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AGROTECH: A Smart Agricultural System Using IOT and ML

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Abstract: Agriculture remains one of the most important sectors that support human survival which supplies basic needs, a source of income for many dependants' community. Despite these advantages, resource scarcity, adverse environmental conditions and pest infestations remain serious threats to crop products. To mitigate these concerns, we present a smart agriculture system which uses the most modern technologies like IoT (Internet of Things) machine learning (ML) and sensors with automation. The system consists of an intelligent irrigation mechanism for efficient utilization of water, an animal detection system used to trace cattle, and a Light Dependent Resistor (LDR) Sensor joined with buzzer for early detection of any global environmental changes. Additionally, the integration of plant disease detection capabilities further enhances the system's effectiveness. By employing various sensors to collect data on environmental factors, including moisture and temperature, the proposed framework enables timely decision-making for crop management. The aim is to provide farmers with actionable insights, ensuring food security while minimizing resource consumption and economic losses. This review paper discusses the potential benefits and implementation strategies of such an intelligent agricultural system, emphasizing the need for innovation in agricultural practices to meet the growing demands of an increasing population.

Keywords: Smart Agriculture System, Animal Detection, Smart Irrigation, Plant Disease, IOT, ML, Wireless communication

I. INTRODUCTION

The ecological cycle and food chain are heavily dependent on plants. Agriculture is undergoing a transformation due to the rapid growth of technology, particularly IoT and AI, which make it possible to monitor plant health and climatic factors like temperature, humidity, and soil moisture intelligently. [1]Sustainable agriculture encourages environmentally conscious farming methods that lower greenhouse gas emissions while maintaining biodiversity, conserving water, and maintaining the integrity of the soil. The number of farmers in India is declining despite rising agricultural output because of increased expenses and low productivity. Enhancing farming productivity and promoting sustainable agriculture can be accomplished through integrating digital technology such as wireless communication. [2]With population growth predicted to reach 9.7 billion by 2050, the global agriculture market is estimated to increase from USD 1.8 billion in 2018. Farmers will gain from the convergence of IoT and AI because it will save them time, yield accurate results, and make crop management, pest control, and monitoring tasks easier. The substantial potential of IoT to transform the agriculture industry is examined in this research.[3]Integrating modern technologies such as sensors, data management, and the Internet of Things, smart farming enhances resource management and agricultural productivity. By automating procedures like agricultural monitoring and irrigation, it contributes to the solution of issues like population expansion and climate change. Farmers, however, might find the technology expensive and complicated.[4]

Water scarcity affects crop yields and food production in India's agriculture. By reducing water usage and using automation and the Internet of Things, smart irrigation systems can ensure effective irrigation based on temperature, humidity, and soil conditions. With this strategy, data will be stored in the cloud for future use and water management will be improved.[5]Having nearly fifty percent of people working for agriculture, India's congress lepends largely on

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agriculture. Through sensors which measure temperature, humidity, and moisture in the soil, smart agriculture using Internet of Things-based systems may precisely control water usage, reducing down on waste and increasing the production of crops.[6] In India, agriculture is a major source of income and is greatly affected by the changing seasons of water availability. Using sensors to monitor soil moisture and humidity, an Internet of Things (IoT)-based smart agriculture system increases production by automating watering and delivering real-time data on crop fields.[7]

The Internet of Things (IoT) increases automation and decision-making in agriculture by allowing physical objects to communicate and share real-time data. Though the idea behind IoT has been around for a while, recent developments have made it more useful for controlling agricultural supplies and tracking crop growth. Three layers—physical, IoT, and cooperative—are included in our suggested architecture to handle different agricultural problems, such as supply chain management and animal control.[8]Since food crops are being used more and more for biofuels and other industrial purposes, crop production is becoming more and more important for sectors like cotton, rubber, and bioenergy. This raises questions about food security. Because every agricultural field is different and has factors influencing its yield, site-specific assessments are required to ensure optimal production. Farmers need creative, technologically advanced solutions to these problems in order to maximise output while reducing resource consumption.[9]The concept of precision agriculture, which combines sensors, data systems, and expert models to increase productivity and sustainability, emerged as a result of the need for exact control of resources such as light, water, and CO2 for green plants to grow to their full potential. Novel frameworks for smart plant management are made possible by recent developments in IoT and AI, which also allow for better agricultural practice decision-making and real-time data utilisation.[10]Seventy percent of Indians depend on agriculture as their main source of income. By ensuring that the appropriate amount of water is applied at the most beneficial times, changing from manual to automated irrigation systems can increase productivity, conserve resources, and improve agricultural performance.[11]

