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Crop Canopy: Empowering Crop Resilience with IoT-Driven Rain Shed Solution

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***Abstract:** India is known for its farming, which has been crucial for its economy. But recently, farming hasn't been doing as well because of unpredictable rain. When the monsoon doesn't behave as expected, it can seriously damage crops, causing farmers to lose a lot of their produce. Unseasonal rains can have significant effects on Post-Harvesting Activities and the quality of harvested agricultural products such as fruit and vegetable crops during different stages of growth and harvesting. Post-harvesting steps are crucial to preserving the quality and ensuring the safety of the harvested products before they reach consumers. After harvesting, drying the crops is essential for storing grains. However, around 70% of farmers use the old method of sun-drying, which becomes a problem when unexpected rain falls. Sometimes, farmers even get hurt or lose their crops due to thunderstorms and lightning. To mitigate these challenges and losses, we have proposed a project aimed at providing an innovative, cost-effective solution: a proper Automated Rain Shed System, which opens and closes to protect crops or plants from unwanted rains and enables remote monitoring of Automated Rain Shed Operations.*

***Keywords:** Automatic Shed, Cloud Storage, Manual Control, Real-Time Monitoring.*

1. INTRODUCTION

In India, Farming is crucial to the economy, around 12 million hectares are affected due to unexpected rain, affecting both horticultural and agricultural crops. This results in about 10% of crops going to waste. Unseasonal rains can have significant effects on Post-Harvesting Activities and the quality of harvested agricultural products. Post-harvesting steps plays a vital role for preserving quality, especially drying grains after harvest. Standing crops like corn, soybeans, and wheat suffer significant losses due to unwanted rainfall, causing economic hardships for farmers. Unseasonal rains also harm fruits with thin skins or nearing maturity,

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like cherries and grapes, leading to cracks and other diseases. Berries like strawberries and blueberries become waterlogged, reducing their quality and life. Leafy greens, tomatoes, root crops, grains, fresh herbs, pulses, and nuts are also adversely affected, facing issues like rotting, wilting, and reduced quality.

To overcome these challenges, we've developed an innovative crop protection system using a moisture sensor. When rain is detected, the sensor triggers an Arduino-Uno, the central controller, activating a Motor Driver and NodeMCU. The NodeMCU processes data, communicates with the cloud, and triggers predefined actions. The Motor Driver activates a protective shield over crops automatically, preventing damage. After the rain stops, the shield reverts, ensuring safety for sensitive crops, equipment, and livestock, allowing smooth agricultural operations. An added feature is the upload of shed operation data to a cloud platform through the ThingSpeak Server, enhancing efficiency and monitoring. This system provides an effective solution to safeguard crops, reducing agricultural losses in India.

2. RELATED WORK

2.1 Existing Methodologies

Rain Sensor Automatically Controlled Drying Shed for Crop Yield Farmers



An agricultural protection system uses sensors like moisture or rain sensors to detect excess moisture or rain during crop drying.[10] These sensors send information to a microcontroller, the AT89S52, it is efficient and programmable which is capable of decision-making. When the sensors detect too much moisture or rain, the microcontroller activates a DC motor to cover over the drying area with a protective shed, safeguarding the crop. Microcontroller can communicate with a smart card and transfer data to a computer via a parallel port. This data is then processed by software installed on the computer. The KEIL software is used to develop the embedded program for this microcontroller [12].

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IoT Based Automatic Shed System to Prevent Unwanted Rain



A smart shed that automatically opens when it starts raining and closes when the rain stops. This works using a rain sensor that senses rain. Whenever the shed opens or closes, it sends a message to your phone using Wi-Fi for remote monitoring. It is a unique umbrella-like cover for the shed.[1] This cover is controlled by a highly torqued motor connected to Arduino. It is designed to protect crops from rain damage by keeping them safe from unwanted rain when it's raining and opening up to let sunlight in when it's dry. This system makes farming easier due to automation, keeping your crops safe from unwanted rain [8].

