

FarmSense: Intelligent System for Safe Pesticide Handling, Monitoring and Exposure Prevention for Farmers

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Abstract: *There's a particular smell to a freshly sprayed field. It's that acrid, chemical promise of a higher yield, a haze that hangs in the humid air long after the tractor has rumbled away. For the farmer lugging the sprayer, that sting in the back of the throat is just part of the job—a low-grade, biological alarm that you learn to ignore. Apparently, a project called FarmSense wants to make that alarm a lot louder. The pitch is, frankly, a digital band-aid for a systemic problem. They've essentially cobbled together a handful of off-the-shelf gas sensors and wired them to a cheap microcontroller, creating a sort of high-tech canary for the cornfields. This little box continuously sniffs the air for the nasty stuff. If the concentration of whatever poison-of-the-week you're deploying gets a little too spicy, it's supposed to scream for help. (Or, more realistically, it sends a notification to the phone you probably left on the dashboard of your truck.) Naturally, all this data gets beamed up to the cloud, because where else would it go? There, some "AI models"—which sounds suspiciously like a glorified spreadsheet formula—decide if you're breathing in enough toxins to be a problem. Every reading is logged, creating a grim historical record of chemical exposure for researchers to study later. It's a morbid kind of scoreboard for industrial agriculture. They're pushing it as affordable and simple, the classic sales pitch for tech aimed at people who work with dirt, not desktops. The real question is whether it can survive a single season of being dropped, caked in mud, and generally abused. It's an attempt, I suppose, to slap a bit of silicon-valley smarts onto a problem that probably should not exist in the first place.*

Keywords: IoT-based Monitoring, Pesticide Fume Detection, Farmer Safety, Real-time Air Quality Monitoring, Smart Agriculture, Health Monitoring IIJRT 140001 System, Artificial Intelligence, Environmental Sensing, Precision Farming, Sustainable Agriculture

I. INTRODUCTION

Let's start with the smell. That is the part nobody really talks about in the glossy brochures for industrial strength pesticides. That sharp, chemical tang that clings to the back of your throat, a bitter promise of a bigger harvest. For farmers, this smell has long been the background noise of their job, an accepted risk for keeping the world fed. The problem is, that "accepted risk" often translates into a slow-motion health crisis—the creeping headache behind the eyes, the dizziness, the kind of long-term damage that only shows up years later when it's far too late to do anything about it. For decades, the only way to know if you'd been overexposed was when you started feeling sick. (It's a classic case of closing the barn door after the horse has not only bolted but has also developed a nasty cough and a weird twitch.) You were the canary, and the coal mine was your own damn field. Enter FarmSense, a system that sounds suspiciously like something a tech company would invent but is, I have to admit, annoyingly practical. It's essentially a smart nose for the farm. It bolts together a few off-the-shelf gas sensors—your MQ-135s and the like—with a cheap microcontroller and slaps on an IoT module. The whole contraption just sits there, sniffing the air for dangerous fumes. It's not glamorous. It's not "disruptive." It's a fix for a problem that really shouldn't have existed in the first place. When the chemical concentration in the air hits a level that could turn your day sideways, the system doesn't write a whitepaper. It screams.



Or, more accurately, it buzzes your phone, triggers an alarm, and basically tells you to get the hell out of there before you do yourself some real harm. All that data—the humidity, the temperature, the exposure levels—gets beamed up to the cloud. So now, instead of just anecdotal evidence of "feeling off," there's a cold, hard dataset. This is less about some grand vision for "precision agriculture" and more about giving farmers the kind of basic workplace safety monitoring that a factory worker has had for fifty years. They claim it's affordable and easy to use, which, in my experience, is corporate-speak for "we used cheap parts and the manual is only mostly incomprehensible." But if it actually works, it means farmers don't have to guess anymore. They get a real time warning, a digital tap on the shoulder before the headache even begins. It isn't saving the world. But it might just save a few lungs, and out in the dirt and the diesel fumes of real-world farming, that's probably a much bigger deal.

