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## Automatic Seed and Fertilizer Harvesting for Smart Farming

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**ABSTRACT:** An Automatic Seed and Fertilizer Harvesting System for Smart Farming represents the main subject of this research paper which combines furrowing and seeding and fertilizing operations in one automated machine unit. An ESP32 microcontroller operates in conjunction with remote control to enable farmers to run the machine without actively present in the field. The prototype unites three main elements which include furrowing blades to open the soil layer and seed distributing apparatus and fertilizer dispersal units into one interface that performs efficiently while traveling across agricultural fields. The aim of this system is to boost farming productivity by utilizing accurate seed deploying systems with controlled fertilizer distribution. Testing of the prototype demonstrates effective operating precision along with user- friendly interaction. Smart farming technology demonstrates potential to improve traditional farming practices so they become both sustainable and more cost-effective.

KEYWORDS: smart farming, automated seeding, esp32 automation, harvesting, remote-controlled

#### I. INTRODUCTION

The world's agricultural industry exists as an essential economic backbone since it produces food for human populations. Standard farming practices demand significant expenditures of time along with intensive human work and extensive effort. Farmers need to perform multiple activities from making soil furrows through seed seeding and terminating operations with fertilizer addition. The completion of these tasks necessitates long durations of work from numerous staff members thus raising expenses. Improper execution of these tasks generates two major outcomes including reduced crop production alongside wasted resources. Many farmers encounter difficulties from irregular distribution of their fertilizer materials. The improper distribution of fertilizers results in both deep and thin application across different field areas. The improper molding of nitrogen in the soil results in damage to plant development. Seeds suffer from improper placement as a frequent problem. Several seeds end up in the same area during planting especially when growing cotton or corn crops. Farmers need to remove excessive seeds manually since improper seed distribution occurs. Seeds placed improperly will face the risk of germination failure due heavyrain that can wash them away from their correct depth. A long period has existed during which technology enhanced farming methods. In the past few decades, ideas like tractors, seeders, and harvesters have helped minimize the process of some phases of farming. In the past, there were technologies such as GPS navigated machinery, self-driving tractors and robotic implements that have boosted yield in mechanized farming. However, the application of these technologies demands massive capital investment, which would hardly be available to small and medium-scale farmers in the developing world.

Development of an automated system stands at the core of this research as it relates to smart farming. The system completes three essential operations which include furrow creation as well as seed planting and fertilizer addition The solution represents an environmentally friendly approach which enables farmers to decrease their manual labour while enhancing their performance accuracy. The control of this proposed system is done by using a web interface, and the hardware components used include ESP32 microcontroller, L298N motor driver, DC motor, relay module, and servo motor. Specifically, it is aimed at enhancing the accuracy of farming and reduce labour intensity. Seeds are placed with accuracy at uniform positions at the appropriate soil depth by this system. A uniform distribution of fertilizers through this system minimizes wastage and enhances the condition of the soil.

This automatic system delivers multiple advantages to users which include: 1. The system saves time when executing farming tasks because it functions beyond human capability.2. Better seed placement emerges from automated methods because seeds reach precise depths and distances thus leading to superior growth.3. The system brings about enhanced operational efficiency through its improved framework which decreases mistakes in the overall farming activities.





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4. Through automation farmers achieve two savings benefits – reduced labour expenses along with decreased seed and fertilizer loss.

The smart farming system allows farmers to run their operations with improved efficiency which produces higher profits. Modern technology through this invention continues to connect Indian farmers with optimal farming practices in a nationwide effort. The system promises enhanced agricultural productivity which directly leads to better food production capabilities for the climbing population numbers. It is an attempt to narrow the gap between conventional agriculture and advanced smart agriculture solutions. In this way, farmers gain increased production and decreased expenses and become a part of a new, more sustainable and technologically advanced form of agriculture for the country.

#### **II. LITERATURE REVIEW**

The study by Singh et al. [1] examined how automation technology benefited precision farming through agricultural research. The authors showed through their research that automated systems use fewer resources to boost agricultural output. The study examined AI and IoT integration for live agricultural monitoring yet it did not investigate how processing various farming operations as part of one automated framework.