Automatic Rain Protection for Crops

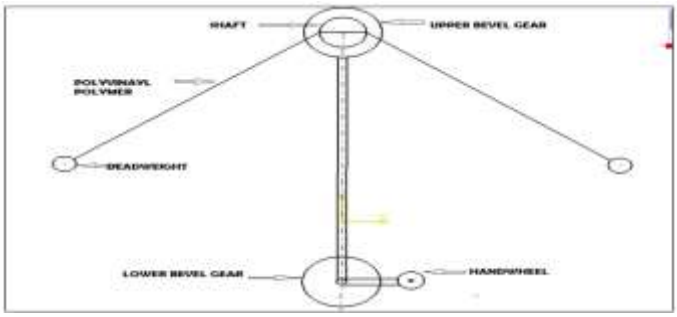


The automatic rain shed design, using Arduino Uno, a rain sensor module, and DC motors, operates without human intervention, aiming to aid farmers against sudden rain [10]. When rain is detected by sensor, a series of copper traces act as a variable resistor, altering resistance based on water amount or surface coverage, as the rain sensor detects water [3], it sends signals the Arduino, then it activates DC motor which covers the area, to protect the crops. This rain shed serves as protecting cover for harvested crops [7]. When rain is detected and closing once the rain ceases.

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Design and Prototyping of Innovative Model for Protecting Crop from Unwanted Rain



The prototype operates via a manual handle that triggers the movement of a specialised cover over crops.[5] Crafted from a distinctive material, this cover has a dual function shielding crops from external elements and collecting rainfall, preventing its contact with the crops. [7]. By reversing the handle's motion, the cover retracts to its original position, unveiling the crops.[1] This innovative mechanism ensures crop protection and water conservation, proving particularly effective during unexpected rainfall. Its adaptability allows for easy removal when protection is unnecessary. Furthermore, the system offers both manual and automatic operation through a mechanical roof movement arrangement [9].

Smart Automation System Using Arduino and Rain Drop Sensor



This project aims to shield crops from heavy rain and save rainwater by using sensors and an automated roof system [6]. When the rain sensor detects rainfall and the soil moisture sensor detects excess water, the roof automatically covers it.[11] The controller activates the GSM module, prompting the DC motor to open the roof when both sensors signal. There's an Arduino-based manual control option in case of any automatic operation problems [5]. Moreover, the GSM module sends SMS alerts to a mobile phone, providing updates regarding crop yield and weather condition which promotes remote monitoring.

2.2 Survey

Data aggregated from government on crop loss and damage in recent years shows that 36 million ha of farmland have been affected due to unwanted rain since 2016 6.65 mha in 2016,

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5.08 mha in 2017, 1.70 mha in 2018, 11.42 mha in 2019, 6.65 mha in 2020 and 5.04 mha in 2021.

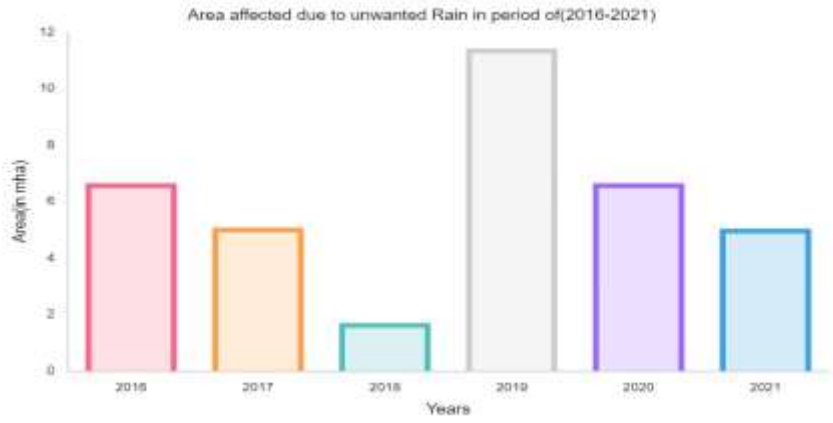


Fig-2.2.1: Area affected in (mha) due to unwanted rain in several years.

Unseasonal rain in March and April has destroyed rabi crops in various parts of the country. Crops over 106 lakh hectares - about 18 percent of the area under rabi crops - have been damaged. This is expected to push up food price

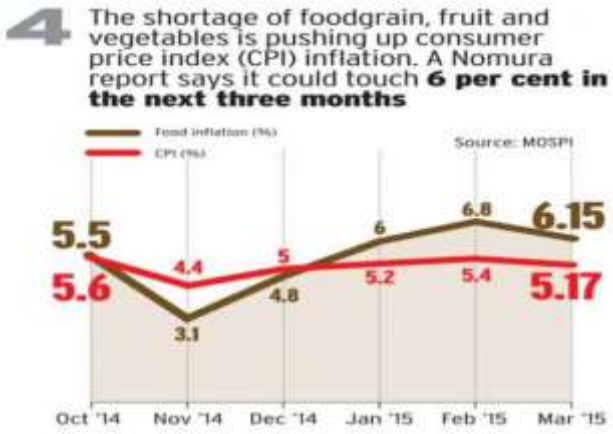


Fig 2.2.2: shortage of food pushing up Consumer price Index (CPI)

