A

Capstone Project Report

On

"Development and Commercialization of IOT Based Vertical Farming"

Submitted

In partial fulfilment of the requirements for the degree of

Bachelor of Technology

in

Electronics and Telecommunication Engineering

by

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Under the Guidance of

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Rajarambapu Institute of Technology, Rajaramnagar

(An autonomous Institute, Affiliated to Shivaji University)

CERTIFICATE

K. E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Autonomous Institute, Affiliated with Shivaji University)

2022-2023

This is to certify that, below mentioned list of students, have successfully completed the project work and submitted project report on "DEVELOPMENT AND COMMERCIALIZATION OF IOT BASED VERTICAL FARMING", for the partial fulfilment of the requirement for the degree of Bachelor of Technology in Electronics and Telecommunication at Rajarambapu Institute of Technology, Rajaramnagar, Dist: Sangli.

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DECLARATION BY STUDENT

We hereby declare that the project entitled**, "Development and Commercialization of IOT Based vertical farming"** was carried out and written by us under the guidance of Prof. P. P. More, Assistant Professor, Department of Electronics and Telecommunications Engineering, Rajarambapu Institute of Technology, Rajaramnagar. This work has not been previously formed the basis for the award of any degree or certificate nor has been submitted elsewhere for the award of any degree or diploma.

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DECLARATION BY GUIDE

It is certified that the work contained in the project report titled **"Development and Commercialization of IOT Based vertical farming**" by above mentioned students, has been carried out under my supervision and this work has been submitted elsewhere for a degree.

Signature of Project Guide

Prof. P. P. More

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ACKNOWLEDGEMENT

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We are indebted to the library personnel's for offering all the help in completing the project work. Last but not only the least we are thankful to our colleagues and those helped us directly or indirectly throughout this project work.

ABSTRACT

Around three million hectares of arable land are lost annually due to soil erosion and conversion for different development goals, which also lowers crop yields. Using vertical buildings and a controlled atmosphere to raise crops, vertical farming maximises productivity and efficiency from a little amount of land.

The suggested approach involves planting saplings in a tray that is placed on a vertical rack while cultivating in a carefully monitored environment. Existing system was developed with Arduino Novelty in this system is, PIC18F4520 which works better than Arduino and helped to achieve more accuracy. The vertical agricultural system and the Internet of Things will both be integrated into this project. In order to eliminate all potential problems and control farming operations from far-off locations, it is necessary to automate farm tasks with minimal human involvement which will be done using mobile application. We can monitor whole system through android application.

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CHAPTER 1

INTRODUCTION

A soil based traditional farming uses up to 70% fresh water and 70-80% soil for farming. Constant changes in environment causes the less production. The data obtained by the statistical analysis of the growth of crops and initial plantation compared with several datasets over a large area based on soil quality, weather monitoring etc. These behavioural conditions and prior knowledge focus on how to improve the production of plants and the quality of plants. For such a production of plants, we are arriving technique known as "Vertical farming".

Due to the lack of traditional farming in urban areas, introducing vertical farming in such area will be more beneficial for creating more suitable food system. There is no wastage of seed, water and fertilizers in this technique. Here we use this technique for cattle feeding, which will provide healthy food for cattle. Using this food milk production will be more as compared to traditional farming food.

Hydroponic, Aquaponics and Aeroponic are the technique for soilless vertical farming. Here we are focusing on the hydroponic technique (i.e., growing crop only on water without use of soil). Vertical farming is method of growing crop in vertical stacked layer.

It often controlled environment agriculture so that aims to optimize plant growth and soilless farming technique is easy to handle. The main advantage of vertical farming is increasing crop yield and easy to implement in small area.

In this vertical we are going to grow the maize for cattle. In general corn contains 6 – 8 % proteins, but while preparing for food it contains 20 – 25 % proteins. Vertical farming helps to increase weight of cattle. This will give more profit to farmers. In this technology it is mandatory to maintain temperature up to 25 degree and humidity up to 60 – 70 %. This technology helps to increase vitamins A, B, C, D in food. PH of hydroponic food is above 8, but regular traditional farming food is acidic as their PH is below 7.

In the hydroponic technique water is spray in every 2hr for 1min. for hydroponic food increases quantity of milk, fat, protein. For one cattle gives 2 trays in 1 day (morning, evening) in that food protein, enzyme, carbohydrate, minerals proportion is more.

During growing hydroponic crops take care of temp it should not be increases above 25 if it is increases above that then spray of water need to increases. And of growing crops use best seed. And make proper hole to the tray. If it is not proper then water remains it and food should not grow proper sometimes fungus to the crop.

In the vertical farming hydroponic technique, we are doing it automatic by using IOT. We are implemented several hardware devices which monitor agricultural variables like temperature, humidity, water level. And are implemented using software and hardware devices. By these kinds of implementation, we are taking off the traditional method of agriculture to extent where there is no human intervention in growing crops efficient utilization of natural resources. By adopting these technologies, we can reduce the wastage of resources and also provide the proper care of growth of crop or plant.

Advantages of Hydroponic Technology:

- Hydroponic plants are better for consumption.
- It is easy technique which require less water.
- Less harvesting time.
- Food is available within 10 - 12 days.
- Plants are healthier with better yield.

1.1 Project Motivation: -

In these project focus on reduces the manual work and make it automatic. Also, we make easy way of farming. So that every farmer can do it. We are making cattle food which is healthier to cattle. In vertical farming food proportion of carbohydrate, protein is more and when cattle feeding this food then the milk production is better and fat, protein is more so that cattle stay healthy. Production is more so that farmer profit is also more.

In vertical farming using hydroponic technique require less water. And from 1kg of seed make more food. In drought places these techniques is very useful.

When wheat is feeding to Hen then the size of eggs will be increases and also weight increases.

1.2 Project Objective:

Vertical farming using hydroponic technology is the best way to grow cattle food like wheat and corn and it is designed in easy way. The objective of this technique is to reduce manual work and make it automatic within reliable cost. Main domain of these project is following:

- Reduce manpower and make it automatic.
- Make easy way of farming.
- Make healthy cattle food.
- Create profit of farmer
- All details send to farmer on app.

The project objective also describes an outcome meaning the effect or change that project is supposed to cause. In practice it is often not simple to distinguish outcomes from output i.e., project product and deliverable. In these techniques require less space and water so anyone can do it and mainly in the drought area. From that product production of milk will be increases. And short time require for making food. These techniques implemented within short period and helpful everyone.

1.3 Project Scope:

The hydroponic method, which is used to grow crops only on water, is employed in vertical farming. These farms use an automated system, and they are modern farms. Delivery trucks will be less in demand as there would be less automotive transportation. utilities and garbage trucks. overall health as a result of less bacteria entering the environment and increased productivity due to the direct channelling of municipal trash into the farm building recycling system. In a vertical farm, water may be used more effectively. less pollutants and CO2 emissions. Crops will be shielded from severe weather. Crops will be eaten right away. There are four different techniques used in vertical farming: aeroponic, hydroponic, and aquaponic.

- **Hydroponic Technique:**

These is the dominant technique used in vertical farming. Hydroponic technique is used to grow plants only in water, without soil or fertilizer. More temperature is not required in this technique.

- **Aeroponic Technique:**

An aeroponic system is by far the most efficient plant-growing system for vertical farms, using up to 90% less water. It is still used in the world of vertical farming, but it is attracting insignificant interest.

- **Aquaponic Technique:**

The Aquaponics system is one step forward from the hydroponics system, which is a combination of farming and fishing in the same ecosystem. Fish grown in indoor ponds produce nutrient-rich waste which is used as feed source for plants. It is small scale vertical farming system.

1.4 Relevance:

The procedure of using hydroponics for vertical farming is to grow crops. These plants are used to feed cattle. There are several ways for farmers to benefit. There are numerous things that can be made efficient.

1) **Reliable Harvest:**

Growing cycles in vertical farm systems are reliable and constant. A vertical farm system totally eliminates external environmental issues including illnesses, pests, and climate control by being completely enclosed and climate controlled.

2) **Low Labour Cost:**

Vertical farm systems have an automatic, completely automated growing system. Only arranging the harvest on site necessitates manual effort, and the required skill level is modest.

3) **Low Water Usage**:

A vertical farm system consumes around 10% as little water as regular hydroponics and about 20% less than traditional farming.