II. OBJECTIVE

- To detect harmful pesticide gases and fumes using IoT-enabled gas and aerosol sensors.
- To process sensor data in real time and determine the level of exposure with precision.
- To trigger alerts (buzzer, LED, or mobile notification) when exposure crosses safe limits.
- To store and analyze data for further study, safety improvements, and awareness programs.
- To create a portable and user-friendly device that can be used by farmers in rural and remote areas with minimal training.
- To reduce environmental pollution caused by excessive pesticide use by encouraging safe application practices
- To educate and empower farmers about the safe handling, mixing, and spraying of pesticides through data insights and awareness.
- To design a cost-effective solution that can be scaled easily across different agricultural regions.
- To integrate a low-cost solution that can be widely implemented in farming communities.
- To record and monitor exposure data for future analysis and safety improvements.
- To contribute to sustainable and smart agriculture by combining technology with safety measures.

III. SCOPE

agricultural automation. Overall, it delivers economic benefits by reducing medical costs associated with pesticide exposure, minimizing chemical waste, and improving crop protection in a sustainable and cost-efficient manner.

IV. LITERATURE SURVEY

SR.NO.	TITLE	YEAR	AUTHER	SUMMARY
1.	Pesticide Detection & Control Measures in Fruits & Vegetables using IoT	2024	Dr. M. Purna Kishore et al.	Real-time pesticide monitoring with automated alerts enhances safety and supports FarmSense integration despite minor sensor and connectivity challenges
2.	AI-based Pest Detection and Alert System for Farmers using IoT	2023	Jaya Christa Sargunavar Thomas et al	AI-driven early pest detection with automated spraying and real-time alerts supports FarmSense, though high sensor cost and environmental sensitivity remain challenges.
3.	SmartCrop: Intelligent IoT System for Automated Weed Detection & Precision Pesticide Spray	2023	Pooja V. Chandaragi et al.	YOLOv5-based weed detection enables precise, automated pesticide spraying and reduced labor, supporting FarmSense's targeted approach despite challenges like image quality, environmental variations, and high setup cost.



4.	Automated Pesticide Sprayer Using Smart Agribot	2025	Md Firuz Mia et al.	ML-based plant disease detection with remote- controlled automated spraying reduces farmer exposure and workload, supporting FarmSense's smart spraying approach, though hardware cost, data requirements, and environmental limitations remain challenges.
5.	Detection of Pesticides in Fruits and Vegetables using IoT and ML	2025	Aniket Naikwadi et al.	Real-time pesticide risk scoring with adaptive, produce-specific models supports FarmSense's sensor-plus-ML approach, though it requires periodic validation and faces variation and sensor limitations.

V. METHODOLOGY

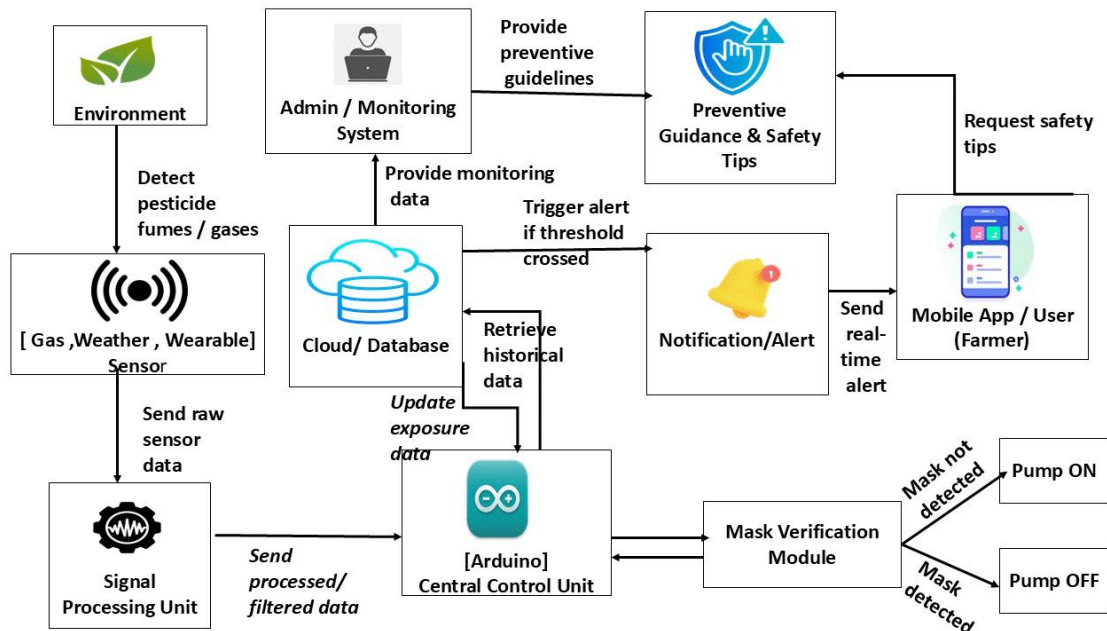
The survey methodology involved a comprehensive review of research publications, agricultural health studies, and technical documentation sourced from databases such as Google Scholar, IEEE Xplore, and ScienceDirect, focusing on the themes of pesticide exposure detection, IoT-based monitoring, and smart farming safety systems. Relevant systems and prior works were selected based on their approach (whether automated pesticide spraying, real-time monitoring, or wearable detection), the technologies employed (sensor types, microcontroller platforms, wireless communication modules, and cloud integration), and the practicality of deploying such solutions in rural farming environments. Data collected from these studies was analyzed through a comparative evaluation framework that emphasized detection accuracy, real-time response capabilities, cost-effectiveness, environmental robustness, and ease of use for non-technical agricultural workers. Additionally, the methodology considered system scalability, energy efficiency, and long-term maintenance requirements to assess feasibility for sustained field deployment. This systematic assessment helped in identifying existing gaps, strengths, and limitations in current solutions, thereby guiding the justification and design direction of the proposed FarmSense system