The unseasonal rains and hail happened when the rabi crops were ready to harvest. The unseasonal rains affected important rabi crops like wheat, maize, onions, mustard, and gram. These crops form 85 percent of the area normally sown for the rabi season.

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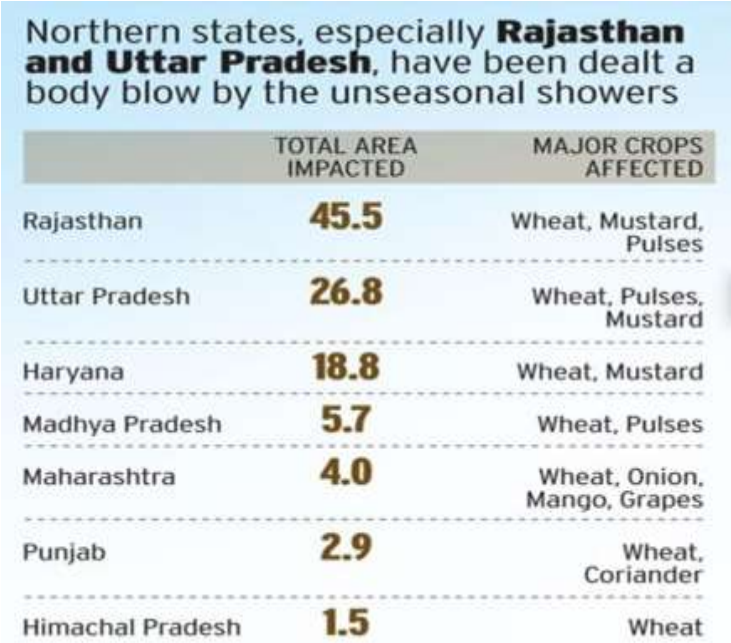


Fig 2.2.3: Unseasonal showers effect on Northern states

Telangana farmers are in trouble after unseasonal rains destroyed much of their standing paddy, maize and cotton crops in September and October. The state's agriculture department has pegged the extent of loss at 1.20 lakh acres. This includes 80,447 acres of paddy, 35,610 acres of cotton and 4,022 acres of maize.

Raining destruction on Telangana

District Name	Excess Cumulative Rainfall (in %)	Excess September rainfall (in %)
Karimnagar	39	126
Siddipet	12	81
Peddapalli	18	89
Kamareddy	15	94
Jagityal	20	61
Nirmal	1	65
Mancherial	10	44
Warangal (Rural)	3	46
Warangal (Urban)	37	78
Adilabad	19	25
Nizamabad	22	121
Rajanna Sircilla	27	139
Jayashankar Bhupalapalli	15	61
Mahabubabad	9	57

