SmartFarmer - IoT Enabled Smart Farming Application

TEAM ID : PNT2022TMID41344

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Project Report Format

1. INTRODUCTION

IoT smart farming solutions is a system that is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, crop health, etc.) and automating the irrigation system. The farmers can monitor the field conditions from anywhere.

1.1Project Overview

Smart farming refers to managing farms using modern Information and communication technologies to increase the quantity and quality of products while optimizing the human labor required. Among the technologies available for present-day farmers are: Sensors: soil, water, light, humidity, temperature management.

1.2Purpose

Smart Farming has enabled farmers to **reduce waste and enhance productivity** with the help of sensors (light, humidity, temperature, soil moisture, etc.) and automation of irrigation systems. Further with the help of these sensors, farmers can monitor the field conditions from anywhere.

Smart farming is a management concept focused on providing the agricultural industry with the infrastructure to leverage advanced technology – including big data, the cloud and the internet of things (IoT) – for tracking, monitoring, automating and analyzing operations.

2. LITERATURE SURVEY

Survey on Smart farming using IOT

ABSTRACT

India is agriculture sector, on either side, is losing ground every day, affecting the ecosystem output capacity . In order to restore vitality and put agriculture back on a path of higher growth , there is a growing need to resolve the issue. A large-scale agricultural system necessitates a great deal of upkeep , knowledge , and oversight . The IoT is a network of interconnected devices that can transmit and receive data over the internet and carry out tasks without human involvement. Agriculture provides a wealth of data analysis parameters, resulting in increased crop yields. The use of IoT devices in smart farming aids in the modernization of information and communication. For better crop growth moisture, mineral, light and other factors can be assumed. This research looks into a few of these characteristics for data analysis with the goal of assisting users in making better agricultural decisions using IoT. The technique is intended to help farmers increase their agricultural output.

2.1 Existing problem

- Open issues and challenges of IoT application in smart agriculture… and monitoring factors in a smart farm.
- The system includes: Smart precision farming helps to improve productivity Internet connectivity is available nearby.
- As farms and agriculture primarily available in rural from long distance and solving the farm related issues still challenging.
- Increasing population and abrupt weather fluctuations around the world has put huge pressure on agricultural food products for quality and sustainable food production .

2.2 REFERENCE

H.G.C.R. Laksiri, H.A.C. Dharmagunawardhana, J.V. Wijayakulasooriya

Development of an effective loT-based smart irrigation system is also a crucial demand for farmers in the field of agriculture. This research develops a low-cost, weather-based smart watering system. To begin, an effective drip irrigation system must be devised that can automatically regulate water flow to plants based on soil moisture levels.Then, to make this water-saving irrigation system even more efficient, an IoT-based communication feature is added, allowing a remote user to monitor soil moisture conditions and manually adjust water flow. The system also includes temperature, humidity, and rain drop sensors, which have been updated to allow remote monitoring of these parameters through the internet. In real time, these field weather variables are stored in a remote database. Finally, based on the present weather conditions, a weather prediction algorithm is employed to manage water distribution. Farmers would be able to irrigate their crops more efficiently with the proposed smart irrigation system.

Dweepayan Mishra, Arzeena Khan, Rajeev Tiwari, Shuchi Upadhaye

Agriculture is a substantial source of revenue for Indians and has a huge impact on the Indian economy. Crop development is essential for enhanced yield and higher-quality delivery. As a result, crop beds with ideal conditions and appropriate moisture can have a big influence on output. Traditional irrigation systems, such as stream flows from one end to the other, are usually used. As a result of this delivery, the moisture levels in the fields can alter. A designed watering system can help to enhance the management of the water system. This research proposes a terrain-specific programmable water system that will save human work while simultaneously improving water efficiency and agricultural productivity. The setup is made up of an Arduino kit, a moisture sensor, and a Wi-Fi module. Data is acquired by connecting our experimental system to a cloud framework. After then, cloud services analyse the data and take the necessary actions.

Shrihari M

The concept of automating agricultural production has been around since the early 1990s, and one of the primary challenges that both scientists and farmers confront is irrigation. Irrigation is a dynamic system that is heavily reliant on outside influences. This article describes a method that uses a custom-built mathematical model to handle data from wireless sensors on Google Cloud, resulting in a smart system. An IoT-enabled design that can scale up to big farms. According to Holistic Agricultural Studies, around 35 have been damaged by animals and people. This intelligent system uses Tensor flow and deep learning neural networks to recognise animals depending on their threat level, as well as human intruders who are not authorised on the farm, and to alert the farmer immediately. An android application is included with the device, which allows for remote access and surveillance through live video streaming.

G. Sushanth, and S. Sujatha

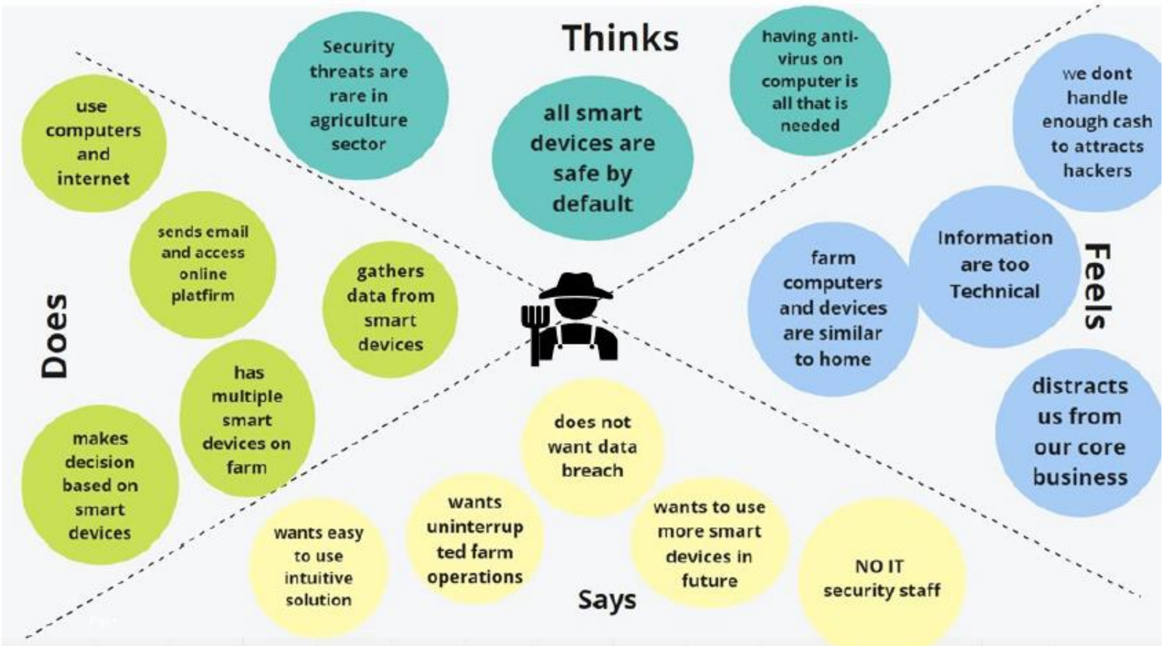
Smart agriculture is a novel concept since IoT sensors can offer information about agricultural regions and then act on it based on user input. The purpose of this study is to develop a smart agricultural system that utilises cutting-edge technologies such as Arduino, Internet of Things, and wireless sensor networks. Through automation, the research tries to take use of emerging technologies such as the Internet of Things (IoT) and smart agriculture. The capacity to monitor environmental factors is a critical component in increasing crop efficiency. The purpose of this study is to develop a system that can monitor temperature, humidity, wetness, and even the movement of animals that might damage crops in agricultural areas using sensors, and then send an SMS notification as well as a notification on the app developed for the same to the farmer's smartphone via Wi-Fi/3G/4G if there is a discrepancy. The system uses a duplex communication link based on a cellular Internet interface, which allows data inspection and irrigation schedule to be changed using an android app. Because of its energy independence and inexpensive cost, the gadget has the potential to be useful in water-scarce, geographically isolated areas.

2.3 Problem Statement Definition

The traditional agriculture and allied sector cannot meet the requirements of modern agriculture which requires high-yield, high quality and efficient output. Thus, it is very important to turn towards modernization of existing methods and using the information technology and data over a certain period to predict the best possible productivity and crop suitable on the very particular land. The adoptions of access to high-speed internet, mobile devices, and reliable, low-cost satellites (for imagery and positioning) are few key technologies characterizing the precision agriculture trend. Precision agriculture is one of the most famous applications of IoT in the agricultural sector and numerous organizations are leveraging this technique around the world. Some products and services in use are VRI optimization, soil moisture probes, virtual optimizer PRO, and so on. VRI (Variable Rate Irrigation) optimization maximizes profitability on irrigated crop fields with topography or soil variability, improve yields, and increases water use efficiency. IoT has been making deep inroads into sectors such as manufacturing, health-care and automotive. When it comes to food production, transport and storage, it offers a breadth of options that can improve India's per capita food availability. Sensors that offer information on soil nutrient status, pest infestation, moisture conditions etc. which can be used to improve crop yields over time.

3. IDEATION & PROPOSED SOLUTION

3.1 EMPATHY MAP CANVAS



3.2 IDEATION BRAINSTORMING

What Is a Smart Farm?

Smart farming refers to managing farms using modern Information and communication technologies to increase the quantity and quality of products while optimizing the human labor required.

