sources, including agricultural markets, weather services, and advisory platforms. Therefore, these systems find it hard to react to sudden changes in climatic conditions or fast changing market conditions that are typical of the Indian agricultural ecosystem.

Moreover, the current methods have a low level of comparative and context-driven decision-making. When applied, agricultural market intelligence is seen as an independent aspect of agronomic planning, such that farmers do not assess a combination of crops, markets and resources. Lack of cross-domain reasoning mechanisms inhibits economically wise and adaptive agricultural policies.

Scalability and generalization to contexts are also other challenges with most systems designed to work with particular crops and regions or environmental conditions, have no generalization to heterogeneous agro-climatic zones. Besides, the lack of focus on farmer-centric design, interpretability, and usability makes them less practical. Non-transparent system logic and complicated interfaces make accessing and gaining trust difficult, especially with small and marginal farmers.

These constraints highlight the necessity of agentic, real time, and explainable decision support systems that can independently collect data, make comparative analysis, and provide adaptive and user-friendly agricultural advice.

VI. PROPOSED DIRECTION AGENTIC AND INTEGRATED SMART AGRI ADVISORY SYSTEMS

Due to the described research gaps, future smart agriculture decision support systems ought to shift towards integrated and agentic advisory systems that would be able to assist in holistic agricultural decision-making. Instead of focusing on the individual tasks, these systems have to integrate the agronomic, climatic, and economic data to support farmers during the overall farming lifecycle. One of the research directions is the adoption of agentic architecture of artificial intelligence that facilitates autonomous acquisition of information, contextual reasoning and adaptive decision support. Alternatively to using only predictive models being trained on past data, agentic systems are able to continuously acquire real-time data in a wide range of sources including agricultural markets, weather services, and knowledge repositories. This knowledge can in turn be synthesized to produce context aware and comparative information to aid the making of informed decisions.

The need to integrate the real time data and the dynamic reasoning is necessary in order to tackle the sudden change in the weather and the market conditions, which change fast. The agentic advisory systems ought to facilitate constant monitoring and on-the-fly assessment of any available options offering the opportunity to make recommendations to change depending on the environmental and economical conditions. This flexibility is needed especially in the Indian agricultural ecosystem where uncertainty and variability are normal.

In addition, it is important that agricultural market intelligence is closely intertwined with agronomic and resource-planning considerations. Through the ability to make comparative analysis of effective use of various crops, markets and input strategies, agentic systems can be used to help make economically informed decisions in order to reduce risk and enhance the profit and sustainability of farmers.

Lastly, the future smart agriculture advisory platforms have to focus on the principle of farmer-centric design, such as interpretability, transparency, and usability. Ease of use, multilingual interfaces and clear explanation of recommendations can help build trust and ease of access, particularly among small and marginal farmers. Together, these guidelines present a roadmap of real-time, agentic, and applicable decision support systems to next-generation smart agriculture.

VII. CHALLENGES AND FUTURE SCOPE

Although the concept of intelligent advisory systems on smart agriculture has gained more and more interest, there are still challenges that are limiting its application and use in large scale. One of the basic issues is the availability and reliability as well as real time accessibility of agricultural information. The agentic advisory systems rely on ongoing receiving of data in the form of heterogeneous data including market platforms, weather services and agronomic repository where data inconsistency, latency and reliability problems may be impactful in influencing the quality of making decisions.

Scalability and situational generalization of various agro-climatic areas are still important issues. The characteristics of agriculture, soil and market dynamics can be quite diverse in different regions of India and advisory systems are not always able to maintain relevance and accuracy when applied on a large scale. The open research problem is how to design agentic systems that are capable of reasoning in a variety of local circumstances, without massive amounts of manual configuration.

Interpretability and trust are also a key issue of importance to farmer adoption. Autonomous decision making systems have to give understandable recommendations that are transparent so that the user can have confidence in them. Farmers are likely to be reluctant to use agentic advisory outputs without justification and explicable reasoning, especially in situations of high stakes of decision making like choice of crop and joining markets.

In deployment terms, the real-time combination of various sources of data and the continuous availability of the system has practical issues. The rural environment may limit continuous access to live information streams due to limited internet connection, limited infrastructure and cost factors thus impacting responsiveness and reliability of the system.