Fig 2.2.4: Raining Destruction on Telangana

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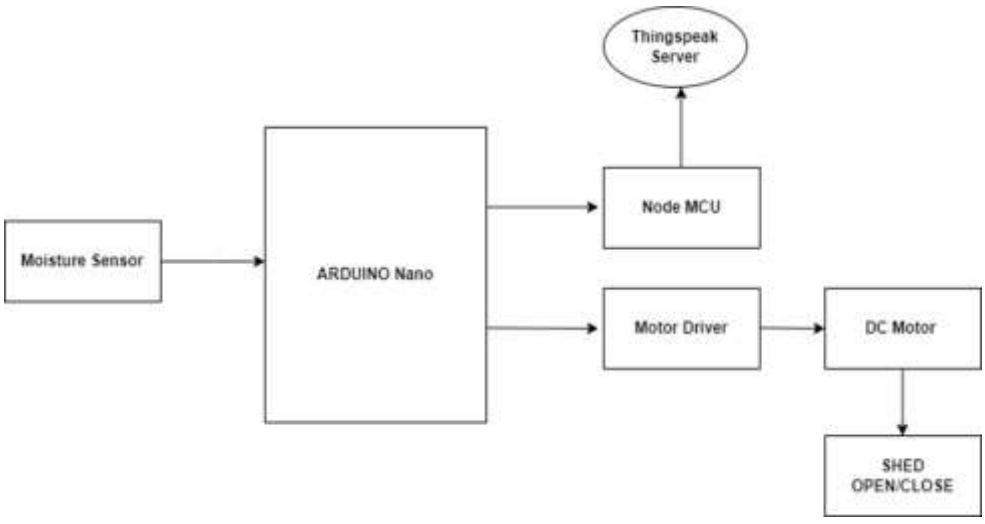
State-wise major Crop area affected due to Unseasonal Rains and Hailstroms during February 2018			
S. No.	States	Major Crops Affected	Preliminary Assessment Area (in lakh ha)
1	Maharashtra	Jowar,Gram, Wheat,Orange, Graphes,Banana and Vegetables	290395
2	Uttar Pradesh	Wheat,Gram,Peas ,Lentil,Rapeseed & Mustard	108199
3	Chhattisgarh	Chickpea,Wheat, Lathyrus,Mustard , Lentils,Linseed Field pea etc.	21828
4	Madya Pradesh	Wheat,Gram,Fiel dpea,Lentil, Linseed,Mustard and Lathyrus etc.	47512
5	Telangana	Paddy,Maize, Flower, Greengram and Sesamum etc.	87748

Fig 2.2.5: State Wise Crops Affected due to unseasonal rain.

Maharashtra is followed by Uttar Pradesh, Telangana, Madhya Pradesh and Chhattisgarh (see Table). Around 300,000 hectares of crops like jowar, gram, wheat and horticulture crops like orange, grapes, bananas, and vegetables were damaged. Similarly, around 100,000 hectares of crops like wheat, gram, peas, lentils, rapeseed and mustard were damaged in Uttar Pradesh.

3. PROPOSED METHODOLOGY

3.1 Block Diagram



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The Automatic Shed Roof project is an agricultural system that uses Arduino Nano, Moisture Sensor, DC Motor and a Node MCU. Arduino Nano acts as the central control unit, moisture sensor, which detects varying moisture levels. When rain is detected beyond a specified threshold, Arduino activates two DC motors via the L293D motor driver IC, which enables the automatic closure of the shed. NodeMCU integrated with an in-built Wi-Fi module makes informed decisions based on moisture levels, by receiving signals from the moisture sensor through the Arduino. Moreover, the Node MCU communicates with the ThingSpeak server. This integration adds uniqueness to the system which allows for real-time storage of shed operation history. Cloud-based storage leads to efficient monitoring and aims to optimise agricultural strategies. The system offers a feature of controlling it manually by users. This feature incorporates buttons that enable users to intervene manually in cases of malfunctions or when specific manual intervention is required. This flexibility ensures that users can take control and change the system's functions which makes the system more reliable.

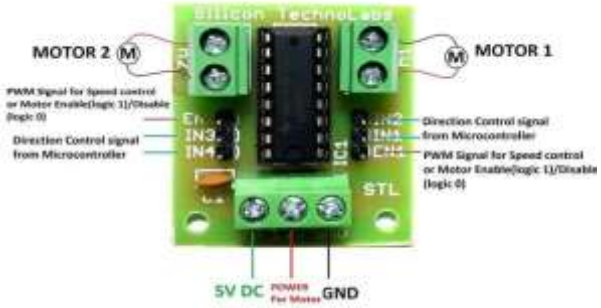
3.2 Details of Component

DC Motor



A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. It plays a crucial role in controlling the movement of the shed, enabling efficient and convenient operation based on the data