Among the technologies available for present-day farmers are:

● **Sensors**: soil, water, light, humidity, temperature management

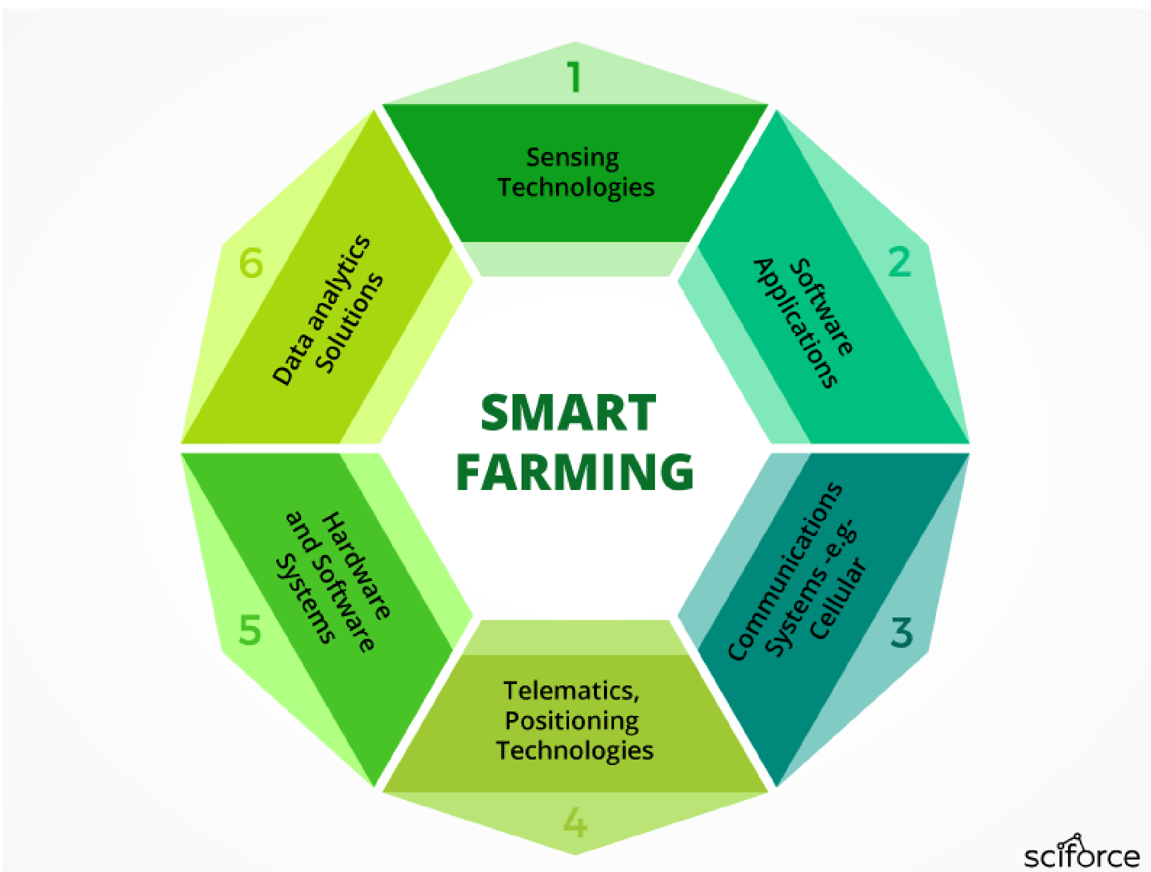
● **Software**: specialized software solutions that target specific farm types or applications agnostic IoT platforms

● **Connectivity**: cellular, LoRa

● **Location**: GPS, Satellite

● **Robotics**: Autonomous tractors, processing facilities

● **Data analytics**: standalone analytics solutions, data pipelines for downstream solutions



The IoT-Based Smart Farming Cycle

The core of IoT is the data you can draw from things and transmit over the internet. To optimize the farming process, IoT devices installed on a farm should collect and process data in a repetitive cycle that enables farmers to react quickly to emerging issues and changes in ambient conditions. Smart farming follows a cycle like this one:

1. **Observation** . Sensors record observational data from the crops, livestock, soil, or atmosphere.

2. **Diagnostics.** The sensor values are fed to a cloud-hosted IoT platform with predefined decision rules and models—also called “business logic”—that ascertain the condition of the examined object and identify any deficiencies or needs.

3. **Decisions** . After issues are revealed, the user, and/or machine learning-driven components of the IoT platform determine whether location-specific treatment is necessary and if so, which.

4. **Action** . After end-user evaluation and action, the cycle repeats from the beginning.

IoT Solutions to Agricultural Problems

Many believe that IoT can add value to all areas of farming, from growing crops to forestry. While there are several ways that IoT can improve farming, two of the major ways IoT can revolutionize agriculture are precision farming and farming automation.

Precision Farming

Precision farming, or precision agriculture, is an umbrella concept for IoT-based approaches that make farming more controlled and accurate. In simple words, plants and cattle get precisely the treatment they need, determined by machines with superhuman accuracy. The biggest difference from the classical approach is that precision farming allows decisions to be made per square meter or even per plant/animal rather than for a field.

By precisely measuring variations within a field, farmers can boost the effectiveness of pesticides and fertilizers, or use them selectively.

Precision Livestock Farming

As is the case of precision agriculture, smart farming techniques enable farmers better to monitor the needs of individual animals and to adjust their nutrition accordingly, thereby preventing disease and enhancing herd health.

Large farm owners can use wireless IoT applications to monitor the location, well-being, and health of their cattle. With this information, they can identify sick animals, so that they can be separated from the herd to prevent the spread of disease.

Automation in Smart Greenhouses

Traditional greenhouses control the environmental parameters through manual intervention or a proportional control mechanism, which often results in production loss, energy loss, and increased labor cost.

IoT-driven smart greenhouses can intelligently monitor as well as control the climate, eliminating the need for manual intervention. Various sensors are deployed to measure the environmental parameters according to the specific requirements of the crop. That data is stored in a cloud-based platform for further processing and control with minimal manual intervention.

Agricultural Drones

Agriculture is one of the major verticals to incorporate both ground-based and aerial drones for crop health assessment, irrigation, crop monitoring, crop spraying, planting, soil and field analysis, and other spheres.

Third Green Revolution

Smart farming and IoT-driven agriculture are paving the way for what can be called a Third Green Revolution.

Following the plant breeding and genetics revolutions, the Third Green Revolution is taking over agriculture. That revolution draws upon the combined application of data-driven analytics technologies, such as precision farming equipment, IoT, big data analytics, Unmanned Aerial Vehicles (UAVs or drones), robotics, *etc*.

In the future, this smart farming revolution depicts, pesticide and fertilizer use will drop while overall efficiency will rise. IoT technologies will enable better food traceability, which in turn will lead to increased food safety. It will also be beneficial for the environment, through, for example, more efficient use of water, or optimization of treatments and inputs.

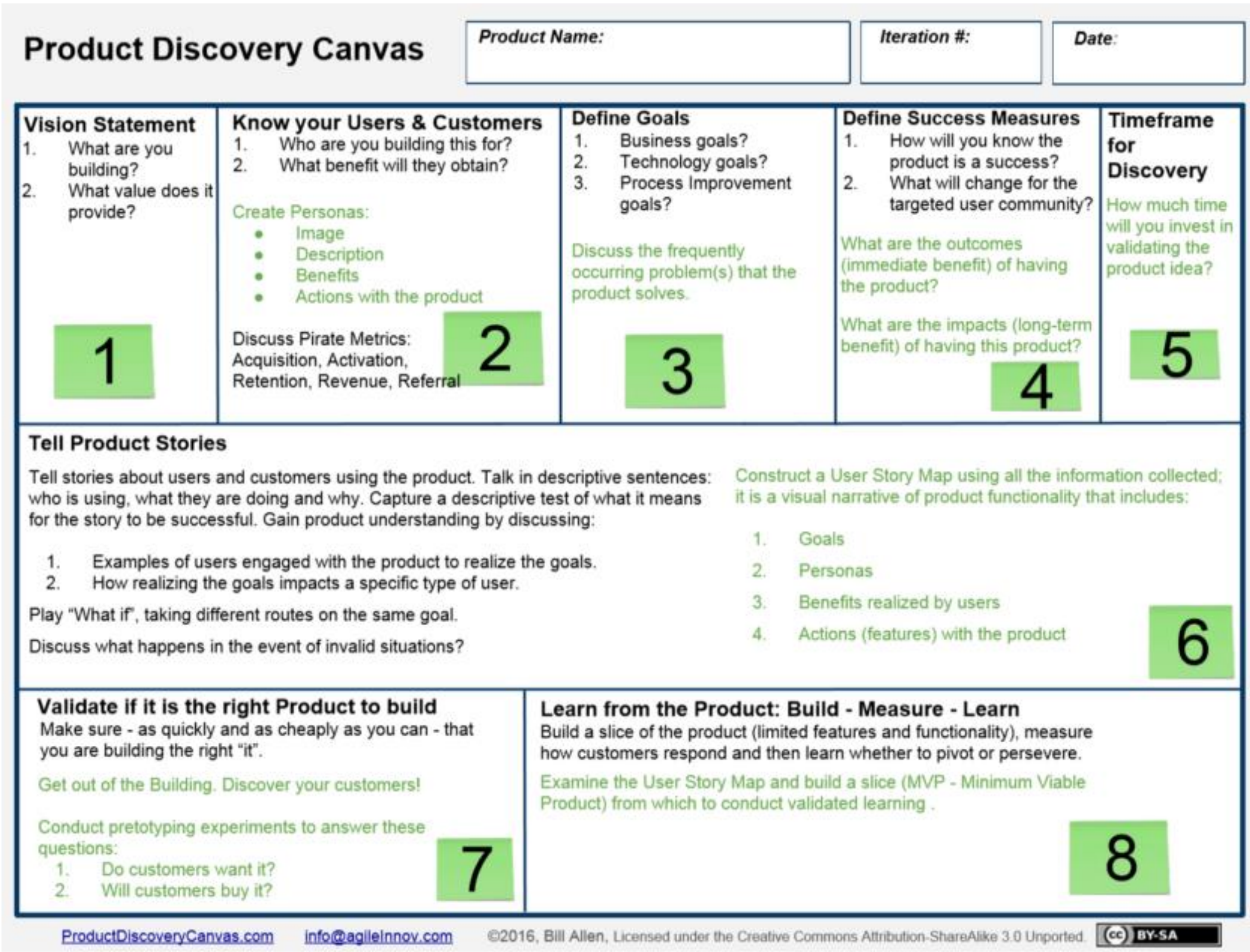
Therefore, smart farming has a real potential to deliver a more productive and sustainable form of agricultural production, based on a more precise and resource-efficient approach. New farms will finally realize the eternal dream of mankind. It'll feed our population, which may explode to 9.6 billion by 2050.