1.5 Summary

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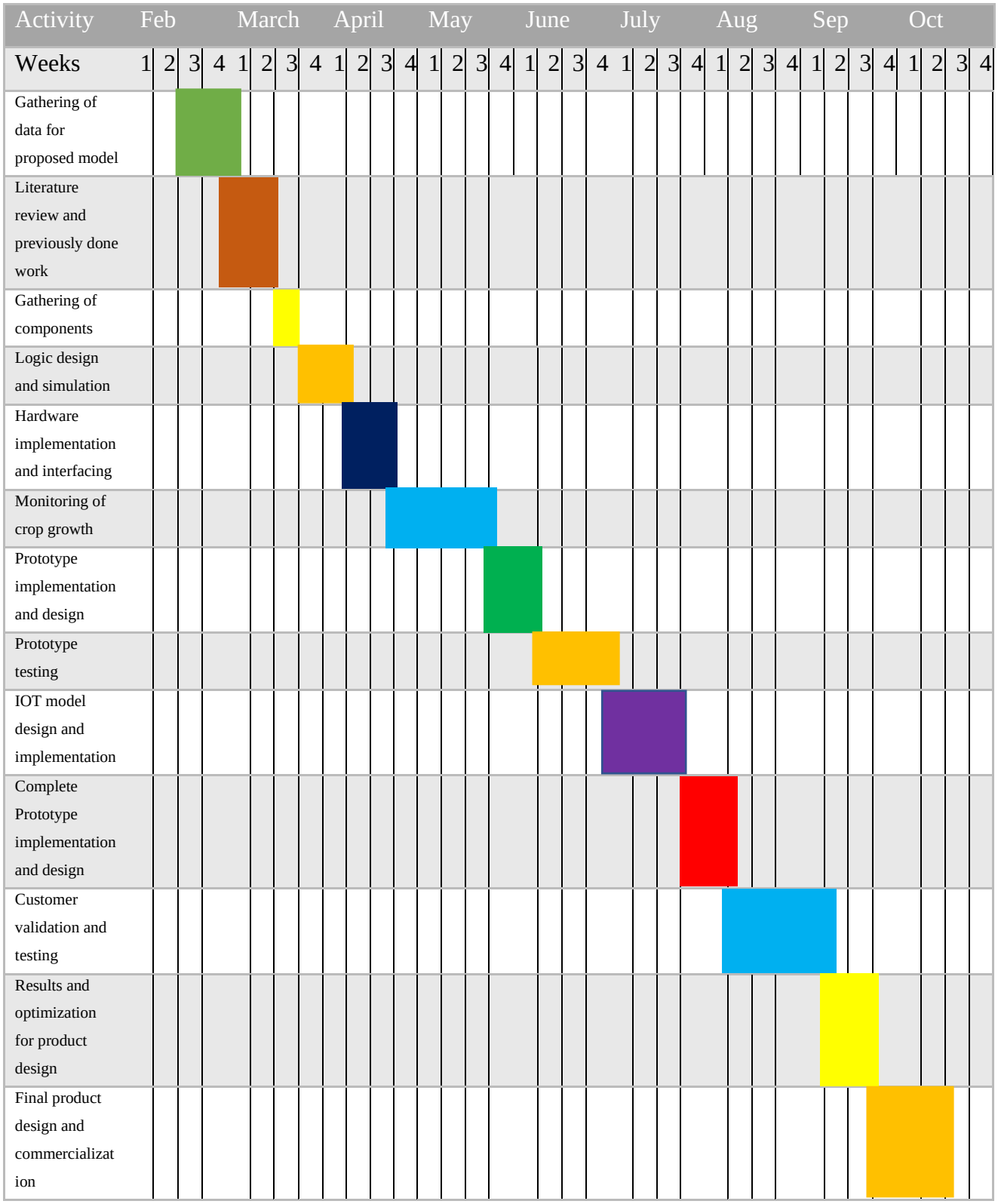
Activity
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Weeks
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Gathering of data for proposed model
Literature review and previously done work
Gathering of components
Logic design and simulation
Hardware implementation and interfacing
Monitoring of crop growth
Prototype implementation and design
Prototype testing
IOT model design and implementation
Complete Prototype implementation and design
Customer validation and testing
Results and optimization for product design
Final product design and commercializat ion

CHAPTER 2

LITERATURE SURVEY

This chapter provides an overview of vertical farming technology in the literature. It also discusses the results of a literature review on the benefits of hydroponic feed.

2.1 Literary Research on Vertical Farming Technology and its types

The global problem of long-term description of the stock of agricultural land per capita is worsening. Information on projected population growth worldwide According to the Food and Agriculture Organization, less land per person will be used for agriculture. This loss is expected to continue due to the effects of climate change, geographic expansion of drylands, declines in freshwater supplies, and population growth. This means that there is not enough agricultural land on the planet to feed the world's growing population. A more comprehensive list of significant factors affecting arable land availability would also include: climate change, water scarcity, declining fisheries, rising costs for agribusiness (fertilizers, fuels and pesticides), rapidly growing world population, and land degradation and land depletion from over-farming.

- **Potential of Vertical farming:**

The idea of vertical farming was put forward with the intention of expanding the amount of agricultural land uphill. By creating a multi-level high-rise on the same lot, a more efficient arable area for crops and grass can be created. It eliminates the hydroponic growing method used in greenhouses and solves land use problems such as the need for fertilizers, pesticides and herbicides. By being close to the consumer, transformation costs can be reduced, year-round production can be planned based on demand, and plant growth conditions can be fine-tuned for maximum yield by adjusting temperature, humidity and light conditions.

- **General Structure of Vertical Farming:**

Vertical farming varies from city to city. The following section explains more general tips on VF structure, designs and concepts. Vertical farming is the practice of growing crops in vertical stacked layers. Vertical farming is also useful for controlled environment farming to optimize plant growth and soilless farming technologies such as hydroponics. Some common options for vertical farming

system structures include rooms, metal rails, and pipe attachment. In 1999, Dickson Despommier, a professor of public and environmental health at Columbia University, proposed a system of vertical farming.

- **Farming System**

Crop Selection:

Almost any crop can be grown in vertical farming if all the required conditions are met. Due to height restrictions, plants that grow on trees, such as bananas, olives, avocados and nuts, are difficult to grow indoors. However, there is another chance to grow tree crops and that is to grow them in an outside area where space is available. In this way, more than 40 different types of vegetables can be selected for growing indoors in a hydroponic vertical way. The most common produce now produced on vertical farms are lettuce, leafy greens, herbs, strawberries and cucumbers. Corn and wheat can also be produced along with crops and soils for biofuels that can be used as herb machines and for animal husbandry.

Hydroponics:

Hydroponics is a technology based on water without soil plants and green feed. In a hydroponic system, plant roots are immersed in a liquid solution containing micronutrients such as nitrogen, phosphorus, sulfur, potassium, calcium, as well as trace elements, including iron, chlorine, boron, zinc, copper.

Aquaponics:

Aquaponics is the result of merging hydroponics, a method used without soil, with aquaculture, which refers to the practice of raising fish. Aquaponics is a more advanced type of hydroponics that involves the production of both aquatic and terrestrial plants and animals on the same surface while maintaining a closed loop. In the biofilter, harmful ammonia is converted into nutrient-rich nitrates, the nutrient-rich aquarium water is filtered by dirt removal units before entering. The plants clean the waste water, which is then recycled back into the aquarium, absorbing nutrients. In order to save energy overall, green houses regulate the temperature at night. In addition to removing carbon dioxide from the fish, the crops also provide a healthy environment for the fish. Production is focused on vertical farming.

Aeroponics:

Aeroponics was invented by NASA (National Aeronautics and Space Administration) in 1990 to grow plants efficiently. Unlike green feed hydroponics and aquaponics, aeroponics does not require any kind of liquid and solid material to grow plants. There are plants are suspended. Aeroponics is a technology of growing plants without any medium using air and fog environment.

- **Livestock Production:**

It has the advantage of considerable cultural verisimilitude. Livestock trade in rich countries has recently placed more emphasis on animal welfare, environmental protection, food safety and human well-being than on product quality. Increased livestock production is required. It must take care of the harmful effects that animal production, food quality and moral requirements for animal health have on the environment. In order to produce more meat and eggs, portly farming also uses vertical farming.

- **Control Environment System:**

HVAC Subsystem:

Temperature, air conditioning or ventilation system are important when designing vertical farming. The following privileges of the HVAC system (Heating, Ventilation and Air Conditioning) make it suitable for vertical farming: internal door quality, energy saving, stability of humidity and heat in vertical farms provided by plant halls. A room or hydroponic unit that uses the least energy and the same amount of energy. Another important point is the heating or cooling of the room or vertical farming unit, which depends on the geographical coordination and the environment around the farm. The use of regenerative energy needs to be supported by a reasonable and sufficient distribution and transmission system.

The Suggestion To Be Within This Procedure:

The use of geothermal equipment, solar power plants for heating or cooling together with the possibility of using underground or surface water, heat pumps. Water supported system translocation heat load. Earth canons are used to realize regenerative energy air collectors for adjusting the required healthy outdoor air quality. Monitoring is carried out control system that directs the supervision of

proper automated intervening tasks. Evaporation the amount of water that happens to the leaves is called transpiration. The stomata of the plants are still preserved open to allow photosynthesis and movement of minerals from the roots through the leaves and making them cool. A single transfer water collected in a confined space can hinder photosynthesis of rice can lead to condensation of plants along with other species surfaces. Transport water condensation contributes to vital infections and mold and therefore, it contributes to the occurrence of dangerous diseases. Uncontrolled humidity helps with this established algae as well as other unrepentant organisms as a result dehumidification is essential in vertical farming

Smart Device:

As a fully automated process, vertical farming makes extensive use of smart devices or sensors and actuators that also communicate with other systems without requiring human contact. Realize vertical farming as a technology, maintain a stable environment, and contribute to the production of accurate information and services. There is a database that has all the knowledge regarding potential diseases. When the ventilation system is considered, there is still a need for outside weather even in situations where crops are grown indoors. Making appropriate decisions about regulator selection requires knowing the context. Building a healthy environment for food production is greatly influenced by knowledge about the amount of crop produced as well as transmissible diseases.