Researchers from Gupta et al. [2] conceptualized a seed- sowing robot with microcontroller capabilities which maintained consistent seed position and optimal seed depth. The combination of servo motors and stepper motors in automated seed dispensers improves seed dispensing accuracy better than traditional manual distribution methods according to their research study. Seed placement received the main focus from the researchers but these scientists failed to incorporate fertilizer application alongside furrowing functions in their research.

The scientific investigation conducted by Patil and Sharma

[3] developed an automated system for fertilizer distribution through fertigation which operated based on soil conditions. Through their experimentation the scientists proved that implementing precision fertigation leads to better soil conditions and decreases chemical fertilizer losses in the field. The research examined nutrient controls independently while omitting seed-planting and furrowing functionalities from their automation model.

The authors from Kumar et al. [4] established an IoT-based agricultural system which utilized ESP32 for remote monitoring and control functions. L298N motor drivers together with wireless communication proved to be effective components for farming process automation according to their research. Research teams stressed remote control capabilities yet failed to develop a single automated machine which would combine seeding together with fertilization functions.

The research by Deshmukh et al. [5] developed an automated agricultural machine which combined three main farming operations into one interconnected system. The researchers showed that integrating these farming operations decreased working time while boosting agricultural output effectiveness. The system operated without real-time remote- control function which reduced its ability to scale up for smart farming applications.

#### III. METHODOLOGY

The "Automatic Seed and Fertilizer Harvesting for Smart Farming" project aimed to develop a single remote-controlled automated system which merged seed furrowing seeding with fertilizing procedures. The ESP32 microcontroller functions as the main processor which communicates with different components through its digital capabilities. Through the L298N motor driver system the model receives motor power to drive its wheels which enables it to advance forward and reverse while rotating.

A metal plow blade serving as an attachment on the back part slices furrows into the soil. The servo motor permits seeds from the hopper to drop at suitable intervals. Through its relay functionality the module operates the fertilizer dispenser through sequential squirts of the right amount of liquid fertilizer into newly dug furrows. Batteries with rechargeable capabilities supply electricity which drives the microcontroller system along with the motor operations. The user controls this model through the remote device which allows them to advance the machine and select specific





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operational functions according to their needs. Through wireless features of the ESP32 the system achieves remote control via mobile applications or exclusive dedicated remote systems which provides users with instant control. Through a single operating machine and remote control technology users can maximize resources while reducing workforce requirements. Soil moisture sensors or GPS modules can be integrated as future upgrades through the machine's modular structure. The approach brings convenience to farmers by reducing the complexity of agricultural labour while establishing opportunities for smart farming advancements on a larger scale.

#### **IV. CONSTRUCTION**

#### A. System Architecture and Components

The automatic seed and fertilizer reaper machine needs different hardware elements that work together to guarantee operational efficiency. The machine operates through a system where all parts unite for automated furrowing and seeding and fertilizing functions.

#### ESP32 Microcontroller:

The machine uses the ESP32 as its critical control element. The system receives operational instructions which then directs every operational instrument. The machine controls motor operations together with furrowing systems and sets correct timings for seed dispersals and fertilizer releases. The ESP32 provides users with a convenient option for remote control and quick setup adjustments because it comes with Wi-Fi and Bluetooth features.

#### L298N Motor Driver:

The L298N motor driver allows the ESP32 to control the DC motors. The ESP32 sends weak signals through the L298N motor driver which converts these signals into motor- operational strength. Through this component the robot achieves movement control through wheel speed adjustments and direction modification that results in forward motion and backward direction along with left and right wheel turns.

#### DC Motors:

The machine operates through two major applications which employ DC motors.

Wheel drive motors: The robot uses wheel drive motors to activate its wheel systems for movement throughout the field. Furrowing motor: The mechanism which operates the metal blade through power from the motor creates straight lines in the soil for planting purposes.

#### Servo Motor:

The servo motor functions as the controller of the seed release mechanism. A servo motor operates to manage the seed container outlet thus allowing seeds to fall properly into the furrow row at defined intervals. The servo arm receives an adjustment directive from the ESP32 which determines seed plantation distance while maintaining uniform seed distribution.