3.3 PROPOSED SOLUTION

Livestock tracking and Geo fencing	Playing an important role in any farm's sustainability, domestic animals are raised as commodities and produce. With 70% thefts in livestock reported every year, real time geofencing is a boon for farmers.
Smart logistics and warehousing	Farms are often huge productions. Harvest times results in yield that is a logistics nightmare. With smart agriculture solutions in place, storage and processing in warehouses can be done smoothly
Smart pest management	Pesticides help in preventing infestations. But the wrong quantity can result in destroyed crops. In order to avoid such situations, smart pest management provides detailed analytics which predict swarm patterns and alerts on the health of the crops.
Smart Greenhouses	While growing delicate and exotic flowers or herbs, climate control plays a big hand. Plants grow and thrive in smart green houses with an increase in quality and yield. As demand increases, smart greenhouses become an important tool to meet the output required. Green houses have been industrialized in size and capacity to grow fruits .

Climate monitoring and forecasting	Nature is a fickle friend of the farmers. Climate change, weather forecasts are now key features in in precision farming. They alert the farmer of the impending changes and help ensure preventive measures. With sensors in place to predict and analyze the weather, crops can be saves from being destroyed.
Remote equipment monitoring	Tractors, pickups and harvesting machines and equipment are IoT enables with sensors. Installing, provisioning and managing IoT endpoints, securely and reliably connecting the same. Ingesting, managing, curating and analyzing IoT data can be done remotely.
Sensor based field and resource mapping	With the help of IoT smart farming systems, one can use sensors to map and keep track of the entire farm. This also includes the stats of the human resources, tools and institutional assets.
Automated Sprinkler System	The weather, humidity in the air, analysis of the soil goes a long way in determining if there is a need for water dispersion. Precise and controlled water dispersion through IoT enabled water meter sensors helps in ensuring that there is no risk of damaging crops due to over watering.

3.4 PROPOSED SOLUTION FIT



4. REQUIREMENT ANALYSIS

4.1 FUNCTIONAL REQUIREMENT

The functional requirements indicate the functions and services of the present system. They describe the behaviour of the system in relation to the needs:

- Measure Temperature.
- Measure soil moister.
- Display the sensor readings on the LCD screen.
- Calculating the date and time.
- Irrigating the soil if needed.
- Turning on the fan if needed.

4.2 NON-FUNCTIONAL REQUIREMENT

The non-functional requirements for the present system consider the following:

- Availability:

The proposed product can be available and operable successfully all the time.

- Reliability:

The system provides an accurate measurement of data, and it can have a longer lifespan.

- Maintainability:

The present system can be improved easily by integrating new components with enhanced features.

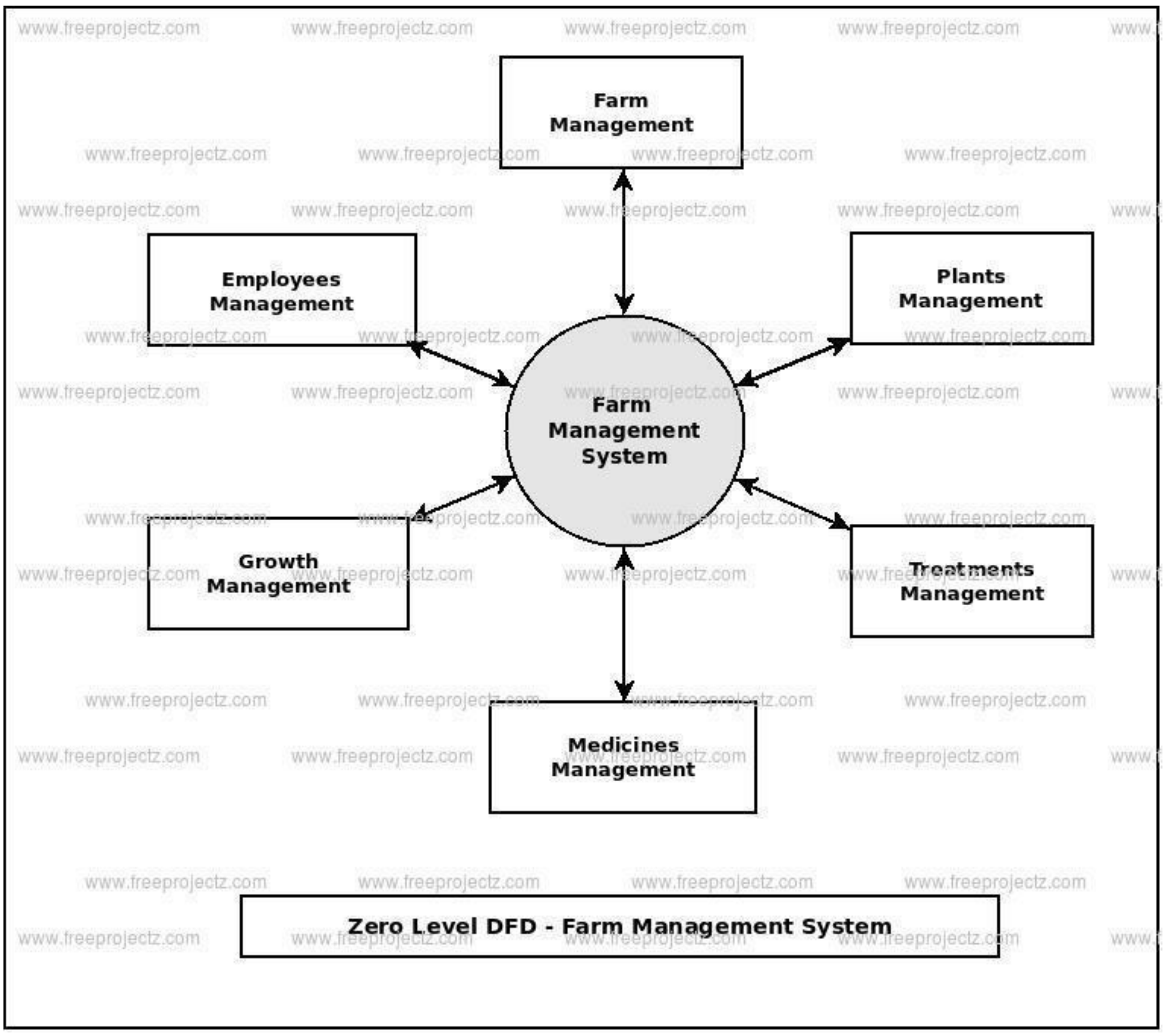
- Simplicity:

The proposed system is user friendly. The usage of this product doesn’t require any prior learning.

5. PROJECT DESIGN

5.1 DATA FLOW DIAGRAMS

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFDcan depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.