2.2 Literature Survey on Hydroponic Fodder:

Livestock production accounts for approximately 25% of India's agricultural GDP and is critical to the survival of small and marginal farmers as well as landless laborers in the country's agricultural economy. Green fodder is considered one of the most important inputs in livestock farming as it provides the nutrients needed for milk and meat production as well as to maintain animal health. A cow producing 8 to 10 liters of milk per day is what the National Dairy Development Board (NDDB) survey recommends. During lactation, if the feeding amount is 25-30 kg of green fodder, 4-5 kg of dry fodder and 4-4.5 kg of concentrate per day. Cattle production and health are directly affected by the quality of green forage. An alternative method of cultivation is hydroponic.

Principles of Hydroponic Technology:

- Hydroponics is growing of cereal grains with necessary moisture, nutrient without soil growing medium.

- Total time period of cultivation of fodder is 7-8 days and total height of fodder developed up to 20-30 cm from roots.
- Different cereal grain i.e maize, bajra, millets, wheat etc. it is practice of growing plant and fodder without using water without soil with effectively and grow fodder for livestock.
- Plants require three things seed, water/nutrient water, and sunlight. Hydroponics is a straight forward way of providing all these nutrients without the need of soil under controlled environment condition to optimize the growth of plants.

Techniques for Production:

- Cultivation can be automatic or it can be a cheap and efficient structure using the principle of seed germination.
- An automatic system has a chamber in which foggers or drip irrigation are installed.
- Relative humidity between 70-80% and temperature maintained at 24 to 30 degrees Celsius are maintained and keep the seed moist.
- However, a low cost sustainable system according to local input needs is required for Indian farmers.
- A specially designed frame made of tubes or angle bars is constructed to hold a plastic tray in which 1-1.5 kg of seed can be placed to produce about 6-7.5 kg of green fodder.

Plant Visit:

Location: A S AGRI AND AQUA LLP(A S GROUP)

It is a group of talented youth and experienced people from different verticals who have come together to explore their common goal of agriculture and aquaculture. A S Group is involved in revolutionary technologies in vertical farming, aquaculture, healthcare and dietary supplements, contract farming, turmeric trading and many more.

We went to one of their turmeric factories in Kanegaon, Sangli.

Minimal tillage practices can be used to prepare the soil for growing turmeric. In the case of an irrigated crop, ridges and furrows are made and the rhizomes are planted in shallow pits on top of the ridges. It is possible to prepare beds with a height of 15 cm, a width of 1 m and an adequate length to ensure a distance between the beds of at least 50 cm. Standard distances between plants are 15-20 cm and between ridges 45-60 cm. Beds are preferably solar to prevent the growth of pests and disease-causing organisms. After the process is completed, the polyethylene sheets used for solar ground

heating should be stored carefully.

Why Choose Vertical Farming:

Led by AS AGRI AND AQUA, the next-generation urban agriculture project involves vertical cultivation of turmeric and includes a secondary polyhouse for large-scale production of organic turmeric.

Vertical farming ensures high performance using fewer resources, saves 80% of water, a significant amount of labor and produces food of excellent quality. Without the use of dangerous chemicals and makes sure that the agricultural land is protected from diseases and unpredictable nature.

Characteristics of Technology:

- 40 to 60 times higher yield
- Less water consumption
- Minimum manpower
- 100% natural product

Fig 1. Plant Visit

CHAPTER 3

PROJECT COMPONENTS

3.1 PIC18F4520:

• PIC stands for Peripheral Interface Controller

• PIC microcontroller is fast and easy to implement program compared to other microcontrollers like 8051.

• Compared to other microcontrollers, PIC microcontroller has fast performance. We are using PIC18F4520 microcontroller in our project.

• PIC18F4520 is introduced by Microchip.

• It is an 8-bit enhanced flash PIC microcontroller with RISC architecture. Thanks to the RISC architecture, the PIC microcontroller has fast performance. PIC programming can be done in mikroC and MPLAB X IDE.

• Pin can be configured as 1 for output and 0 for input.

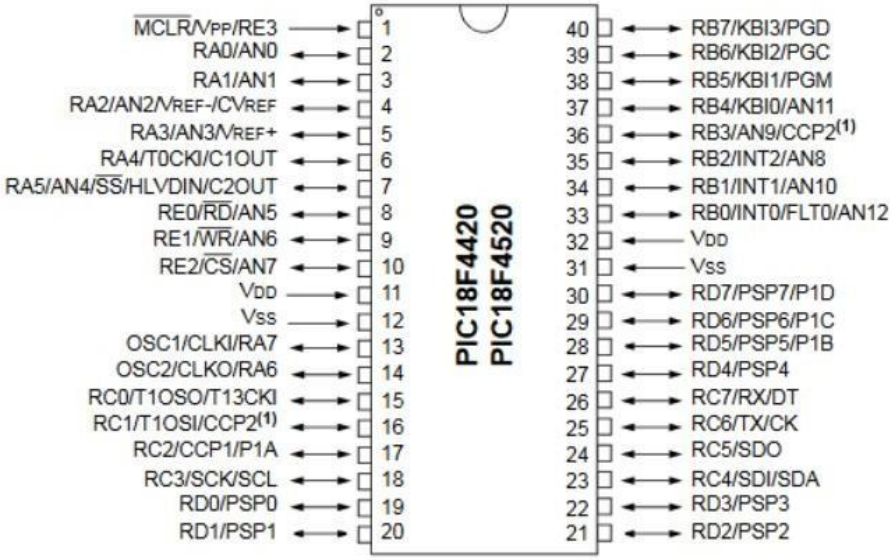

Fig 2: PIC18F4520 Pin Diagram

Operating Frequency	DC-40MHz
Operating Voltage	2-5.5V
Program Memory (Bytes)	32768
Program Memory (Instructions)	16384
Data Memory (Bytes)	1536
Data EEPROM Memory (Bytes)	256
Interrupt Sources	20
I/O Ports	5 (Port A-E)
Timers	4 (8-bit timer:1 16-bit timer:3)
Capture/Compare/PWM Modules	1
Enhanced Capture /Compare/PWM Mode	1
Serial Communication	MSSP, Enhanced USART
Parallel Communication	Yes
10-bit ADC Module	13 input channels
Resets (and Delays)	POR,BOR RESET Instruction, Stack Full, Stack underflow (PWRT, OST), MCLR (optional6y), WDT
Programmable High/Low-voltage Detect	Yes
Programmable Brown-out Reset	Yes
Instruction Set	75 instructions 83 with extended Instruction Set Enabled
Packages	40-pin PDIP 44-pin QFN 44-pin TQFP

Table 1: PIC18F4520 Features

- **PIC18F4520 Registers:**

In the PIC16F family, if the actual physical state of a pin differs from the value written in the PORT register, unexpected output behavior will occur. This problem is known as a read modify write (RMW) problem.

To solve this problem, the LAT register is added to the PIC18F family.

PIC18F series has three registers as TRIS, PORT, LAT. So each port is associated with these three registers.

The TRIS register is used to configure a port pin as an input or output. The TRIS register is used to determine the direction of each digital IO pin.

The PORT register is used to read data from the input pins or is used to check the state of the input pin. The LAT register is used to write data to the output pins.

Writing data to the LAT register is equivalent to the PORT register, but as for the LAT register, it reads the Latch port regardless of the physical state (voltage level) of the corresponding pin. So the PIC18F series will not have the RMW problem.

3.2 Water Level Sensor: (HC-SR04)

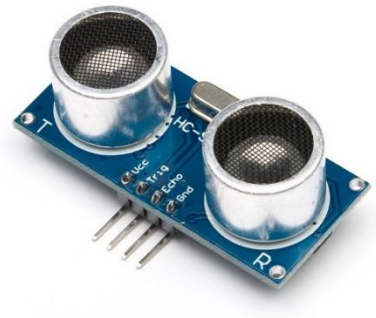

Fig 3: HC-SR04

Water level sensors are used in the upper part of the water tank to achieve automation when turning the engine on and off.