II. LITERATURE REVIEW

Sr.	Title	Author Name	Abstract	Advantages	Limitations
No.		and Publication			
1.	"Smart System	T. Shastrakar,	This paper tells us	The system	However, the
	for Plants Using	S. Dhole, A. Patle,	about to automate	automates	system depends
	IOT & AI"	and S. Mohd.	irrigation by turning the	irrigation based on	heavily on sensor
		IJCRT, 2023	motor on or off based	plant health and	accuracy, faces
			on the health of the	sensor data,	scalability
			plants, or sensor values.	allowing remote	challenges for
			Via an android app, the	monitoring via an	larger farms, and
			farm owner may keep	Android app,	requires stable
			an eye on the procedure	which optimizes	internet
			online.	water usage and	connectivity for
				reduces manual	effective operation
				intervention.	
2.	"Smart	M. Dhanaraju, P.	This paper emphasized	The system	However, it faces
	Farming:	Chenniappan, K.	the role of many	improves farming	challenges like high
	Internet of	Ramalingam, S.	technologies used for	efficiency through	initial costs, limited
	Things (IoT)-	Pazhanivelan, and R.	farming, particularly	IoT technologies	adoption due to a
	Based	Kaliaperumal.	the IoT, in making	and promotes	lack of technical
	Sustainable	Agriculture, 2022, 12,	agriculture smarter and	sustainable	knowledge in rural
	Agriculture"		more effective in	practices using	areas, and the need
			meeting future	sensors and	for reliable internet
			requirements using	communication	infrastructure.
			sustainable IoT-based	tools, making it a	
			sensors and	future-ready	

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			communication technologies.	solution for agricultural	
			8	challenges.	
3.	"IoT based Soil Nutrition and Plant Disease Detection System for Smart Agriculture"	S. Suhag, N. Singh, S. Jadaun, P. Johri, A. Shukla, and N. Parashar, 10th IEEE International Conference on Communication Systems and Network Technologies, 2021	A smart farming system includes hardware like polyhouses, sensors, to monitor crop spacing and soil moisture. The software connects to these sensors, allowing farmers to manage irrigation and automate harvesting with robotic arms. A mobile app helps them sell crops efficiently.	The system monitors crop conditions and soil moisture, enabling precise irrigation management, automates harvesting with robotic arms, and improves crop selling efficiency through a mobile app.	It requires significant hardware investment, may involve technical complexities in integration, and depends on consistent connectivity and maintenance.
4.	"A Research Paper on Smart Agriculture using IOT."	R. Srivastava, V. Sharma, V. Jaiswal, and S. Raj International Research Journal of Engineering and Technology (IRJET), 2020	The system measure moisture of soil and level of water in fields. This system works well in the ideal conditions and further improvement can be made when the conditions are not ideal like proper illumination or lightning.	The system effectively measures soil moisture and water levels in fields, helping optimize irrigation under ideal conditions.	However, its performance may degrade under non-ideal conditions, such as poor illumination or lighting, and further improvements are necessary to enhance its reliability.
5.	"Smart Irrigation system using Internet of Things,"	A. Anitha, N. Sampath, and M. A. Jerlin, International Conference on Emerging Trends in Information Technology and Engineering. IEEE, Feb. 2020	This paper proposed an IoT based smart irrigation system utilizing sensors to record the data and store it in the cloud storage.	The system utilizes sensors to record irrigation data and stores it in cloud storage, enabling easy access and analysis for optimized irrigation management.	However, it relies on internet connectivity for cloud access, and potential data security issues may arise with cloud storage solutions. Additionally, the system's effectiveness can be influenced by sensor reliability and calibration.
6.	"Smart Farming System using IoT for Efficient Crop Growth,"	M. S. D. Abhiram, J. Kuppili, and N. A. Manga, IEEE International Students' Conference on Electrical,	In this paper, All the values i.e. temperature, humidity level, soil moisture level and the rain condition are sent to the smart	The system provides real-time updates on temperature, humidity, soil moisture, and rain	However, it relies on Wi-Fi connectivity, which may not be consistently available in rural
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	Agriculture:	M. Aggoune,	various technologies,	technologies, such	complex and may
	Toward Making	W. Aggoune,	especially IoT, in order	as wireless sensors	require significant
	the Fields	Special Selection On	to make the agriculture	and cloud	investment.
		_	-		
	Talk,"	New Technologies	smarter and more	computing, in	Additionally, there
		For Smart Farming	efficient to meet future	enhancing	are challenges
		4.0: Reasearch	expectations. For this	agricultural	related to data
		Challenges and	purpose, wireless	efficiency and	management,
		Opportunities. 2019	sensors, Cloud-	preparing for future	security, and the
			computing,	demands.	need for skilled
			communication		personnel to
			technologies are		operate and
			discussed thoroughly.		maintain such
					systems.
10.	"From parallel	M. Kang and FY.	In this paper, we	The paper outlines	However, the
	plants to smart	Wang,	present the three steps	a three-step	approach may
	plants:		toward the parallel	approach for	require substantial
	intelligent	IEEE/CAA Journal of	management of plant:	managing plant	computational
	control and	Automation Sinica,	growth description (the	growth—growth	resources and
	management for	2017	crop model),	description,	sophisticated
	plant growth,"		prediction, and	prediction, and	algorithms, which
	F,		prescription. This	prescription—	could pose
			approach can update	enhancing the	challenges for
			the expert system by	expert system with	implementation in
			adding learning ability	learning	resource-limited
			and the adaption of	capabilities and an	
			_	*	settings.
			knowledge database	adaptive	Additionally, the
			according to the	knowledge	effectiveness of the
			descriptive and	database for	system relies on the
			predictive model.	improved plant	quality and
				management.	accuracy of the
					crop models used.
11.	"Sensor based	K. Kansara, Vishal	This review is proposed	The system	However, the
	Automated	Zaveri, Shreyans	to supports aggressive	promotes efficient	reliance on
	Irrigation	Shah,	water management for	water management	technology may
	System with	SandipDelwadkar,	the agricultural land.	in agriculture	pose challenges in
	IOT: A	and K. Jani,	Microcontroller in the	through	terms of initial
	Technical		system promises about	automation,	setup costs and
	Review,"	International Journal	increase in systems life	reduces power	maintenance.
		of Computer Science	by reducing the power	consumption with	Additionally, the
		and Information	consumption resulting	the use of	system's
		Technologies, 2015,	in lower power	microcontrollers,	effectiveness
			consumption.	and minimizes	depends on the
			Automated irrigation	human error in soil	accuracy and
			system has a huge	moisture	reliability of the
			demand and future	adjustments,	sensors used for
			scope too. It is time	making it time-	monitoring soil
			saving, led to removal	saving and reliable.	moisture levels.
			of human error in	ESEARCH IN SCI	40 mini