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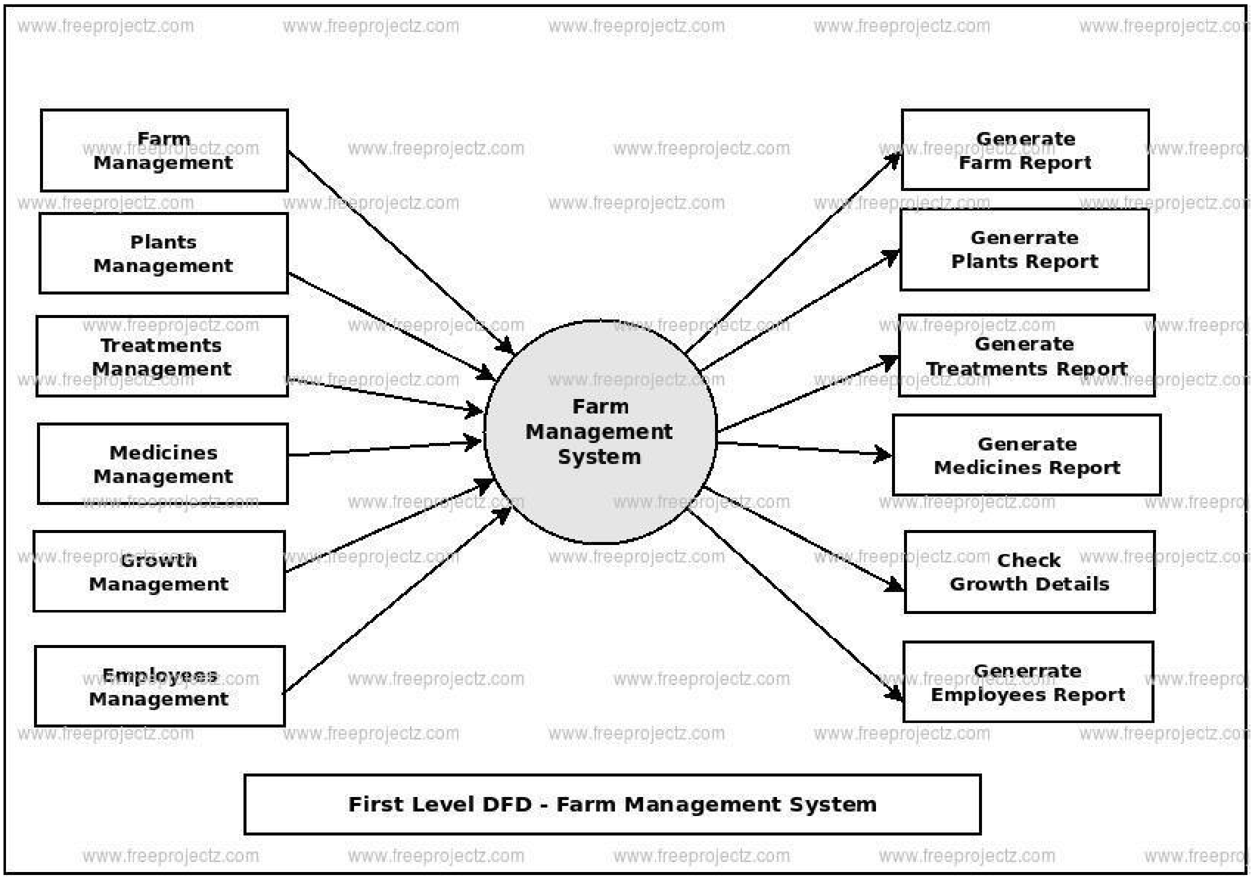

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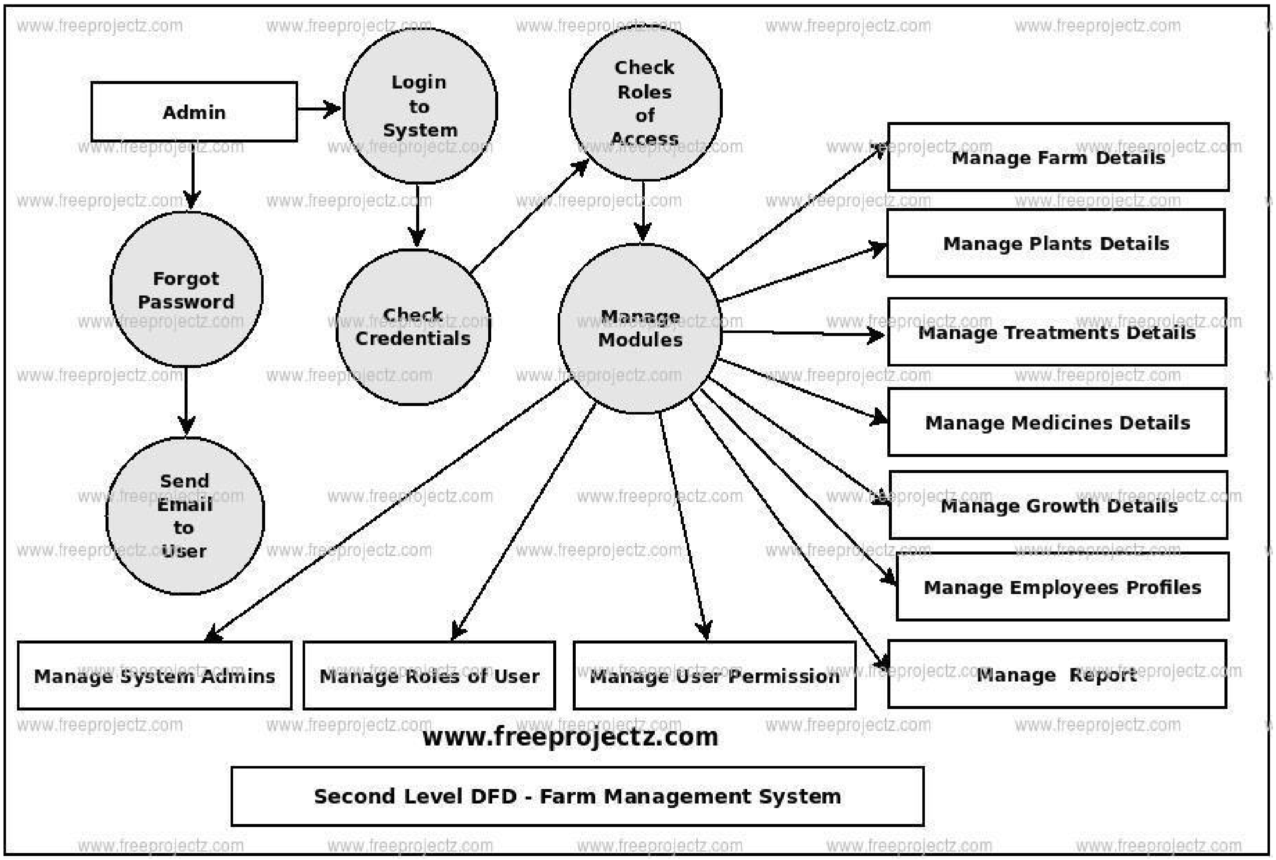
In 1-level DFD, **the context diagram is decomposed into multiple bubbles/processes**. In this level, we highlight the main functions of the system and breakdown the high-level process of 0-level DFD into subprocesses.



Fg : 5.3

This level two data flow diagram (DFD) template can **map out information flow, visualize an entire system, and be shared with your stakeholders**.

This is the **Zero Level DFD** of **Farm Management System**, where we have eloborated the high **level** process of **Farm**.

There are certain challenges you need to be aware of if you are considering investing into smart farming

5.2 SOLUTION & TECHNICAL ARCHITECTURE

SOLUTION :

Smart Farming systems uses modern technology to increase the quantity and quality of agricultural products. Livestock tracking and Geo fencing. Smart logistics and warehousing. Smart pest management. Smart Greenhouses.

- Precision Farming. Fine-tune responsiveness to crop and livestock variabilities through real-time data gathering and connected devices. ...
- Crops and Livestock. Oversee operations using unmanned aerial vehicles (UAVs)
- Smart Irrigation.
- Remote Sensing.

One Stop Solution

Get the hardware as well as the software bundled with the solution.

Equipment and livestock Efficiency Analysis

Know real-time equipment efficiency and its current status.

Soil Moisture Management

Manage moisture level in crop through actuator triggered sprinkler system.

Personalized Mobile App

We will configure the mobile app for your personalized experience.

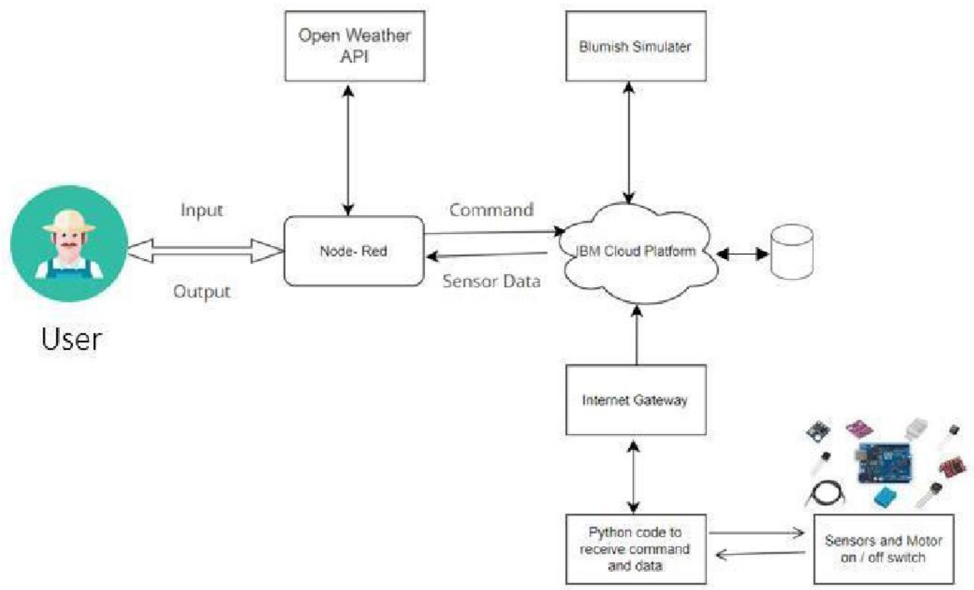
Table-1 : Components & Technologies:

Component	**Description**	**Technology**
1. User Interface	How user interacts with application e.g. Web	MIT App Inventor
2. Application Logic-1	Logic for a process in the application	Python
3. Application Logic-2	Logic for a process in the application	IBM Watson IOT service
4. Application Logic-3	Logic for a process in the application	IBM Watson Assistant
5.Database	Data Type, Configurations etc.	MySQL, NoSQL, etc.
6. Cloud Database	Database Service on Cloud	IBM Cloud
7. File Storage	File storage requirements	IBM Block Storage or Other Storage

Table-2: Application Characteristics

S.No	Characteristics	Description	Technology
1	Open-Source Frameworks	List the open-source frameworks used	Technology of Opensource framework
2	Security Implementations	Sensitive and private data must be protected from their production until the decision-making and storage stages	Node-Red, Open weather App API, MIT App Inventor
3	Scalable Architecture	scalability is a major concern for IoT platforms. It has been shown that different architectural choices of IoT platforms affect system scalability and that automatic real time decision-making is feasible in an environment composed of dozens of thousand.	Technology used

TECHNICAL ARCHITECTURE :



1. The different soil parameters temperature, soil moistures and then humidity are sensed using different sensors and obtained value is stored in the IBM B2 cloud.