Features and Specifications:

- Power Supply: 5V
- Quiescent current: 2mA
- Effectual angle: < 15 degree
- Ranging distance: 2 CM to 500 CM
- Resolution: 1 CM
- Ultrasonic Frequency: 40kHz

Pin No.	Function	Name
1	Supply voltage; 5V	VCC
2	Trigger	Trig
3	Echo pulse	Echo
4	Ground(0V)	Gnd

Table 2: HC-SR04 Pin Description

3.3 ESP8266-01 Wi-Fi Model:

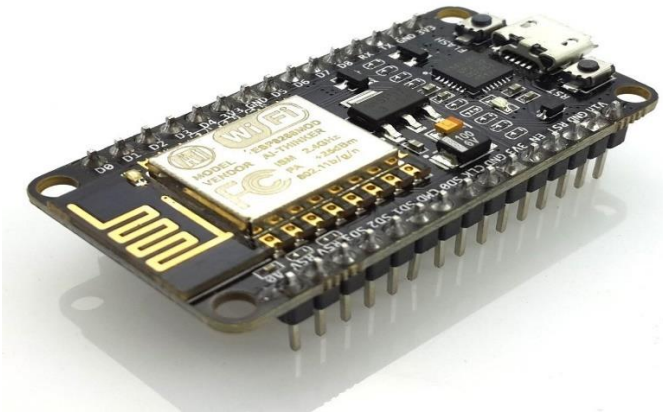

Fig 4: ESP 8266-01 Wi – Fi Model

ESP8266 IS Wi-Fi enabled system on Chip module. It is used for development of IOT based application.

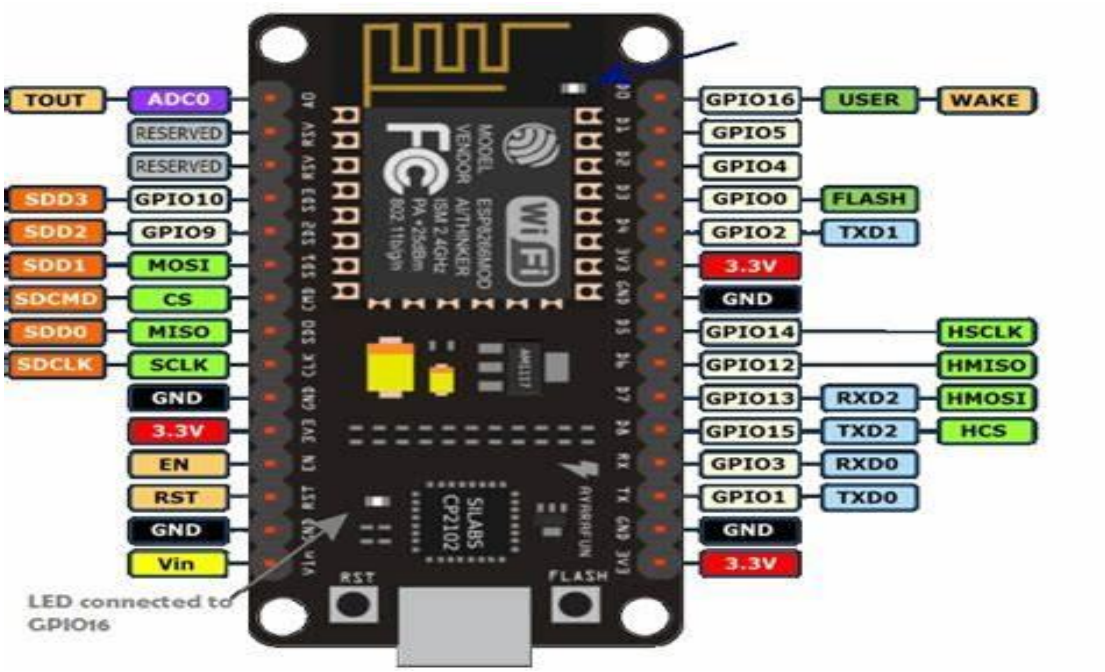

Fig 5: ESP8266-01 Pinout

ESP8266-01 Features:

- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB
- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

Pin Category	Name	Description
Power	Micro-USB, 3.3V, GND, Vin	**Micro-USB:** NodeMCU can be powered through the USB port **3.3V:** Regulated 3.3V can be supplied to this pin to power the board **GND:** Ground pins **Vin:** External Power Supply
Control Pins	EN, RST	The pin and the button reset the microcontroller
Analog Pin	A0	Used to measure analog voltage in the range of 0-3.3V
GPIO Pins	GPIO1 to GPIO16	NodeMCU has 16 general purpose input-output pins on its board
SPI Pins	SD1, CMD, SD0, CLK	NodeMCU has four pins available for SPI communication.
UART Pins	TXD0, RXD0, TXD2, RXD2	NodeMCU has two UART interfaces, UART0 (RXD0 & TXD0) and UART1 (RXD1 & TXD1). UART1 is used to upload the firmware/program.
I2C Pins		NodeMCU has I2C functionality support but due to the internal functionality of these pins, you have to find which pin is I2C.

Table 4: ESP8266 Pin Description

3.4 LM35

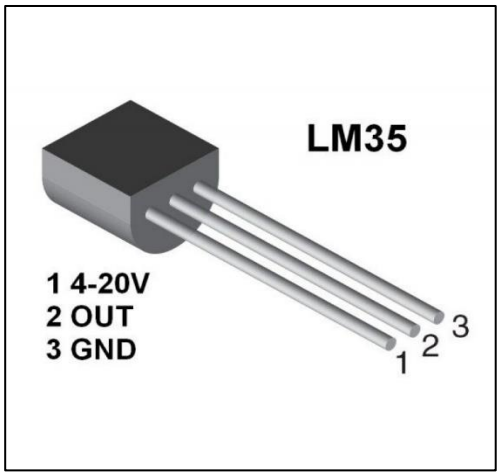

Fig 6: LM35

Features and Specifications

- Operational Voltage: 4 – 30 Volts
- Output Voltage:-1 – 6 Volts
- Output Current: 10 mA
- Operating Temperature: -55^0C -150^0C
- Output Impedance: 0.1 ohms for 1mA load
- Drain Current: > 60 uA
- Sink Current: 1 uA
- Accuracy: 0.5^0C at 25^0C

Pin No.	Function	Name
1	Supply voltage; 5V(+35V to -2V)	VCC
2	Output voltage (+6V to -1V)	Output
3	Ground(0V)	Ground

Table 5: LM35 Pin Description

3.5 Humidity and Temperature Sensor Module -SL -HS-220

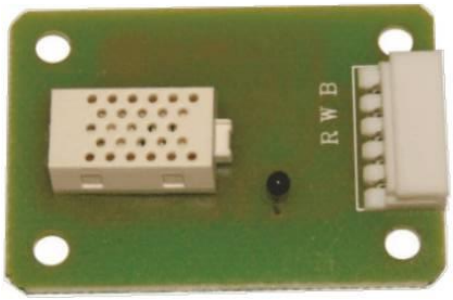

Fig 7: Humidity and Temperature Sensor Module -SL -HS-220

Pin No.	Function	Name
1	Thermistor sensor	-
2	Thermistor sensor	-
3	Power supply	R
4	Humidity output	W
5	Ground	B

Table 5: SL-HS 220 Pin Description

Specification:

- Rated voltage: DC 5V +/- 5%
- Rated power: 1.6 mA (max. 3 mA)
- Operating temperature range: 0 – 60℃
- Operating humidity range: below 95% RH
- Humidity measurement range: 20 ~ 950/0RH
- Storage temperature range: 0 ~ 70˚C
- Humidity storage range: Lower than 95% RH
- Humidity measurement accuracy: +/-5% RH at 25℃, Vin=5.0 V output 1815-2146 mV
- Typical humidity data corresponding to output: Based on supplied 5.0 V power supply, at 25℃.