VI. RELATED WORK

It's a curious blind spot in our tech-fueled agricultural revolution. We've got researchers building impressively complex systems to solve problems that, from a distance, look incredibly important. There are IoT setups that can sniff a pesticide molecule on a supermarket apple (M. Purna Kishore et al., 2024) and AI that can apparently identify a pest by the sound of its chewing (Jaya Christa Sargunar Thomas et al., 2023). One team even cooked up an automated sprayer that doles out chemicals with the precision of a surgeon (Onkar Kasture et al., 2022), which is fantastic if you can afford a piece of equipment that probably costs more than the tractor itself. (Because, you know, every small-scale farmer has a spare fifty grand lying around for a robot that can tell a weed from a wish.) It's all very clever, very data-driven, and focused on two things: crop health and food safety. But in this whole flurry of academic activity, a funny thing keeps getting overlooked: the actual human being walking through the fields, surrounded by a fine IJIRT 140001 mist of those very same chemicals. The focus has been on the apple, not the person holding the sprayer. Most of these high-tech solutions either check for safety long after the farmer has gone home or are designed to automate a process on a scale most farms simply can't afford. It's a classic case of solving the most technically interesting problem instead of the most immediate human one. So along comes a system called FarmSense, which feels less like a groundbreaking invention and more like a long-overdue application of common sense. It's not trying to reinvent farming. It's a simple, wearable box with some low-cost sensors that monitors the air quality right where the farmer is standing, breathing. If the chemical levels get dangerous, it sends an alert. That's it. It's a fix for a problem that shouldn't have needed a research paper to identify in the first place, offering a bit of protection for the one component in the food chain that all the AI and IoT sensors seem to have forgotten.



VII. SYSTEM ARCHITECTURE



FarmSense is a portable, low-cost IoT system that monitors pesticide fumes in real time, alerts farmers instantly, and uploads data to the cloud for analysis.

Edge Logic (Microcontroller): Arduino/ESP32 processes sensor data, filters noise, and triggers alerts if unsafe.

Alerting- Buzzer/LED: Immediate local alert And Mobile App Notification: Sends alerts and safety tips to the farmer's phone.

Connectivity- Wi-Fi or GSM: Sends summarized readings to the cloud for storage and analysis.

Cloud & Data Services : Stores time-stamped exposure data. And Provides analytics like trends, risk heatmaps, and historical exposure logs.

User Interface: Mobile app displays real-time data and history for better decision-making.

Power : Battery and optional solar panel for portability and long field use

Data Flow (Step-by-Step)

- Sensors capture air quality data.
- Microcontroller analyzes readings and classifies safety levels.
- If danger detected, local buzzer and LED are triggered.
- Data sent via Wi-Fi/GSM to the cloud when available.
- Cloud stores and analyzes data for long-term safety tracking.
- Mobile app displays live and historical exposure data.