2. Arduino UNO is used as a processing Unit that process the data obtained from the sensors and whether data from the weather API.

3. NODE-RED is used as a programming tool to write the hardware, software and APIs. The MQTT protocol is followed for the communication.

4. All the collected data are provided to the user through a mobile application that was developed using the MIT app inventor. The user could make a decision through an app, weather to water the field or not depending upon the sensor values. By using the app they can remotely operate the motor switch.

5.3USER STORIES

1. The hardware

To build an IoT solution for agriculture, you need to choose the sensors for your device (or create a custom one). Your choice will depend on the types of information you want to collect and the purpose of your solution in general.

In any case, the quality of your sensors is crucial to the success of your product: it will depend on the accuracy of the collected data and its reliability.

2. The brain

Data analytics should be at the core of every smart agriculture solution. The collected data itself will be of little help if you cannot make sense of it.

Thus, you need to have powerful data analytics capabilities and apply predictive algorithms and machine learning in order to obtain actionable insights based on the collected data.

3. The maintenance

Maintenance of your hardware is a challenge that is of primary importance for IoT products in agriculture, as the sensors are typically used in the field and can be easily damaged.

Thus, you need to make sure your hardware is durable and easy to maintain. Otherwise you will need to replace your sensors more often than you would like.

4. The mobility

Smart farming applications should be tailored for use in the field. A business owner or farm manager should be able to access the information on site or remotely via a smartphone or desktop computer.

Plus, each connected device should be autonomous and have enough wireless range to communicate with the other devices and send data to the central server.

5. The infrastructure

To ensure that your smart farming application performs well (and to make sure it can handle the data load), you need a solid internal infrastructure.

Furthermore, your internal systems have to be secure. Failing to properly secure your system only increases the likeliness of someone breaking into it, stealing your data or even taking control of your autonomous tractors.

6. Connectivity

The need to transmit data between many agricultural facilities still poses a challenge for the adoption of smart farming. Needless to say, the connection between these facilities should be reliable enough to withstand bad weather conditions and to ensure non-disruptive operations.

Today, IoT devices still use varying connection protocols, although the efforts to develop unified standards in this area are currently underway. The advent of 5G and technologies like space-based Internet will, hopefully, help find a solution to this problem.

7. Data collection frequency

Because of the high variety of data types in the agricultural industry, ensuring the optimal data collection frequency can be problematic. The data from field-based, aerial and environmental sensors, apps, machinery, and equipment, as well as processed analytical data, can be a subject of restriction and regulations. Today, the safe and timely delivery, and sharing of this data is one of the current smart farming challenges.

8. Data security in the agriculture industry

Precision agriculture and IoT technology imply working with large sets of data, which increases the number of potential security loopholes that perpetrators can use for data theft and hacking attacks. Unfortunately, data security in agriculture is still, to a large extent, an unfamiliar concept.

Many farms, for example, use drones that transmit data to farm machinery. This machinery connects to the Internet but has little to zero security protection, such as user passwords or remote access authentications.
Some of the basic IoT security recommendations include monitoring data traffic, using encryption methods to protect sensitive data, leveraging AI-based security tools to detect traces of suspicious activity in real-time, and storing data in the blockchain to ensure its integrity.

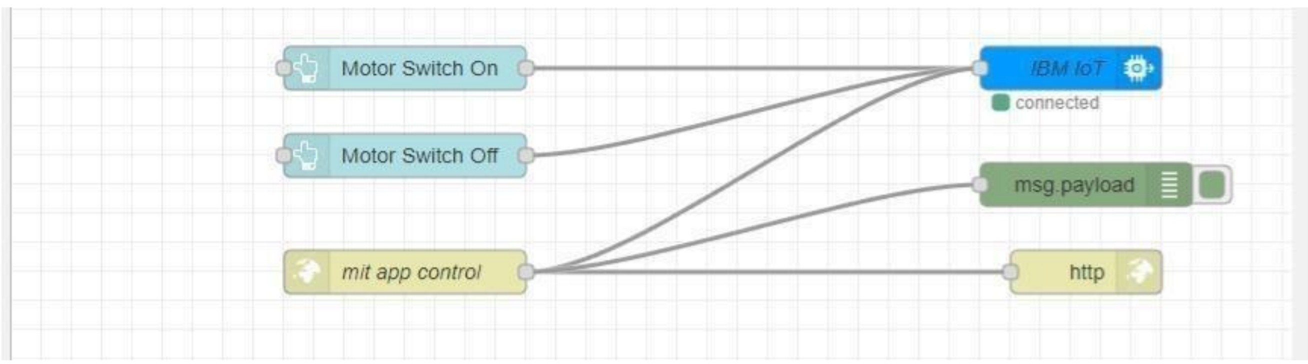
To fully benefit from IoT, farmers will have to get familiar with the data security concept, set up internal security policies, and adhere to them.

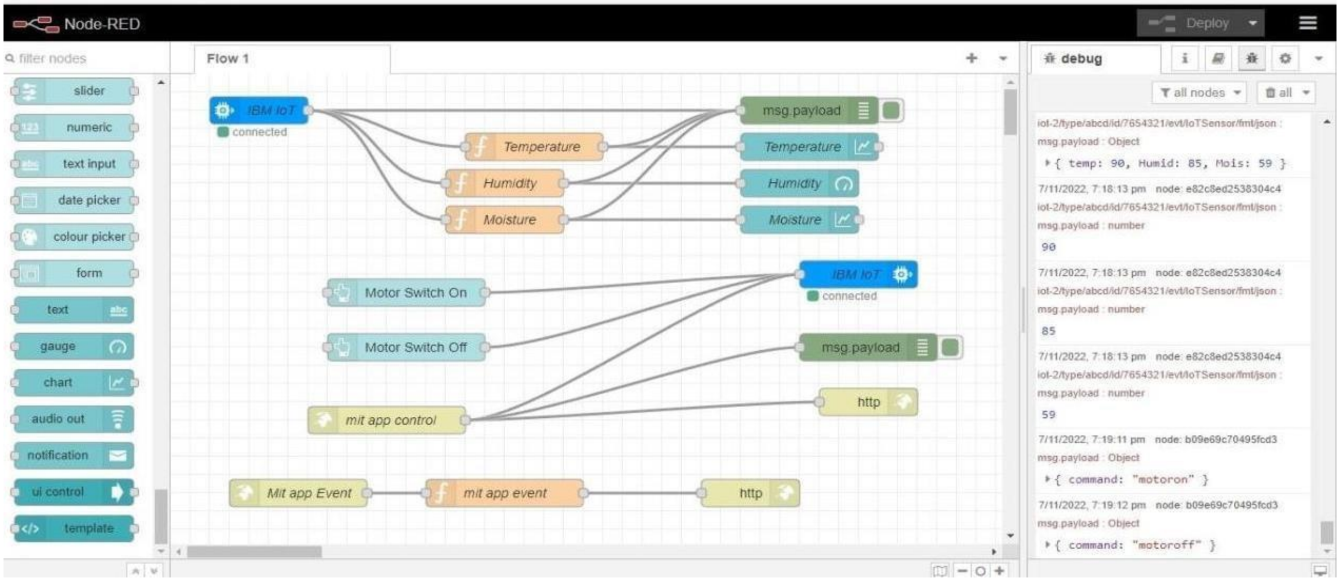
6. PROJECT PLANNING & SCHEDULING

6.1 SPRINT PLANNING & ESTIMATION

In Scrum Projects, Estimation is done by the entire team during Sprint Planning Meeting. The objective of the Estimation would be to consider the User Stories for the Sprint by Priority and by the Ability of the team to deliver during the Time Box of the Sprint.