CHAPTER 4

BLOCK DIAGRAM AND CIRCUIT DIAGRAM

4.1 Block Diagram

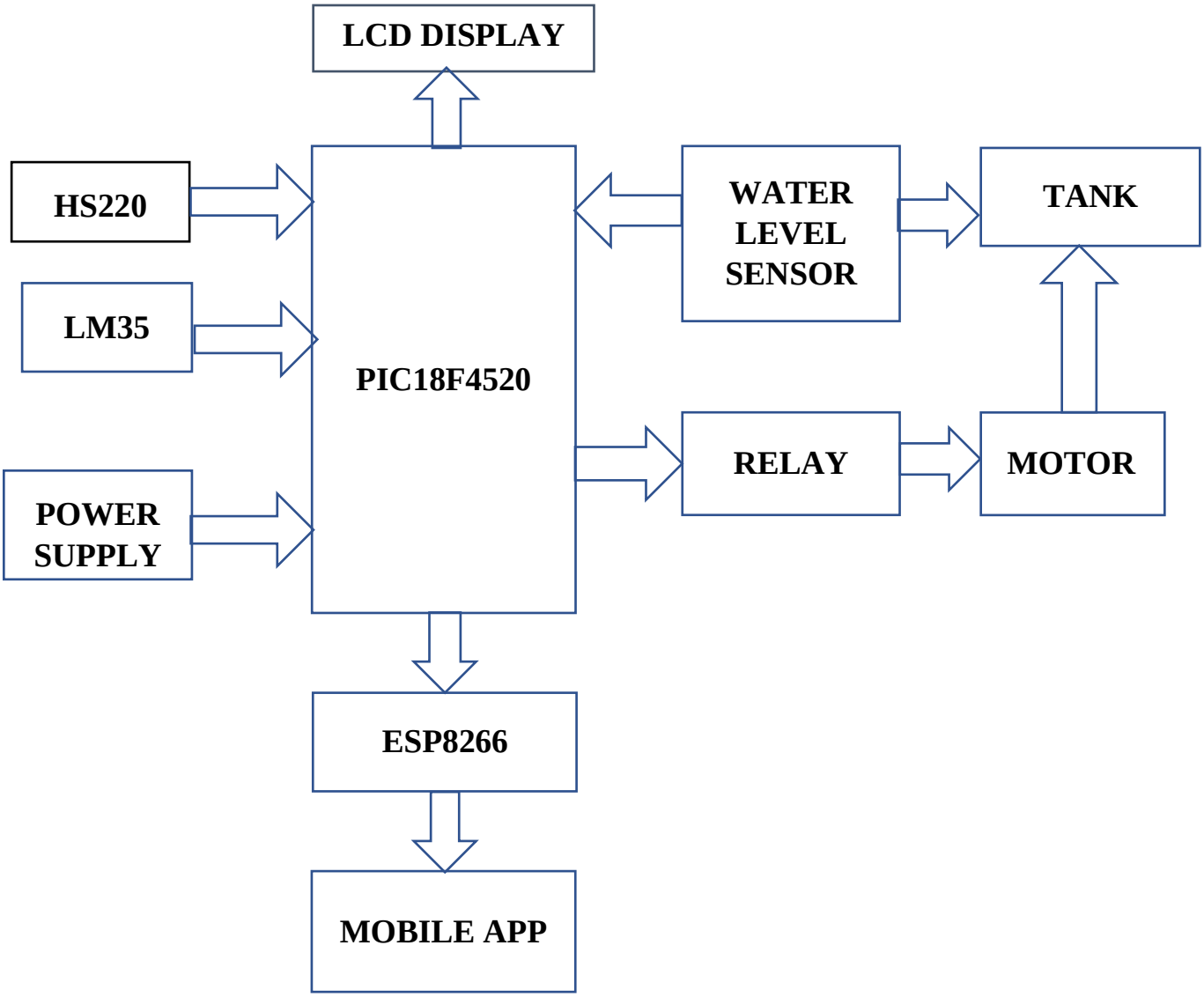

Fig 8: Block Diagram

PIC18F4520 is the microcontroller used here which is responsible for taking the data from the sensor and taking appropriate action. The HS220 sensor can be used for humidity measurement and the LM35 sensor can be used for temperature measurement. The HS220 sensor detects the humidity level of the environment in which they are placed. Humidity changes with temperature. If the temperature increases, so will the humidity. Then the water level sensor is used and informs whether the tank is empty or not.

LCD is used to print data on the display screen. And the Wi-Fi module is used to display information about the vertical farming unit in the application. When the tank is empty, the engine starts automatically.

4.2 Circuit Diagram:

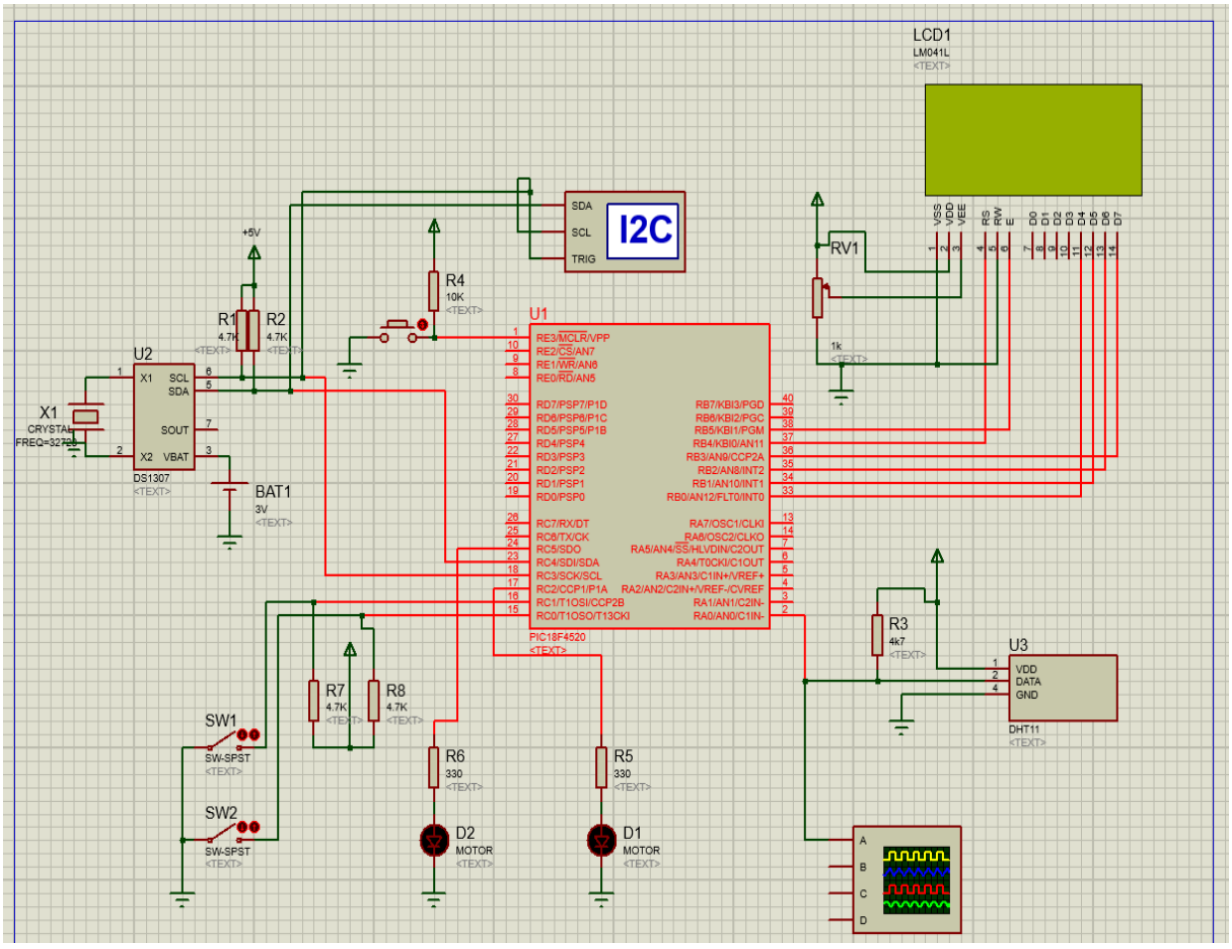

Fig 9: Circuit Diagram

CHAPTER 5

HYDROPONIC UNIT

5.1 Hydroponic Unit: -

This chapter will cover the structure and operation of a hydroponic system. The hydroponic unit system is maintained by a controlled environment using automation by electronic components. The hydroponic system also describes all the information about hydroponic growing of green fodder.

Fig 10: Hydroponic Unit

Components of Hydroponic Unit:

Sr. No.	Component	Quantity
1	PVC pipes	86 feet
2	Elbows (PVC pipes connection)	4
3	Water Tank	1 (plastic)
4	Motor	1, half HP
5	Irrigation pipes	20 feet
6	Irrigation pipe elbow	1
7	Fogger	8 (netafim), 2.5 feet diameter
8	Reducer	4
9	TEE	16

Structure and Working of Hydroponic Unit: -

The frame size of this hydroponic unit varies according to the livestock consuming the feed, i.e. increasing the number of livestock and increasing the frame size. Here we make frame only for cattle. This unit produces about 10 to 12 kg of green fodder per day. That means 3 ready-to-feed trays per cattle per day.

Hydroponic growing of green fodder fully automated, efficient structure using germination and cultivation for about 7 to 8 days using only water to a height of about 17 to 2 cm. An automatic system with a fogger for water irrigation is installed. Relative humidity and temperature are maintained and foggers spray a fine mist of water onto the tray to keep the seeds moist.

A specially designed frame made of PVC pipes or an angle for holding plastic measuring trays, in which approx. 1 kg of seed can be placed for the production of approx. 2 to 2.5 kg of green fodder. The dimensions of the bins are 1ft x 1.5ft designed to be easily managed by anyone and other standard sizes such as 41”x41”x7”, 29”x53”x7”, etc. are available at market. To reduce costs, the frame is

completely made of tube. This frame has a vertical compartment for magazines. Frame dimension is 4ft x 3ft x 6ft. A total of 9 coasters fit into the frame.

An arrangement of frame or irrigation pipes and misters can be used to pump water from a tank at the bottom into pipes in which holes have been punched. The foggers fit into the punched holes of the pipe.

Misters spray water onto trays that contain growing green fodder. The fogger on and off timing varies depending on the temperature. The ideal temperature is 20-30 degrees celsius and the fog on time is 1.5 minutes and off time is 3 hours. Once the temperature rises above 30 degrees celsius, you will increase the fog on time to 2 minutes and off time to 3 hours. If the temperature is blowing 20 degrees Celsius, then during the time of fog 1 min per 4 hour interval. An important point is that this mist system operates from 8:00 am to 8:00 pm to reduce the risk of mold on the root side of the green fodder. Water atomizer using half HP motor with filter, the filter is used to prevent clogging of the atomizer holes.