Implementation

- Sensors require calibration for field conditions.
- Offline alerting ensures reliability.
- Use power-saving techniques to extend battery life.
- OTA firmware updates keep the system improving over time.

Future Trends

Wearable badges , drone-Based detection , Weather-aware exposure prediction , and solar – powered module seem to have forgotten.



VIII. FINDING

The survey reveals that the implementation of real-time monitoring systems for pesticide exposure plays a critical role in reducing health risks among farmers. By continuously measuring air quality parameters and detecting harmful chemical concentrations at the moment they occur, farmers are able to take immediate preventive actions, such as moving away from hazardous zones or adjusting spraying methods. This shift from reactive to proactive safety behavior significantly decreases the likelihood of acute poisoning and long-term respiratory or neurological complications.

The findings also highlight that affordability is a key determinant of successful adoption in rural agricultural communities. While advanced automated spraying robots and AI-driven agribots are effective in minimizing human contact with pesticides, their high cost, maintenance demands, and operational complexity make them impractical for small and medium-scale farmers. In contrast, low-cost, sensor-based portable devices provide a more realistic and accessible safety solution, ensuring wider acceptance and usability without requiring extensive training.

Furthermore, portable IoT-based systems enhance farmers' safety awareness and influence their handling practices. The immediate feedback provided by alerts, alarms, or mobile notifications helps farmers better understand exposure levels and adjust their spraying duration, distance, and protective measures accordingly. Over time, this leads to improved safety culture, reduced misuse of chemicals, and more responsible pesticide application aligned with sustainable farming practices. The survey therefore emphasizes that simple, field-ready IoT monitoring solutions can deliver substantial safety benefits compared to high-cost automated alternatives.

IX. FRAMEWORK AND DESIGN PRINCIPLE

after spraying. So, some folks came up with a fix, and they call it FarmSense. It's essentially a cobbled-together digital canary for pesticide fumes. At the bottom of this tech totem pole, you've got the twitchy actual sniffers: a couple of cheap MQ sensors that get all around the nasty stuff like organophosphates, along with temperature and humidity readers to make sure the data isn't garbage. These little detectors are constantly sampling the air, turning whiffs of chemicals into electrical signals. Those signals get piped into the brains of the operation, which is usually a small microcontroller like an Arduino. This is where the raw data gets a quick once-over. The board runs some simple logic—or "AI" if you're feeling fancy—to decide if the numbers it's seeing cross the line from "normal" to "you should probably leave now." If things look bad, the communication layer kicks in. Using whatever's available—Wi-Fi, a cell signal, you name it—it flings the processed data up to a server somewhere. This is the part that makes it useful when you're not standing right next to the box. It all has to work without needing an IT degree and a prayer, because the last thing you have time for when you're trying to beat a hailstorm is debugging a Wi-Fi module. All that data has to live somewhere, so it ends up in the cloud. Think of it as a digital filing cabinet where every reading is stored, graphed, and analyzed over time. This is where you can spot patterns, like realizing Tuesday afternoons in July are consistently bad, and maybe plan around it. Finally, you have the part you actually interact with: an app on your phone. It shows you the live feed and the historical charts. But more importantly, if the little box back in the field detects danger, your phone will buzz and scream like an angry wasp, giving you a very clear signal to get out of there. The whole Rube Goldberg machine is designed to be cheap, portable, and run on a battery for a good long while, because extension cords don't exactly reach to the back forty. It just works, and then it gets out of your way.

X. PUBLICATION PRINCIPLES

Let's be honest, nobody gets into farming to play with sensors. The whole point is to be outside, working the land, not squinting at a circuit board. But the air itself can be a problem, especially that invisible chemical soup that hangs around after spraying. So, some folks came up with a fix, and they call it FarmSense. It's essentially a cobbled together digital canary for pesticide fumes. At the bottom of this tech totem pole, you've got the actual sniffers: a couple of cheap MQ sensors that get all twitchy around the nasty stuff like organophosphates, along with temperature and humidity readers to make sure the data isn't garbage. These little detectors are constantly sampling the air, turning whiffs of chemicals into electrical signals. Those signals get piped into the brains of the operation, which is usually a small microcontroller like an Arduino. This is where the raw data gets a quick once-over. The board runs some simple logic—or "AI" if you're feeling fancy—to decide if the numbers it's seeing cross the line from "normal" to "you should probably