L293D Motor Driver

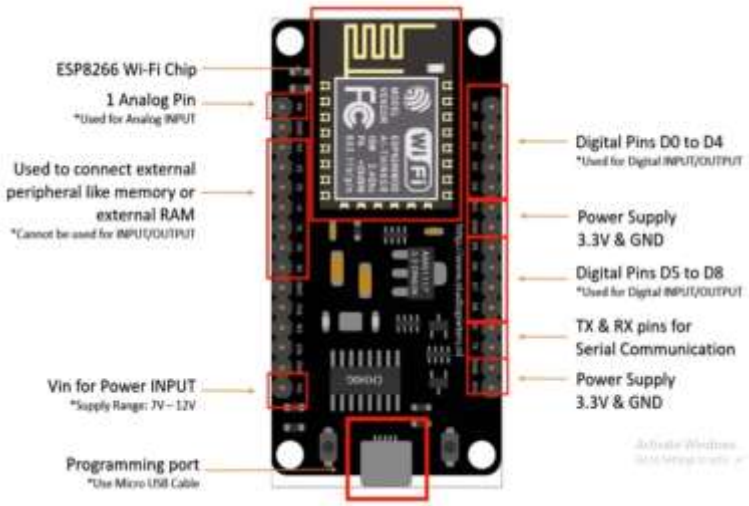


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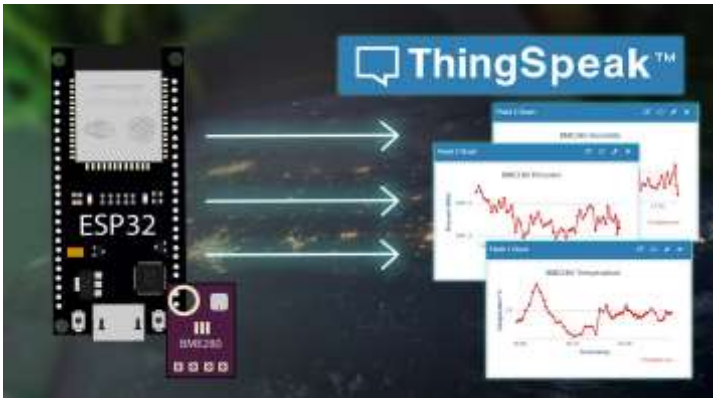
L293d IC is known as a motor driver. It is a low voltage operating device like other ICs. It provides the continuous bidirectional Direct Current to the Motor. The L293D motor driver IC is used in the automatic shed system to control the direction and speed of the DC motor responsible for opening and closing the shed. It receives signals from the microcontroller and protects the motor from damage.

NODE MCU



Node MCU is an open-source firmware developed for the ESP8266 Wi-Fi chip, making it a versatile platform for IoT applications. Node MCU serves as a crucial component in the Automatic Shed by enabling data processing, connectivity with the ThingSpeak server for cloud storage and monitoring, facilitating remote access, and integrating manual control functionalities for improved flexibility and reliability in agricultural crop protection.

ThingSpeak Server



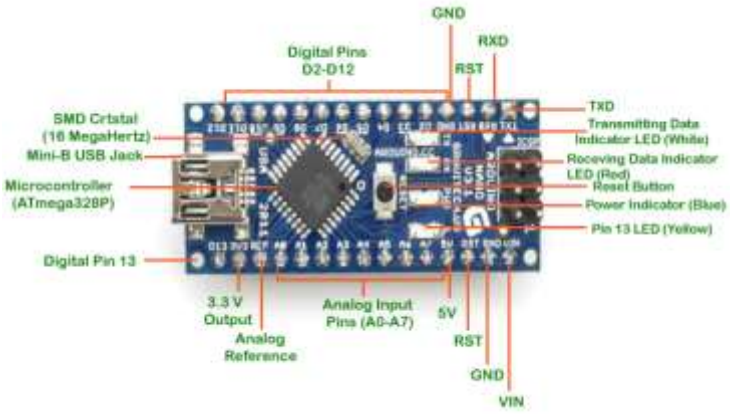
One of the key elements of a generic IoT system that bridges the various ‘things’ is an IoT service. The real power of IoT is harnessed when the things connect to a ‘service’ either directly

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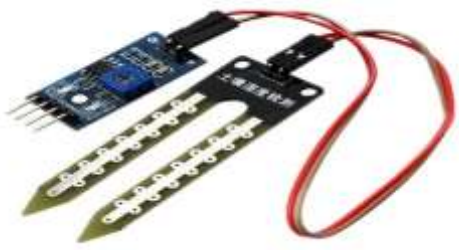
or via other ‘things’ . One such IoT application platform that offers a wide variety of services such as analysis, monitoring and counter-action capabilities is ‘ThingSpeak’. ThingSpeak, a cloud-based IoT platform, stores and analyses real-time data from the Automatic Shed Roof system, enabling remote monitoring and analysis of shed operations. It helps to create insights of data, allowing users to interpret information through graphs and charts. With its API integration, ThingSpeak facilitates seamless communication between IoT devices like the Node MCU, enhancing data transfer. Additionally, ThingSpeak ensures efficient handling of high volumes of data.