Procedure to Cultivation of Green Fodder:

1. Treated corn and wheat seeds should be soaked for 8 hours before cultivation or placing on trays.
2. About 1 kg of soaked corn seed is spread in each tray.
3. At the end 2-2.5 kg of green fodder is produced in 10-12 days per bin and production cost per kg of fodder is Rs 3 to 4, depending on seed availability.

Precautions for Hydroponic Technology:

1. Seeds treated with pesticides and fungicides should not be used for cultivation.
2. Water should be changed every three days to reduce microbial contamination.
3. To prevent mold growth, cleanliness, washing and cleaning of seeds should be necessary to reduce the contamination of mold growth.
4. White corn seeds are better compared to yellow corn for hydroponic feed production.
5. Quality seeds should be used for growing fodder.
6. Green shed netting is important for proper aeration and lighting to prevent yellowing of the leaves.

5.2 Comparison of Green Fodder Cultivation Using Hydroponics and Conventional Land-Based Cultivation:

S	Parameter	Conventional Land Based Fodder Cultivation	Hydroponics System
1	Area required	1 hac land to produce 600kg/day	50 sq mt to produce 600kg/day
2	Fodder production in days	65-70 days	7-8 days
3	Water requirement	Very high at 30liters per kg of green fodder	Minimum at just 1.5 to 3 liter per kg of green fodder
4	Soil fertility	Required	Not required
5	Fodder yield	Depend on environment, cultivation practices	Controlled conditions
6	Fertilizer application	Required	Not required
7	Fencing and farm production	Essential	Not required
8	Green fodder utilization	Wastage some part	Almost no wastage
9	Labour requirement	Intensive for sowing, harvesting, cultivation practices, etc.	Minimum, 1-2 person

CHAPTER 6

METHODOLOGY FOR GROWING CATTLE FEEDING

6.1 Methodology:

We use corn as feed for cattle.

First, soak the grains overnight. Sprouting occurs due to soaking.

Then place the germinated grains in the hydroponic tray for another 10 days in the vertical farming unit. Sprouted grains should be spread evenly in the tray.

The transformation of the seed into nutritious food takes place in 10 days.

6.2 Days Monitoring of Maize:

Before moving to a true vertical farming unit in our project, we were interested in 10-day corn tracking.

On the first day, soak 1 kg of corn seeds overnight.

Then we put the corn in the reservoir for the next 12 days. Spread the corn evenly on a tray and sprinkle with water every 2 hours a day for 12 days.

In general, the transformation of seed into feed takes place in 12 days.

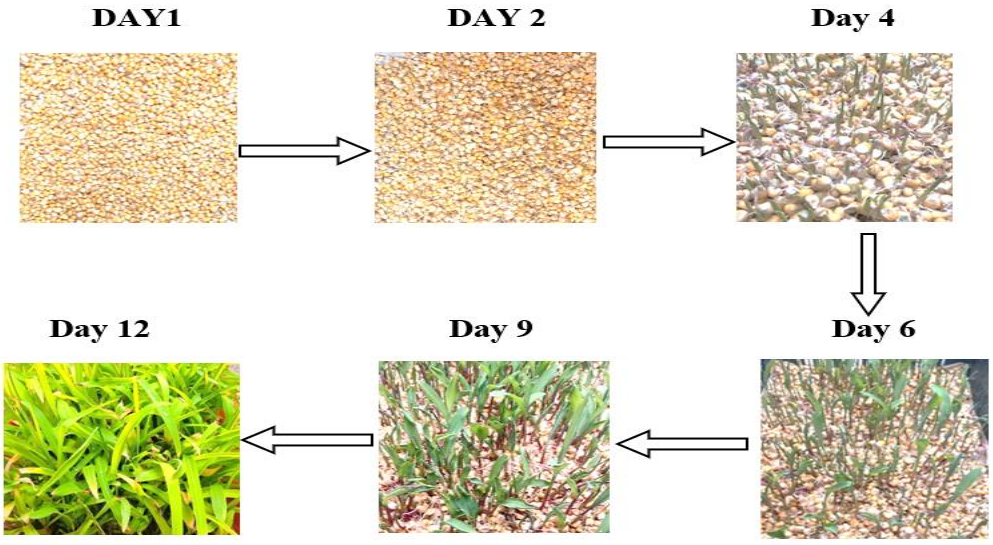

Fig 11: Crop Monitoring (Day 1 – 12)

6.3 Why a Farmer Should Shift Towards Vertical Farming Feed

Vertical farming is the best method for growing fodder in drought-prone areas.

Vertical farming ensures good food quality regardless of weather conditions, water availability and crop conditions.

The feed is nutritious and can be used for all farm animals.

Cattle can eat a whole cookie on a tray that contains roots and feed. Roots are a source of protein and starch.

Fresh fodder can be produced all year round.

Cattle can be fed high protein feed. Thus, a weight gain of 1.22 to 2.55 kg can be achieved. There is higher milk production.

Compared to other alternatives, there is a significant reduction in feeding costs.

CHAPTER 7

ANDROID APPLICATION

7.1 App Building:

Application Functionality

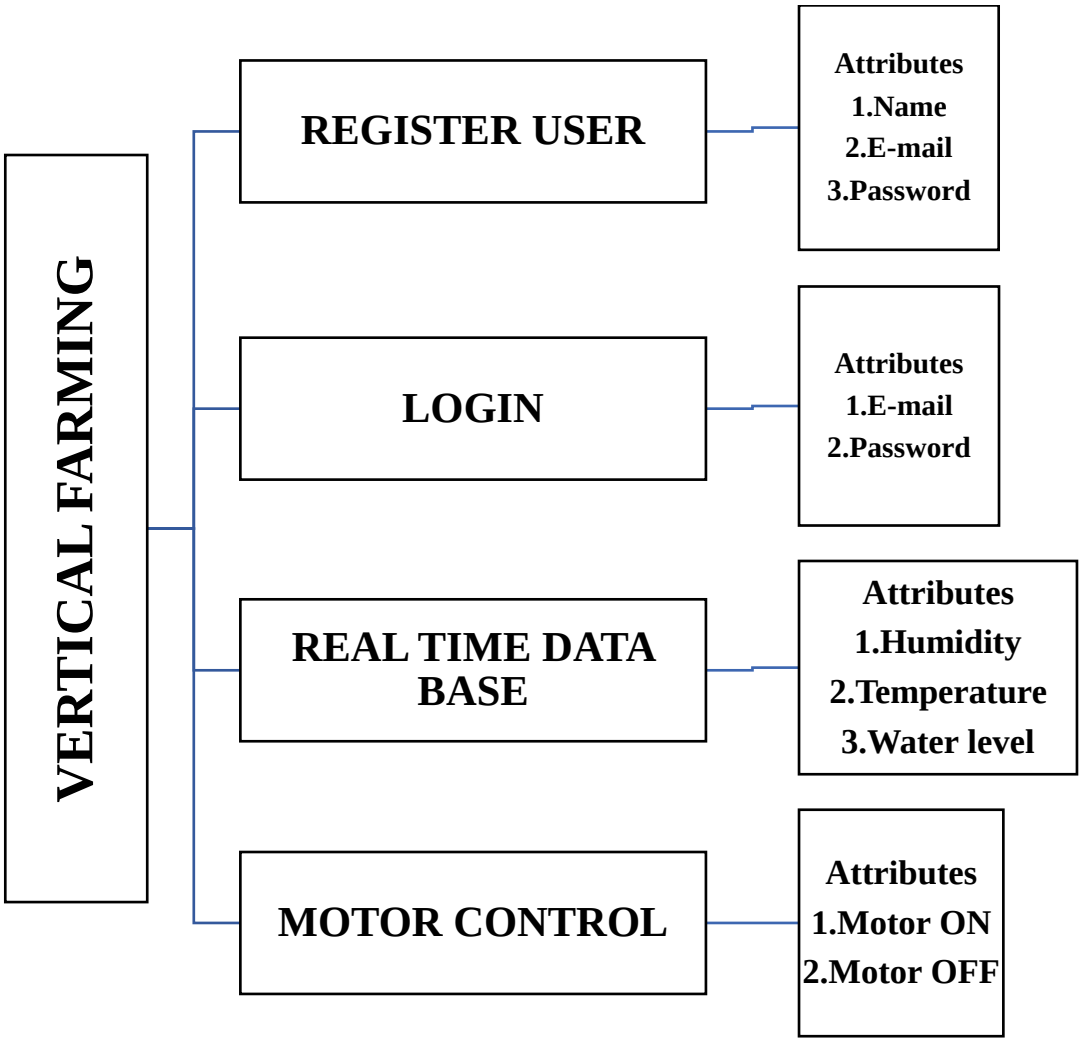

Fig 12: Android Application (Block Diagram)

We use Google's Firebase real-time database to store data. NoSQL stores data in the form of a logical tree in which nodes and children represent data attributes. Under the root node we created four nodes Register User, Login User, Real Time Data and Engine Control.