NODE RED

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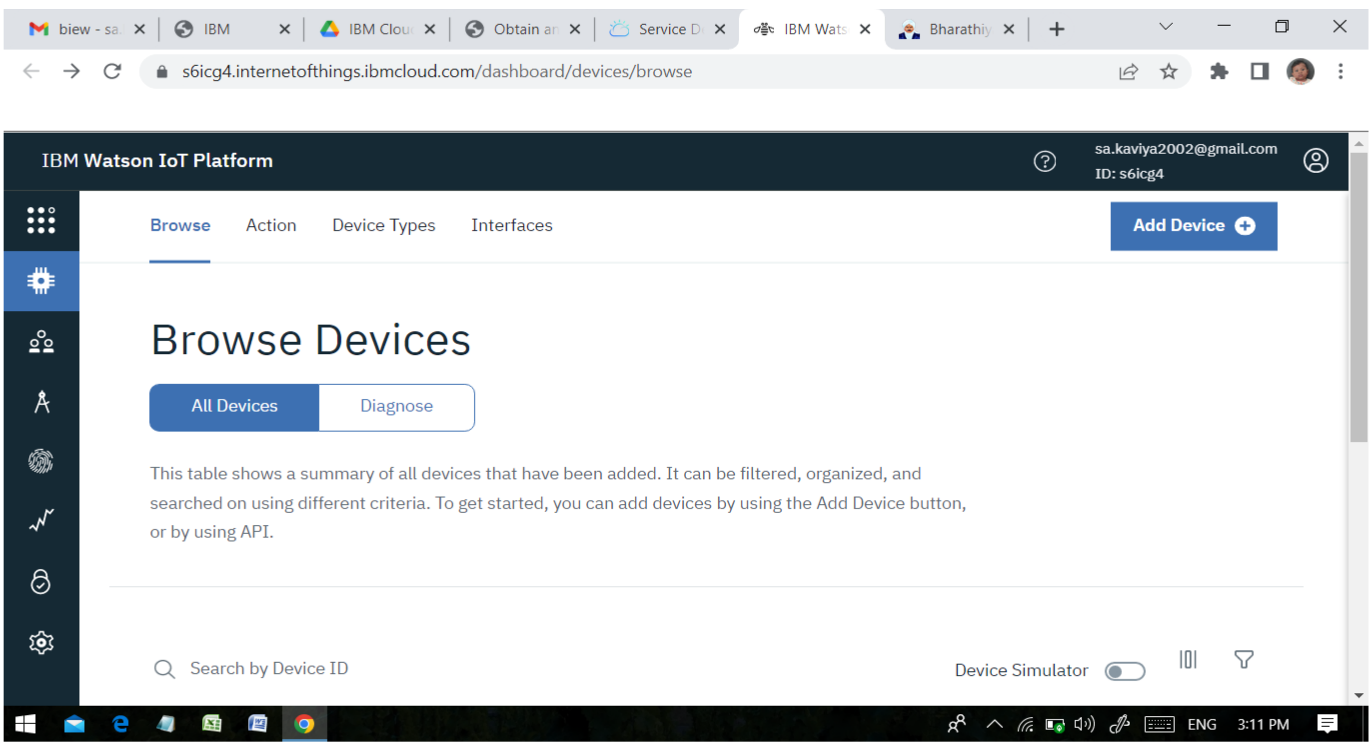
WATSON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Action
Device Types
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This table shows a summary of all devices that have been added. It can be filtered, organized, and searched on using different criteria. To get started, you can add devices by using the Add Device button, or by using API.
Search by Device ID
Device Simulator
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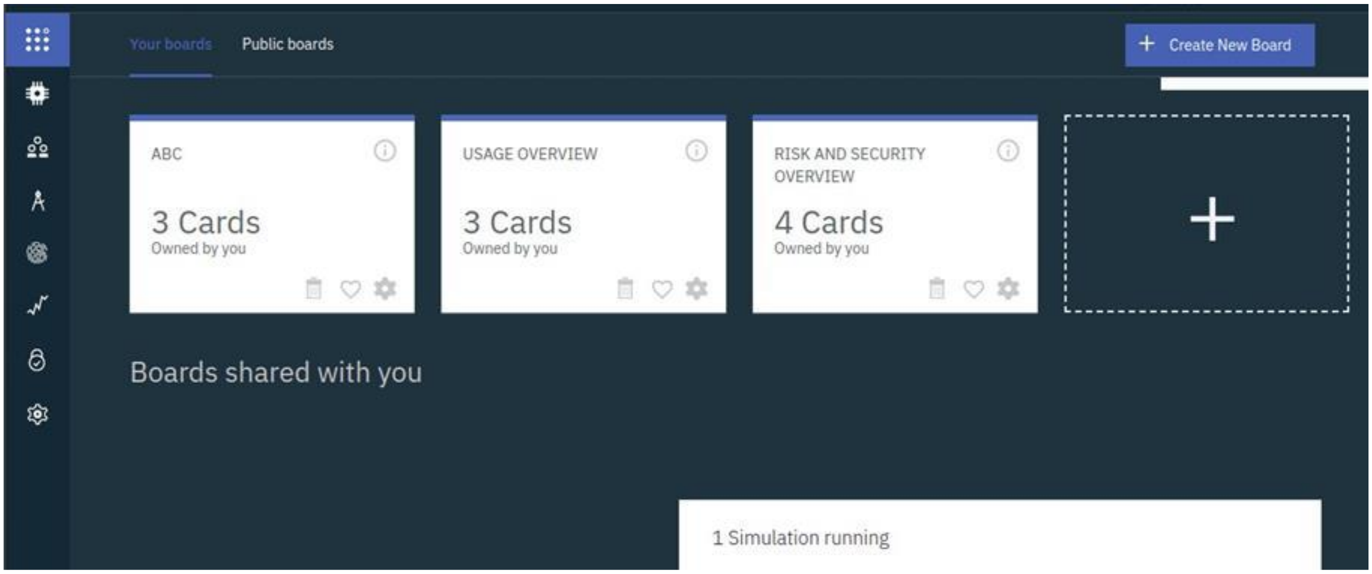

Your boards
Public boards
Create New Board
ABC
3 Cards
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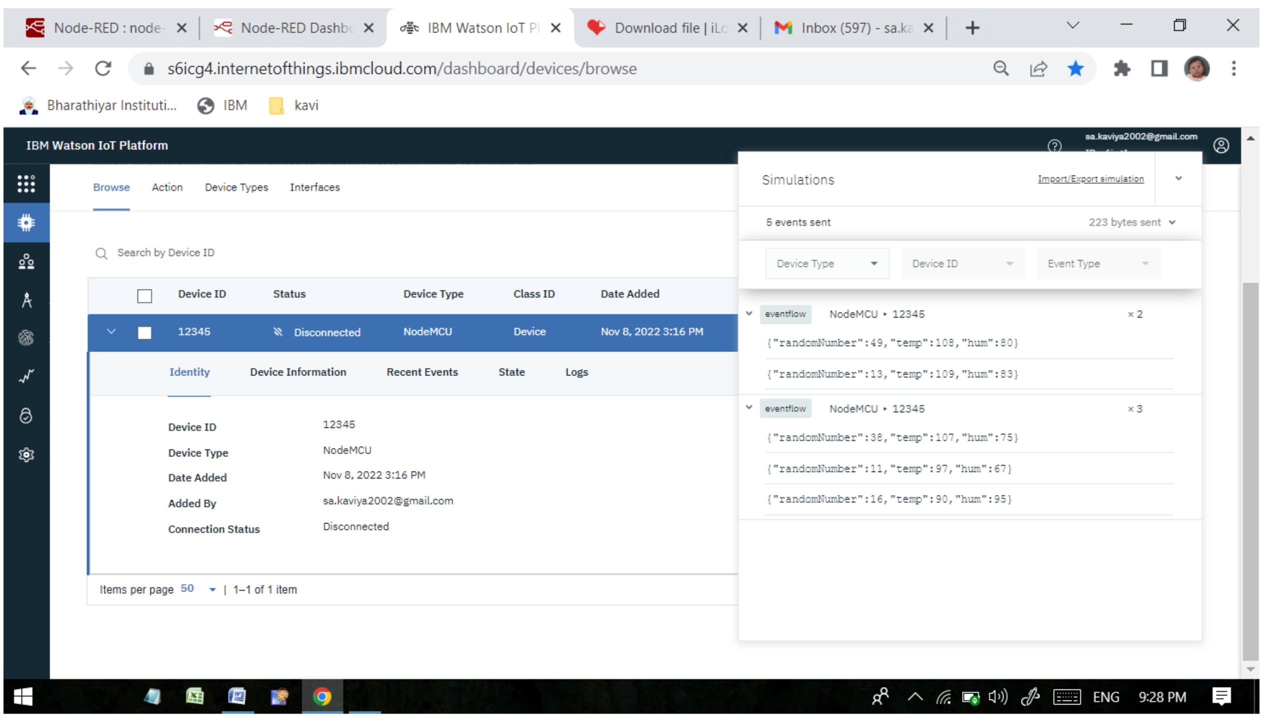
1 Simulation running