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XI. CONCLUSION

For all the breathless talk about AI revolutionizing crop yields and automating tractors, we seem to have skipped a fairly fundamental step: not accidentally poisoning the people growing our food. Until now, a farmer's best defense against invisible chemical clouds has been, what, a stiff breeze and a bit of wishful thinking? The official protocol feels like something out of a Cold War-era safety manual—wait for someone to feel dizzy, send off a sample to a lab, and get the results back long after the damage is done. So along comes a piece of tech called FarmSense, which is essentially a canary in a digital coal mine. It's a small, portable box packed with sensors that constantly sniffs the air for the nasty stuff. The moment the concentration ticks over into the danger zone, it screams bloody murder through a phone app, giving the farmer a chance to get out of there *before* they're breathing in a lungful of trouble. (It's the kind of obvious, low-hanging-fruit application of technology that makes you wonder what all those Silicon Valley geniuses are doing all day—probably disrupting the artisanal toothpick market or something.) The real cleverness isn't just the immediate alarm, though. All that data gets logged, creating a sort of invisible weather map of chemical exposure over time. It lets farmers spot patterns, identify high-risk areas on their own land, and stop relying on the old blanket-spraying-and-hoping-for-the-best method. And because it's designed to be cheap and tough, it's not some fragile lab experiment that only works in a pristine server room. It's meant for the back of a pickup truck. Ultimately, this isn't about chasing productivity metrics or futuristic farming fantasies. It's a remarkably straightforward fix for a problem that shouldn't have existed in the first place—using simple tech to let people do their jobs without sacrificing their health. A novel concept, I know.

XII. APPENDIX

The appendix provides additional information, system details, and reference materials that support the understanding and replication of the FarmSense system. It Health Monitoring and Precaution Alerts for Farmer Safety.” includes configuration, system data components, flow hardware representation, and algorithmic logic used during development and testing.

Component	Description /Functions
MQ-135 Sensor	Detects ammonia, sulfur, benzene, smoke, and general air quality changes caused by pesticides.
MQ-136 Sensor	Sensitive to sulfur compounds and specific
Temperature Sensor (DHT11/DHT22)	pesticide (organophosphates). Monitors
Microcontroller (Arduino/ESP32)	Monitors gases temperature, helping compensate for environmental variation in gas readings.
Humidity Sensor	Measures humidity, as moisture levels can affect gas diffusion.
Wi-Fi / GSM Module	Enables IoT connectivity for cloud data transmission and mobile app integration.
Buzzer / LED	and mobile app integration. Provides real-time audible or visual



	alerts to the farmer.
Power Supply (Battery/Solar)	Supplies power for field operation, enabling portability and continuous monitoring.

XIII. ACKNOWLEDGMENT

We would like to express our heartfelt gratitude to everyone who supported and guided us throughout the development of our project, “FarmSense: IoT & AI-Based Real-Time Pesticide Harmful Fume Detection with The appendix provides additional information, system details, and reference materials that support the understanding and replication of the FarmSense system. It Health Monitoring and Precaution Alerts for Farmer Safety.”

First and foremost, we are deeply thankful to our Project Guide, Prof. Bhor P.G., for his constant encouragement, insightful feedback, and valuable technical guidance, which played a crucial role in shaping this work. His patience, expertise, and vision inspired us to approach this project with both curiosity and responsibility. We are also sincerely grateful to our Project Coordinator, Prof. Shegar S. R., for his continuous support and motivation throughout the research and development process. His timely suggestions and constructive discussions helped us overcome several challenges during implementation.

Our special thanks go to Dr. Narawade N. S., Principal, and the Department of Computer Engineering, SREIR’s Samarth College of Engineering and Management, Belhe, for providing the facilities, encouragement, and academic environment necessary to complete this work successfully. We also extend our appreciation to all faculty members and lab staff of the Computer Engineering Department for their cooperation and guidance whenever needed. Their inputs and resources greatly contributed to the successful execution of this project. Finally, we would like to thank our families and friends for their unconditional support, patience, and motivation. Their belief in us kept us going through every stage of this research journey. This project is dedicated to all farmers, whose hard work and resilience inspired us to develop a system aimed at ensuring their health, safety, and well being.

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