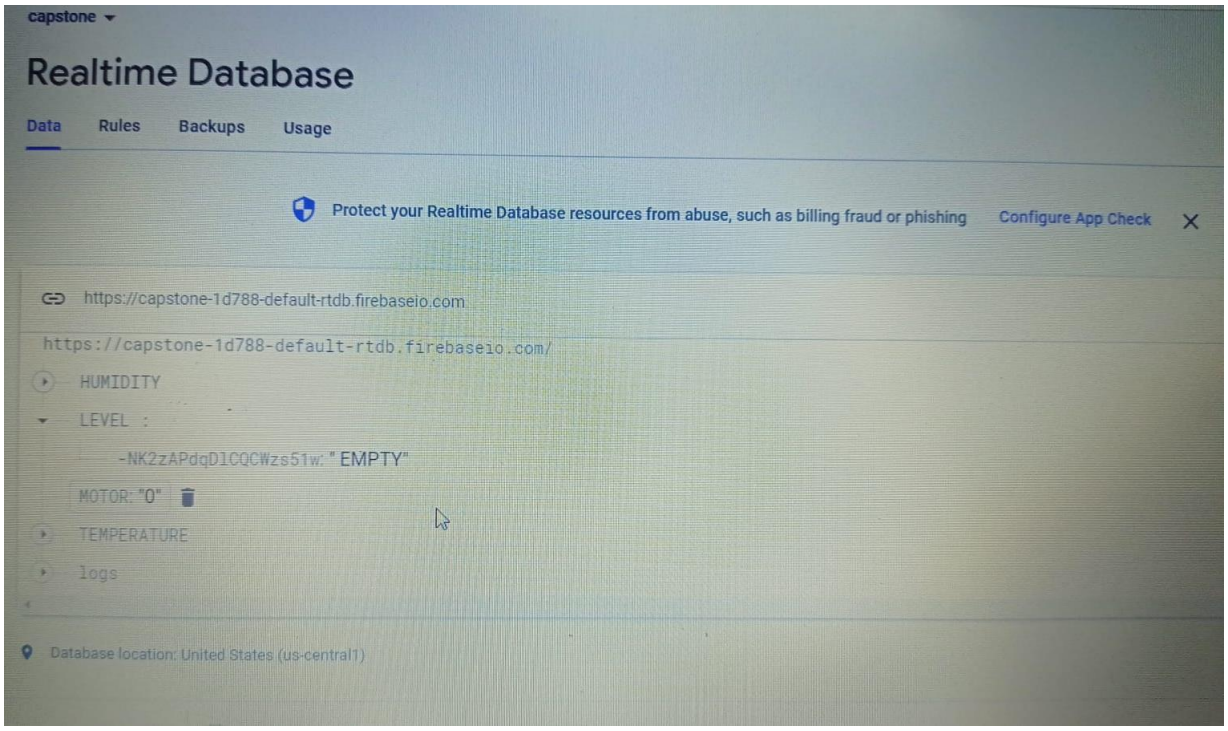

Fig 13: Firebase

Functional Requirements

Functional requirements define the basic actions that the system must perform. The functional requirements for the system are divided into three main categories, humidity and temperature sensing, water pump control and Android applications. See use cases for more details.

App First Page

1. This is the first page of the Android app.
2. Welcome text and project name will be displayed here.

Fig 14: App First page

App Registration Page

1. The system shall record registration details.
2. The system shall record full name ,E-mail ID and password.
3. The system shall accept the user name as E-mail ID.

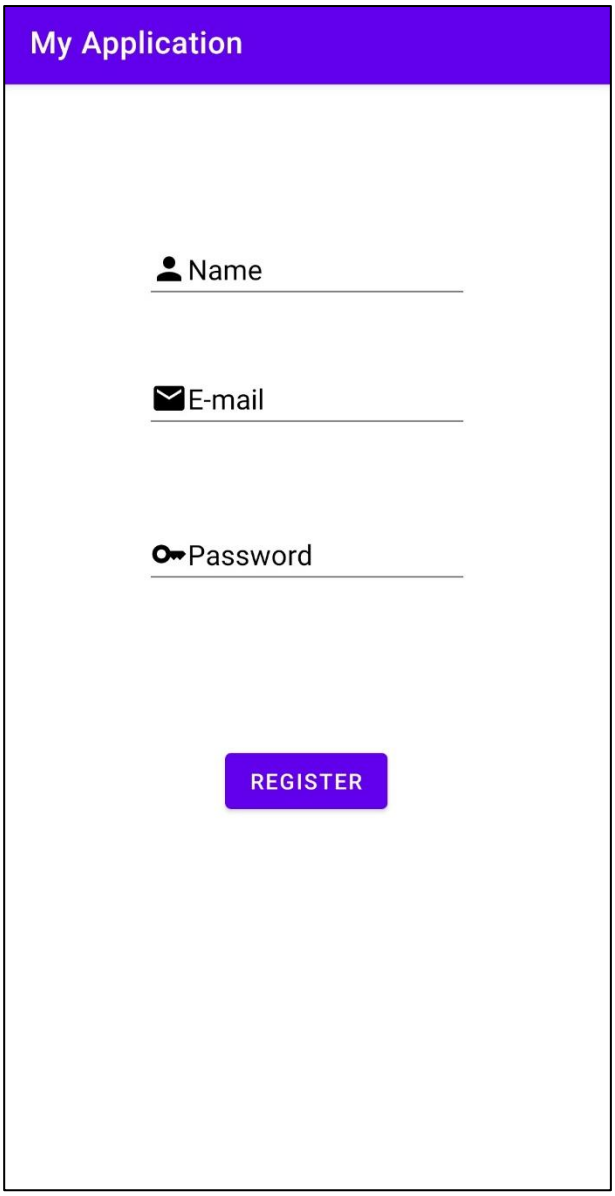

Fig 15: Registration Page

App Login Page

1. The system will track the username with the previous record.
2. The system will allow the user to enter a password.
3. The system will allow a valid user to enter the system.

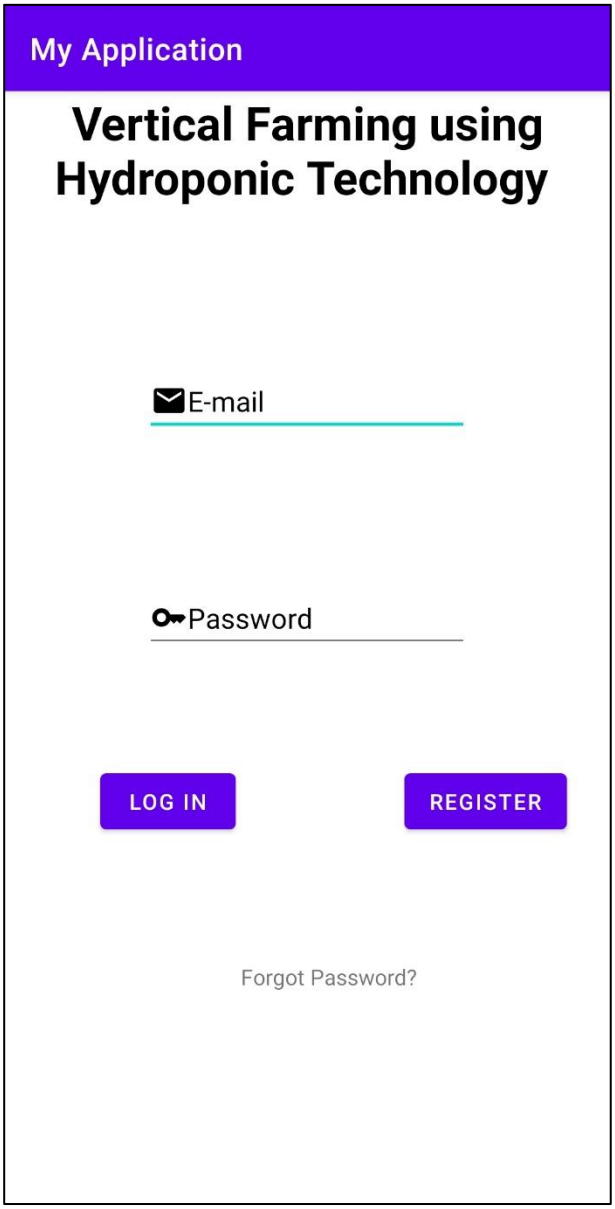

Fig 16: App Login Page

App Home Page

1. The system must allow the display of environmental monitoring system data, including humidity and temperature.
2. In this section, the value of temperature, humidity and water level will be displayed.
3. It will also allow the user to turn on/off the engine remotely using the app.
4. On the home page there are buttons to turn the engine on/off.