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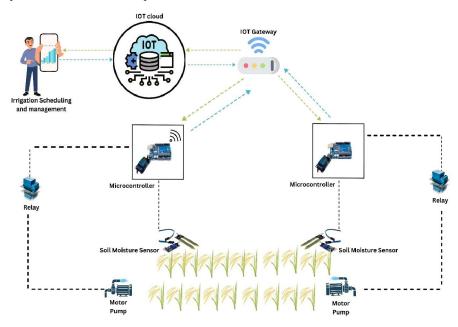
Volume 4, Issue 2, November 2024

			adjusting available soil		
			moisture levels.		
12.	"IoT Smart	U. H. D. Thinura, N.	In this paper, work.	The system allows	However, the
	Plant	Ariyaratne, V. D.	With our new solution,	gardeners to	system's
	Monitoring,	Yasaswin, L. H. D.	gardeners can monitor	monitor key factors	performance relies
	Watering and	Ranul, H. M.	some important factors	such as plant	on stable internet
	Security	Sumudu, and M.	like the plant's	health, soil	connectivity and
	System".	Herath,	healthiness, soil	moisture, air	sensor accuracy.
			moisture level, air	humidity, and	Additionally, initial
		ResearchGate	humidity level, and the	surrounding	setup and
			surrounding	temperature,	maintenance costs
			temperature and water	enabling remote	may be a barrier for
			their garden from	watering via a	some users.
			anywhere in the world	mobile app from	
			at any time by using	anywhere at any	
			our app.	time.	

III. SYSTEM ARCHITECTURE

The system architecture consists of:

- **IoT Sensors**: Sensors deployed in the field collect data on environmental parameters such as soil moisture, temperature, humidity, and light intensity.
- Cloud Platform: The sensor data is sent to a cloud platform where it is stored and processed. ML models analyze the data and generate insights.
- **User Application**: Farmers access the processed data and insights via mobile and web apps. They receive real-time updates and alerts about crop conditions, diseases, and resource recommendations.



IV. CONCLUSION

This review highlights the potential of smart agricultural systems integrating IoT, sensors, and AI models to transform modern farming. By automating irrigation, detecting animals, and monitoring environmental conditions, these systems

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offer efficient, data-driven solutions for improving crop yields, resource management, and sustainability. Continued advancements in these technologies will further enhance agricultural productivity and resilience.

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