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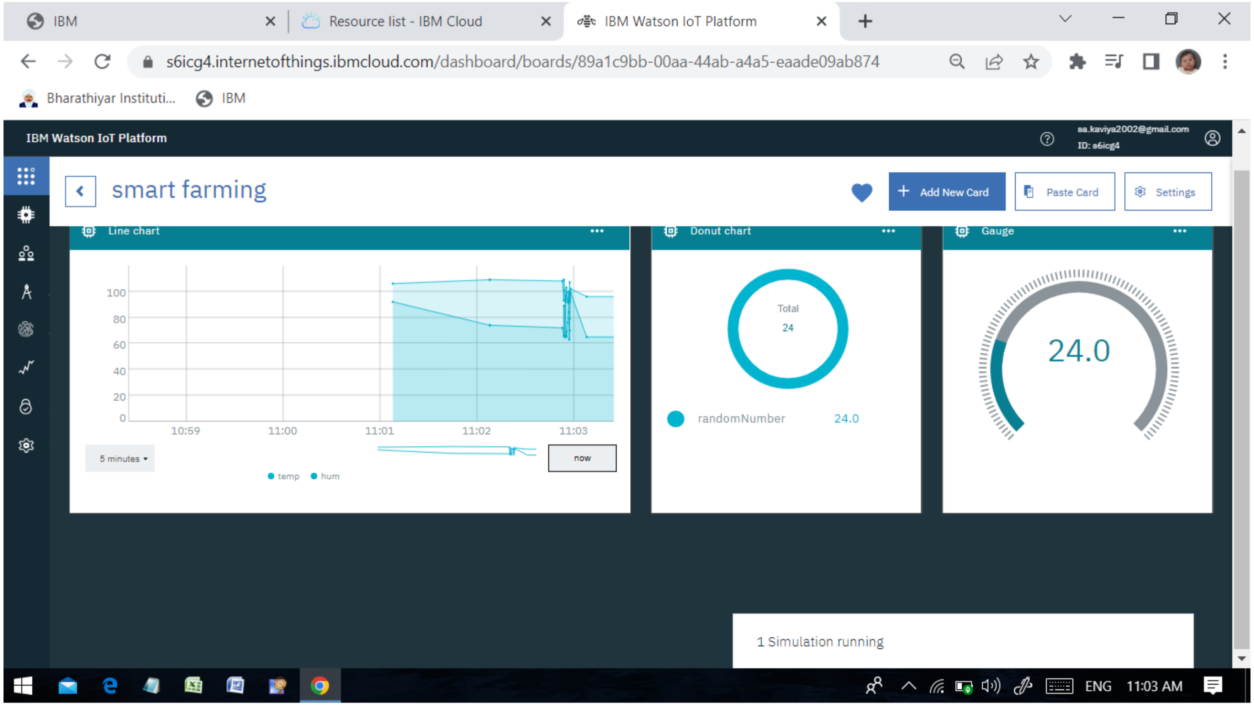
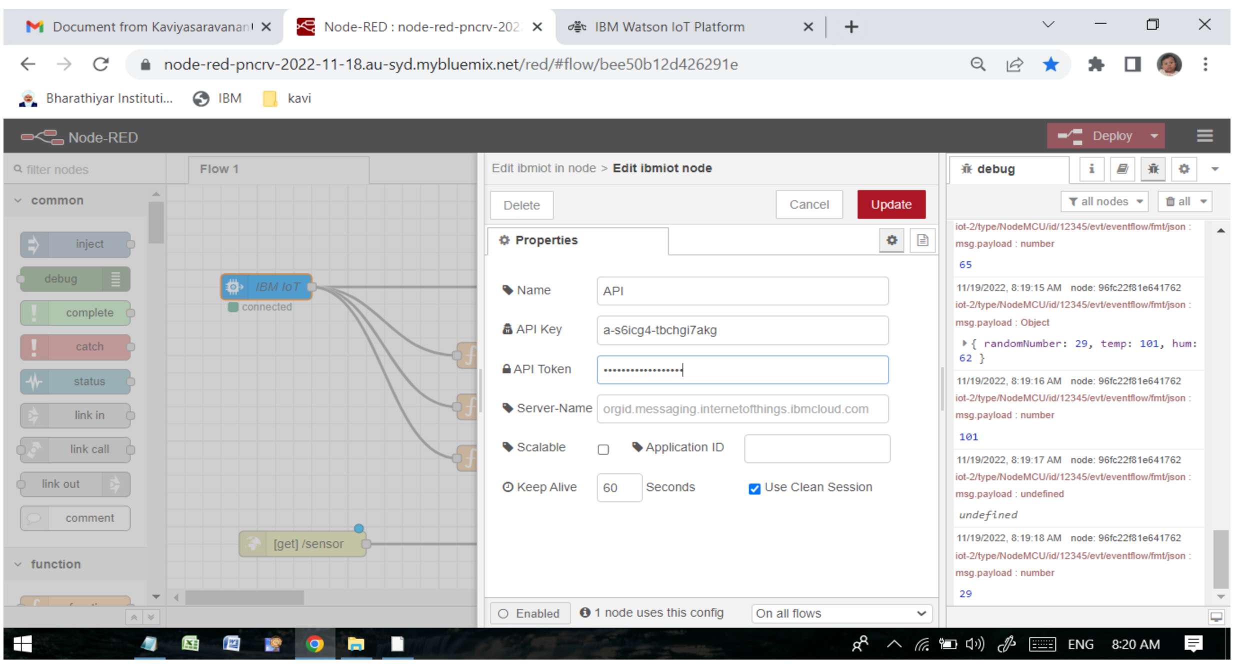
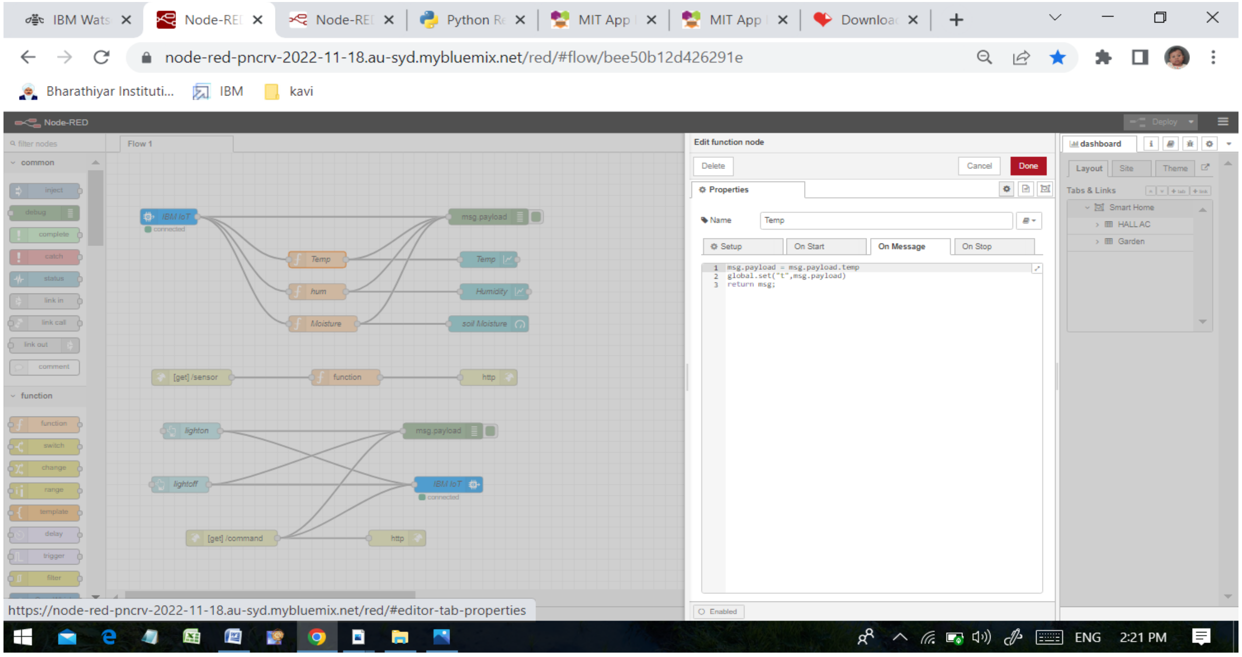