ARDUINO NANO



The Arduino Nano is an open-source breadboard-friendly microcontroller board based on the Microchip ATmega328P microcontroller (MCU). The Arduino Nano acts as the system's central controller, managing the moisture sensor and DC motors via the L293D motor driver. It monitors soil moisture levels, activates the shed closure during rain. Additionally, it enables manual control through buttons and interfaces with the Node MCU to share sensor data and facilitate communication with ThingSpeak for data storage and processing.

Soil Moisture Sensor



Soil Moisture Sensor is one kind of low-cost electronic sensor which detects and measures soil moisture levels. It provides real-time data to the Arduino Nano. This data triggers actions, such

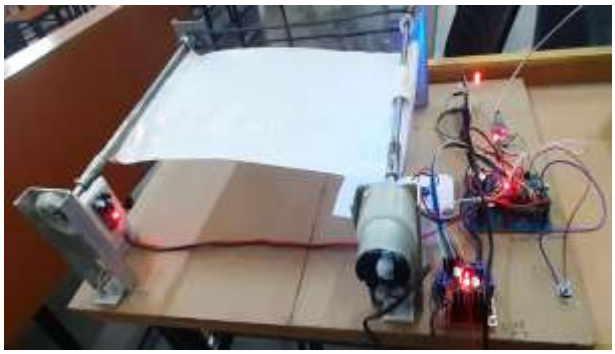
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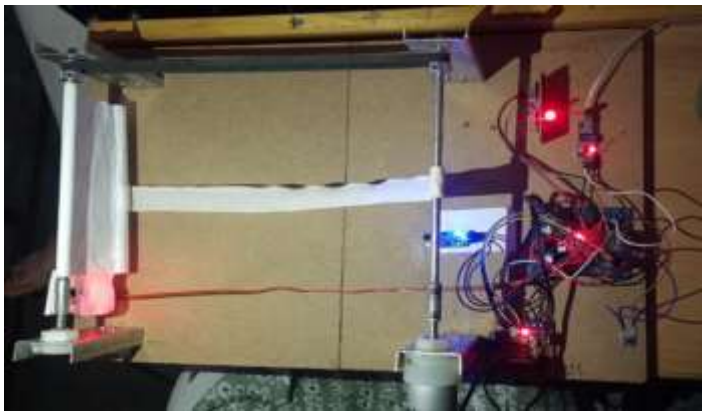
as automatically closing the shed, when moisture levels reach specified thresholds, indicating rainfall. The sensor's input enables accurate decision-making in the system, ensuring timely crop protection.

4. RESULTS AND DISCUSSIONS

An effective system was developed to safeguard crops by automatically opening and closing the shed upon rain detection, ensuring their protection. This system provides seamless communication between NodeMCU and Arduino, enabling the real-time monitoring of shed operation by providing valuable insights with specified time and status of shed on the ThingSpeak server. The system provides a straightforward interface for human intervention as necessary, incorporating user-friendly buttons for manual control. The system is automated by opening a shed by detecting rain and closing the shed when rain stops. It makes the system energy efficient.



Continuous monitoring of moisture levels showcased its reliability in real-world farming scenarios, immediate response to change in moisture levels makes it efficient. Its ability to showcase data insights helps farmers enhance its usefulness as a smart farming tool. By leveraging advanced technologies like NodeMCU and integrating with the Thingspeak server, this automated system offers a simple and accessible solution. It empowers farmers to streamline their processes, contributing significantly to enhanced productivity and crop management.



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The Thing Speak server acts as a central hub for storing and analysing data related to shed operations with date and time, allowing farmers to monitor shed operation records remotely.

5. CONCLUSION

The Automatic Shed Roof system stands as a modern solution for modern agriculture, effectively addressing critical challenges faced by farmers during unwanted rain. It is an integration of cutting-edge technologies like the Arduino nano, NodeMCU, moisture sensor and Thingspeak server revolutionises crop protection by automatically opening and closing the shed in response to moisture levels indicating rain, it shields crops from potential damage, reducing agricultural losses caused by excessive water. This system more focuses on smart farming enabling automated protection using IOT. The system not only performs automated opening and closure but also creates insights of data which empowers farmers with real-time data insights. The collaboration with ThingSpeak server allows for seamless data storage and analysis, providing farmers with a comprehensive understanding of historical operation records. This information serves as a powerful tool for informed decision-making, enabling precise irrigation scheduling and resource management.

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