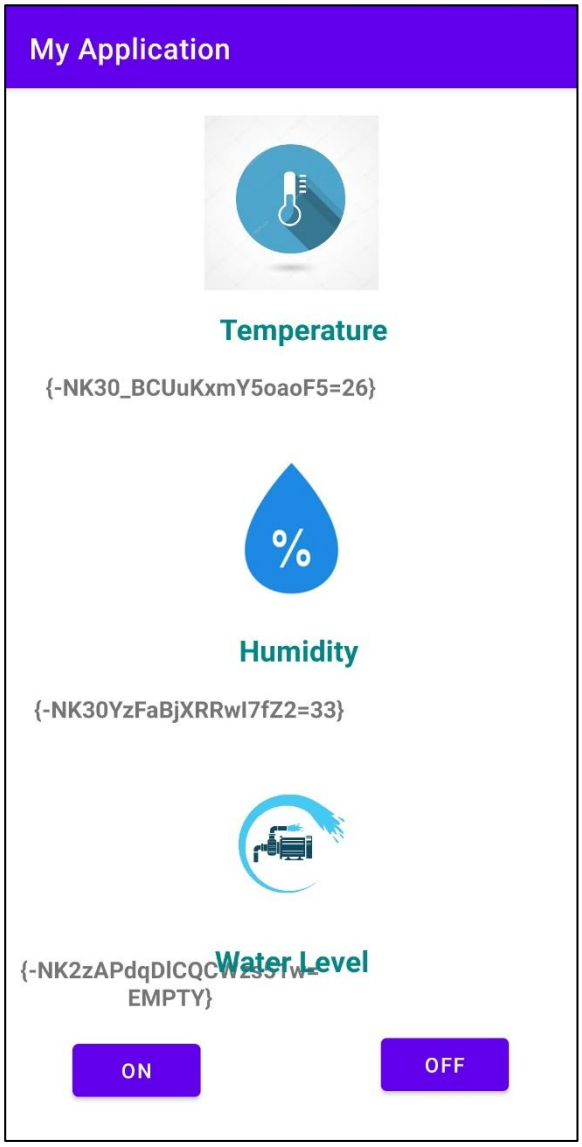

Fig 17: Home Page

Non-Functional Requirements

Every type of user can utilise this application safely. Nobody will be able to view a user's profile without knowing his private password if they log out of a session. The database utilised here is strong, dependable, and quick, so the user won't have to wait long for the output. You can use any platform to access this kind of application. The database won't use any additional RAM because there are no instances of redundancy.

Performance Requirement:

1. The performance requirement defines acceptable response times for system functionality.
2. User interface screens take no more than two seconds to load.

Safety Requirements:

1. The transmission of information should be securely transmitted to the application without any changes to the information.
2. The user must log in with valid credentials to the application.

Features:

1. Reliability

The system must be highly reliable due to the importance of the data and the damage that incorrect or incomplete data can cause. Because the system provides the right tools for effective system sensing and monitoring.

2. Applicability

Because the system is easy to operate and navigate in the most expected manner without lag. In such a case, the system program reacts accordingly and quickly transitions between its states.

3. Maintainability

The module should be designed keeping in mind that bugs may need to be fixed for future optimization.

4. Correctness

CHAPTER 8

PROJECT IMPLEMENTATION

8.1 Hardware Implementation

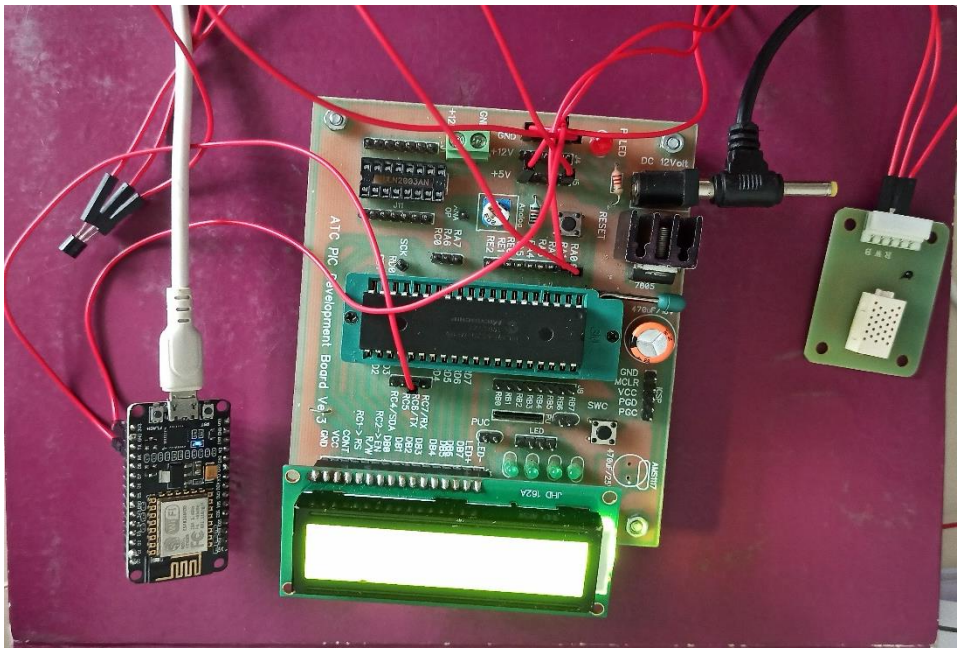

Fig 18.1: Hardware Implementation

Fig 18.2: Hardware Implementation

CHAPTER 9

RESULT AND DISCUSSION

9.1 Vertical Farming Result:

The following result of vertical farming is done using hydroponic technique. First, we took corn seeds and then put those seeds in water for 24 hours after the seeds germinated. Then these germinated seeds are placed in the container.

Then all these reservoirs are placed in a vertical agricultural unit.

Then, depending on the temperature and humidity, a sprayer is dripped onto the seeds. And when the water tank is empty, the automatic motor starts. After 12 days, crop growth will be completed up to 20 cm. Temperature, humidity, water level in the tank

Vertical farming using hydroponic technology 12 day result is as follows:

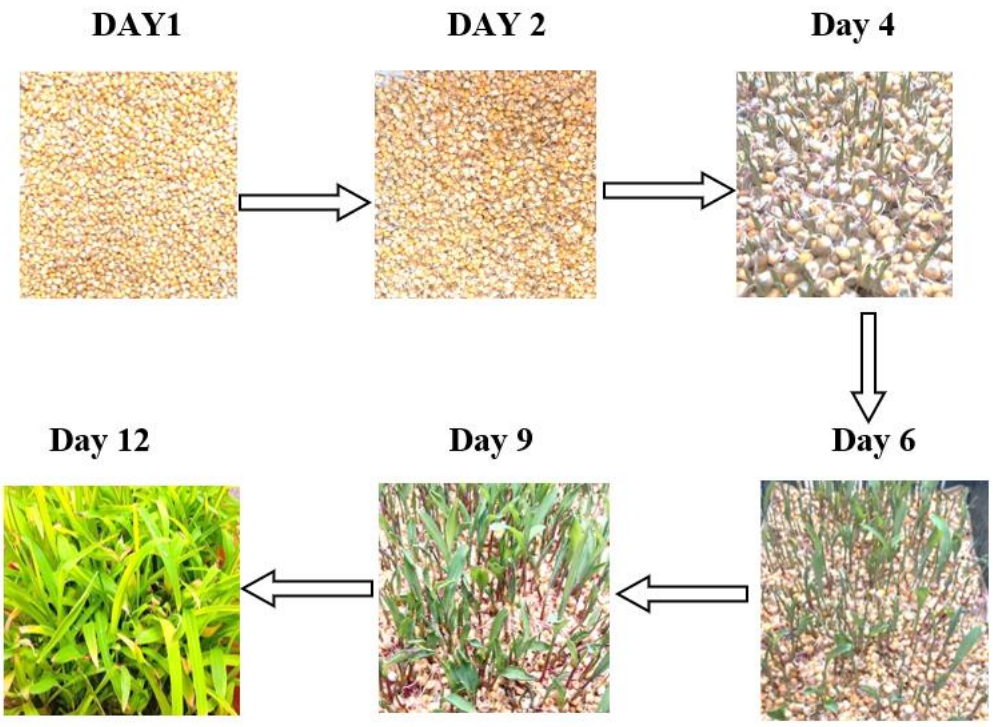

Fig 19: Result

Hydroponic feed is more pleasant and nutritious than conventional feed. Crude protein (CP), ether extract (EE) and nitrogen-free extract (NFE) levels increase during hydroponic feed growth, while crude fibre (CF), neutral detergent fibre (NDF), total ash (TA) and insoluble ash levels decrease (AlA).

In addition, there are other possible health benefits of hydroponic feed. And foods with the highest enzyme content are grown. And the duration is usually about 12 days. They are a great source of antioxidants in the form of vitamins C and E and can increase production by feeding sprouted grains.

CHAPTER 10

CONCLUSION AND FUTURE SCOPE

10.1 Conclusion:

Using low-cost technology and locally grown grains, hydroponic technology can be used to grow nutritious, palatable and digestible feed.

Impending climate change and less land availability.

An alternative production technology is hydroponic feed technology.

10.2 Future Scope:

- Improve the quality of livestock feed
- Useful cattle feeding technique in drafty areas
- The production standard of food will increase

CHAPTER 11

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Summary