#### Relay Module:

The relay module enables the control of the fertilizer dispensing function. The servo functions as a controller that enables the ESP32 to operate the fertilizer release as either on or off. There is a safety mechanism in the module that controls the high currents for the fertilizer motor without causing any issues for the low-power ESP32.

#### Lithium Ion Battery:

Namely the lithium-ion battery pack serves as the primary power source that powers all system components. Through its supply of suitable voltage and current the microcontroller obtains power together with the motor driver and motors. The lightweight rechargeable high-energy batteries enable the robot to function efficiently as a portable piece of fieldwork equipment.

#### Seed Container:

The seed container together with the servo motor functions as a unit to dispense seeds from its storage. The seed container functions through servo-controlled access to let seeds fall into the furrows when the robot reaches strategic points during its operation.





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#### Fertilizer Container:

The fertilizer container holds either liquid or solid fertilizer. The relay module along with motor functions together to measure the amount of fertilizer that the system releases.

#### Metal Furrow Blade:

Attached to the back end of the robot the furrow blade consists of metal construction which receives power from a DC motor. The blade cuts even lines into soil which prepares suitable planting areas.

#### Wheels:

The wheeled robot contains four DC motor-powered wheels that use an L298N motor driver for control. The robot moves through various types of terrain with the help of these wheels.

#### B. Architecture Integration

The "Automatic Seed and Fertilizer Harvesting for Smart Farming" system combines different components which enable efficient automation of furrowing and seeding as well as fertilization. The central control function of the ESP32 microcontroller facilitates movement coordination of the L298N motor driver together with DC motors and servo motors. The entire device functions through battery power and employs relays and sensors to improve automation control. The system enables live operating adjustments through its remote-control system to maintain accurate seed and fertilizer delivery capabilities. The system achieves multiple function execution through its integrated design which reduces manual labour together with enhancing farming efficiency. The system uses electronic components with mechanical assembly features alongside automated elements to advance smart farming strategies and maximize resource efficiency and production levels.



#### Fig.1. Flowchart Of Proposed System

#### C. Flowchart





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Start: When the process starts the system turns on its components while preparing to receive remote control instructions. Initialize ESP32 and Motors: The system initializes the ESP32 microcontroller before setting up the motors consisting of the DC motor and servo along with the relay component.

Remote Control Command Received: The system operates until it receives direction from the remote control which enables the user to control robotic movements.

Decision Point: Move Forward/Backward/Turn: Through the remote -control system the robot selects its path between forward movement and backward movement as well as turning. The forward process enables the furrow mechanism operation. Backward/Turn: Adjusts the robot's position.

Activate Furrow Mechanism (Plow): A DC motor enables operation of the furrowing mechanism to create planting trenches within the soil.

Dispense Seed: The servo motor sends seeds into the developed soil trenches through controlled periodic actions.

Dispense Fertilizer: Relay module operates the fertilizer dispenser that provides correct fertilizer dosage when seeds are addressed.

Decision Point: Continue or Stop Based on Remote: The system verifies if the remote directive is to stop operating or to proceed with the planting tasks: The system repeats the operation sequence and checks the movement to execute the cycle for the upcoming planting position.

Stop: Ends the process.

End: The device stops all movement operations then terminates its business sequence.

#### D. Block Diagram



Fig.2. Block Diagram Of Proposed System





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Prototype



Fig.3. Actual Prototype

#### V. WORKING

An agricultural system operating from a distance controls the Automatic Seed and Fertilizer Harvesting System that performs both furrowing and seeding and fertilizing operations simultaneously. This automation system executes critical farming operations while reducing labour dependency use and enhances operational precision. The remote-controlled system operates through the processing power of its ESP32 microcontroller that directs commands to control all system elements. The furrowing mechanism leads the model design and uses a DC motor for operation. The mechanism operating at the front of the model performs trenching activities to make way for seeding operations. The seed dispensing unit begins its operation after the furrow has been created. The servo motor enables the precise distribution of seeds from the mounted storage container through its controlled release mechanism. A modification of the servo motor's activation timing controls how far apart seeds get placed.