Subsequent studies must aim at coming up with effective agentic decision support models that prioritize real-time information synthesis, contextual reasoning, and explicable advisory systems. The field of autonomous agents, adaptive reasoning techniques, and edge-directed intelligence can be improved to provide system resilience in limited circumstances. Moreover, the multilingual and user-friendly interfaces and smooth connectivity to government and market data platforms can be prioritized to enhance accessibility and adoption. To unveil the full potential of agentic AI-driven advisory systems to serve the smart agriculture sector, it will be necessary to address these challenges.

VIII. CONCLUSION

This paper has given a broad overview of smart agriculture intelligent decision support systems that have been created, and the focus has been on data-driven and AI-enabled advisory systems. The systems currently in place that deal with pest analysis, environmental monitoring, crop advisory and agricultural market intelligence were reviewed systematically to gain an insight into their strengths and weaknesses. As it is shown in the analysis, although considerable improvement has been made in the domain of single decisions, the majority of the current solutions are fragmented and focused on predictions. Such systems may not be able to provide real time flexibility, autonomous integration of information and cross domain reasoning which makes them less useful in aiding holistic and dynamic agricultural decision-making. These

drawbacks are particularly important in the Indian agribusiness context which is characterised by the occurrence of rapid changes in the weather, unstable markets and variable farming conditions. According to the given gaps, this review highlights the increased demand of agentic, real-time, and explainable decision support system, which are capable of collecting heterogeneously gathered information, conducting comparative analysis, and providing a context-sensitive recommendation. The observations made during this research serve as a basis of future research to integrated and farmer-focused advisory systems that could support the future changes of smart agriculture.

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REFERENCES

- [1]. V. Sase, P. Patil, S. Gangurde, S. Chaudhari, and A. Mali, "Smart-Agri Advisor: Optimizing Sustainable Farming Decisions," *Int. J. Adv. Comput. Eng. Commun. Technol.*, vol. 14, no. 1, pp. 504–508, May 2025. Available: <https://doi.org/10.65521/ijacect.v14i1.568>
- [2]. V. R. R. K. C. Kamduri and P. Gupta, "Smart Agriculture Advisor: A Machine Learning Approach to Precision Farming," in *Proc. 2025 IEEE World AI IoT Congr: (AIIoT)*, Seattle, WA, USA, May 2025. Available: https://www.researchgate.net/publication/394655702_Smart_Agriculture_Advisor_A_Machine_Learning_Approach_to_Precision_Farming
- [3]. V. Nalawade, B. Kadam, C. Jadhav, G. Pabale, and P. Kokane, "Crop Advisor: Intelligent Crop Recommendation System," *Indian J. Agric. Eng. (IJAE)*, vol. 5, no. 1, pp. 1–6, May 2025. Available: <https://www.journals.latticescipub.com/index.php/ijae/article/view/941>
- [4]. "AI and Related Technologies in the Fields of Smart Agriculture: A Review," *Information*, vol. 16, no. 2, Art. no. 100, Feb. 2025. Available: <https://www.mdpi.com/2078-2489/16/2/100>
- [5]. D. Dahiphale, P. Shinde, K. Patil, and V. Dahiphale, "Smart farming: crop recommendation using machine learning with challenges and future ideas," *Artificial Intelligence and Applications*, 2025. doi: 10.47852/bonviewAIA52026214. Available: <https://doi.org/10.47852/bonviewAIA52026214>
- [6]. A. Gupta, D. Nagda, P. Nikhare, and A. Sandbhor, "Smart crop prediction using IoT and machine learning," *Int. J. Eng. Res. Technol. (IJERT)*, NTASU–2020, vol. 09, no. 03, 2021. Available: <https://www.ijert.org/smart-crop-prediction-using-iot-and-machine-learning>
- [7]. S. Bhargavi and S. Srinivasan Jagannathan, "Crop recommendation system using machine learning," *Int. J. Eng. Res. Technol. (IJERT)*, vol. 11, no. 06, 2024. Available: <https://www.ijert.org/crop-recommendation-system-using-machine-learning>
- [8]. Z. Ali, A. Muhammad, N. Lee, M. Waqar, and S. W. Lee, "Artificial intelligence for sustainable agriculture: a comprehensive review of AI-driven technologies in crop production," *Sustainability*, vol. 17, no. 5, p. 2281, 2025. doi: 10.3390/su17052281. Available: <https://doi.org/10.3390/su17052281>

- [9]. (Open Review) “Crop yield prediction using machine learning: a systematic literature review,” *Computers and Electronics in Agriculture*, vol. 177, 2020, Art. no. 105709.
Available: <https://doi.org/10.1016/j.compag.2020.105709>