The process to activate fertilizer dispensing takes place at the same moment. The model contains a fertilizer storage element that consists of either a container or a modified bottle which distributes the fertilizer systematically. The relay module acts as a controller to activate and deactivate the dispensing system which maintains equally dispersed fertilizer during seed plantations in the trench. The model operates using a four- wheel drive system which is powered by an L298N motor driver. The system design enables effective and fast transportation on various terrains. A user can exercise total directional and speed control and select precise stopping points through the device's remote functionality. The system operates using rechargeable batteries which provides energy efficiency during all-day operation in agricultural fields.

The developed automation system showcases agricultural applications while maximizing operational accuracy and operational efficiency and operational convenience. An automated system that incorporates various farm operations enables more efficient use of resources and reduced manual work to improve agricultural output.

#### VI. FUTURESCOPES

#### 1. Automation and Ai Integration

AI algorithm incorporation in autonomous navigation needs to be improved in the existing remote-controlled system. This allows the device to recognize seeding and fertilizing routes best without any external assistance.

#### 2. Soil and Crop Monitoring

Incorporation of sensors like soil moisture, pH content, and nutrients would provide information for plant spacing adjustment of fertilizers.





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#### 3. GPS-Based Precision Farming

GPS would assist in surveying the fields in precision farming to allow precise planting of plants with little waste of resources and high yields.

4. Mobile App Control and Data Analysis

It should hence remotely operate the harvester, maintain constant tracking of the current positions, in addition to sending logs data of planting seeds and fertilization to be used for future reference on a mobile app.

5. Energy Efficiency with Solar Power

Installation of the solar panels will be used in powering motors and the microcontroller, and there will be battery charge savings coupled with sustainable growth of green agriculture.

#### 6. Multi-Functionality and Modular Design

The design will involve making multi-functional attachments that can be replaced for other crops and reducing the transition level to newer seed and fertilizers.

#### VII. ADVANTAGES

- 1. Reduces manual labor
- 2. Increases Farming Efficiency
- 3. Minimize Seed and Fertilizer Wastage
- 4. Ensures Precision
- 5. Minimizes resource wastage
- 6. Cost-effective
- 7. Efficiency and time efficiency improve simultaneously
- 8. Remote-controlled operation
- 9. Improves Crop Yield
- 10. Scalable and Adaptable for Different Crops
- 11. Reduce Labor Costs
- 12. Optimizes Resource Utilization

#### VIII. RESULT

Various tests showed that the developed system is capable of furrowing, placing seeds, and fertilizing in an effective manner while consuming power in small proportions. The remote operation also in effect facilitated by the ESP32 microcontroller though the operation was equally enhanced hence convenient to the users. It was also found that the system took less time and effort when compared to the manual methods of planting the seeds and fertilizers with high levels of precision. Huge, small, and medium farming activities may benefit from its battery-powered features and compatibility with other sizes of measurements. Thus, the findings derived from the analyses and modelling present the prospects of the proposed system in creating smart, sustainable and efficient farming.

Feature	Manual Farming	Proposed Automated System
Energy Sources	Human Effort	Battery
Seed Placement Accuracy	Low	High
Fertilizer Wastage	High	Low
Remote Operation	No	Yes





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Labour Requirement	2-3 persons	l person (remote)
Eco-friendliness	Low	High
Time Required	More	Less
Efficiency	Low	High

Fig. Comparison Chart

#### IX. CONCLUSION

The "Automatic Seed and Fertilizer Harvesting for Smart Farming" system is a significant development in enhancing conventional farming. The project integrates furrowing, seeding, and fertilizing into a single machine, which can be operated with a remote. This makes farmers work faster and more precisely. The system employs an ESP32 microcontroller and L298N motor drivers, relay modules, and DC and servo motors. All these parts combine to ensure the machine runs smoothly and completes every task properly.

This project demonstrates how intelligent farming devices can cut down on manual labor, conserve resources such as seeds and fertilizers, and distribute them evenly in the field. The remote-control aspect allows farmers to drive the machine with ease without exerting much physical energy, which is particularly convenient for small and medium-sized farms.

In the future, the system will be better by incorporating sensors to monitor soil moisture, seed count, and fertilizer flow. AI technology can also be utilized to compute routes for the machine to travel independently. This project generally is a solid foundation in making more sophisticated and cheaper farming machines, supporting smart and sustainable agriculture.

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