6.2 SPRINT DELIVERY SCHEDULE

Configuration of Node-Red to send command to IBM cloud

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Theme
Tabs & Links
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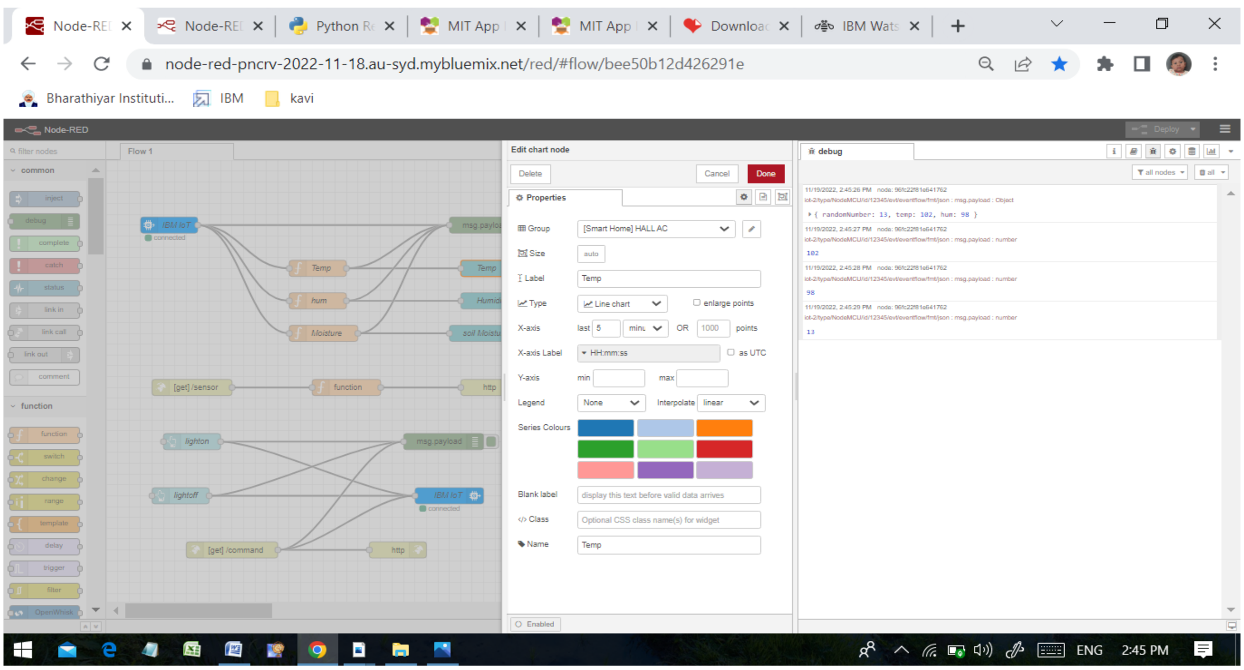
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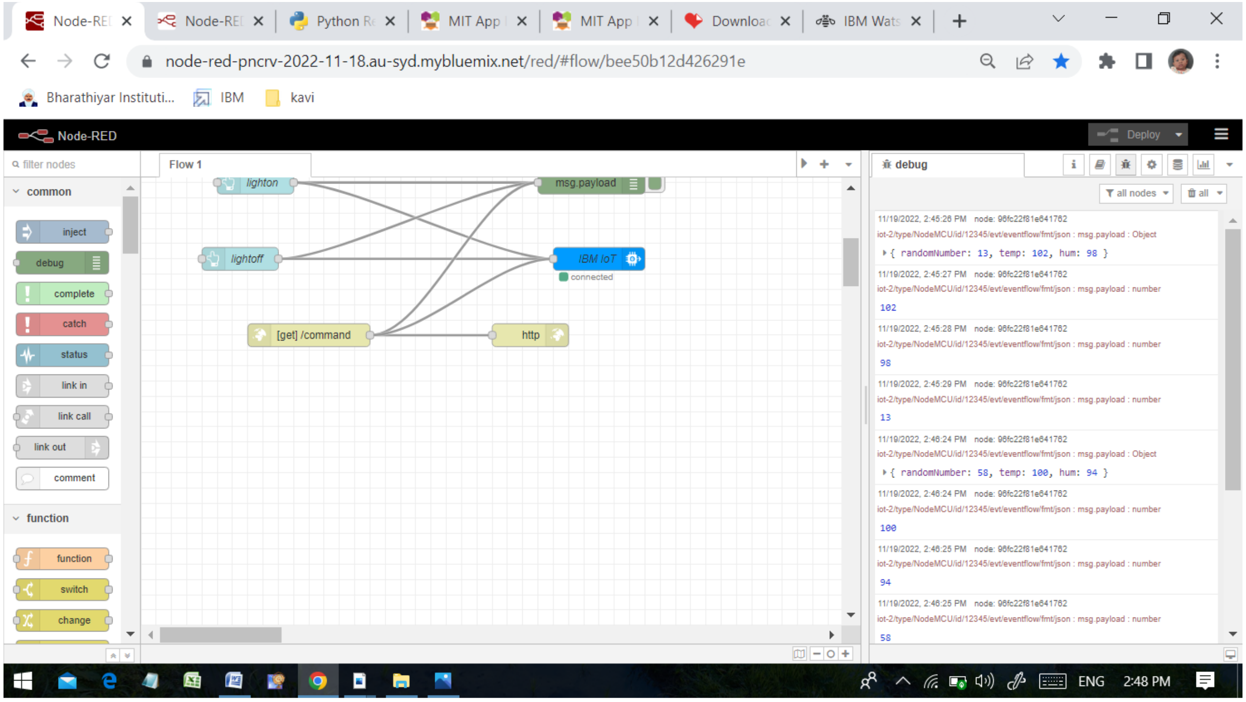
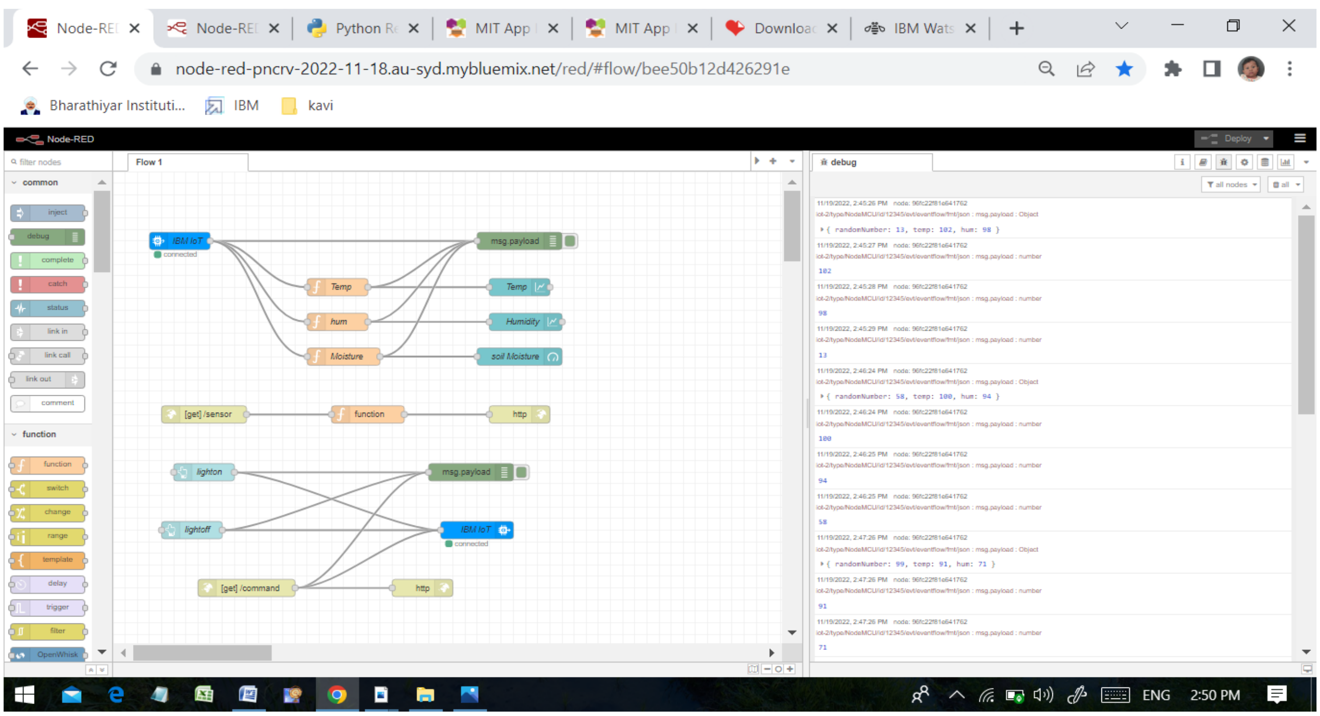
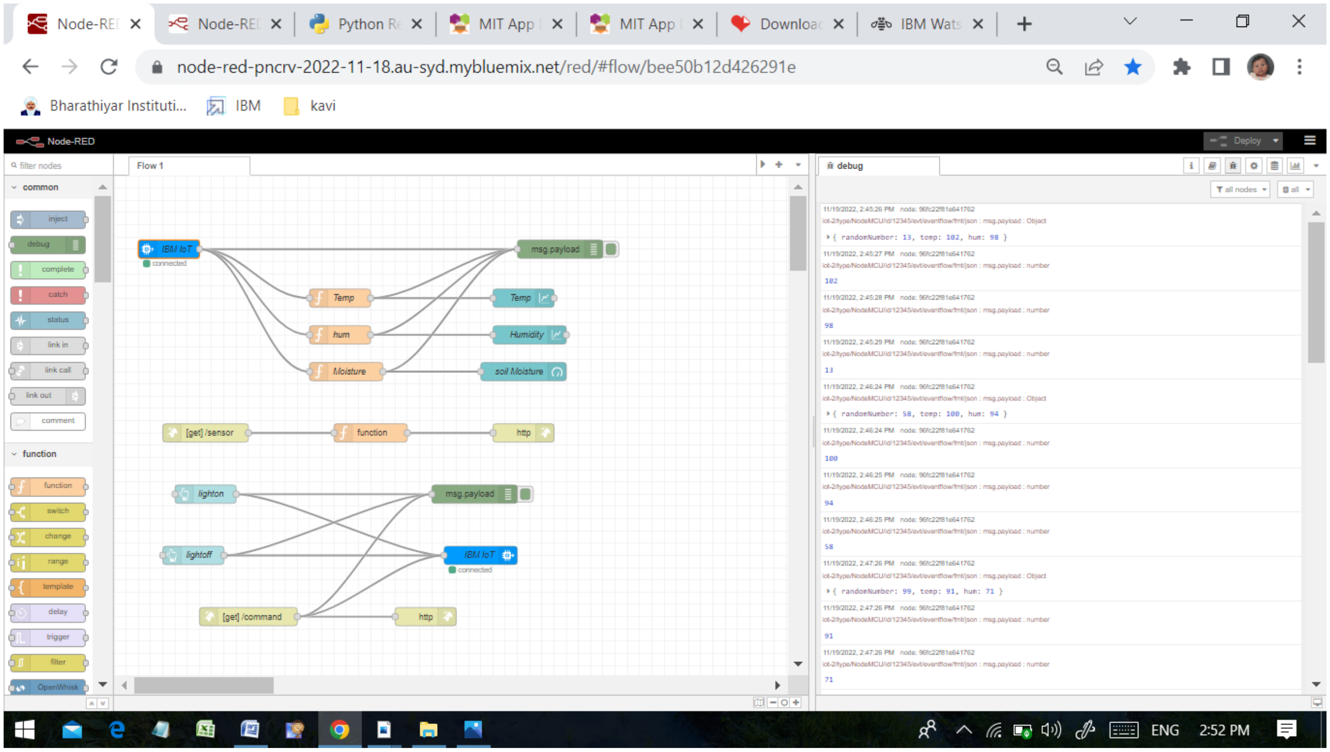
OR
1000
points
X-axis Label
HH:mm:ss
as UTC
Y-axis
min
max
Legend
None
Interpolate
linear
Series Colours
Blank label
display this text before valid data arrives
Class
Optional CSS class name(s) for widget
Name
Temp
Enabled
debug
ENG
2:45 PM

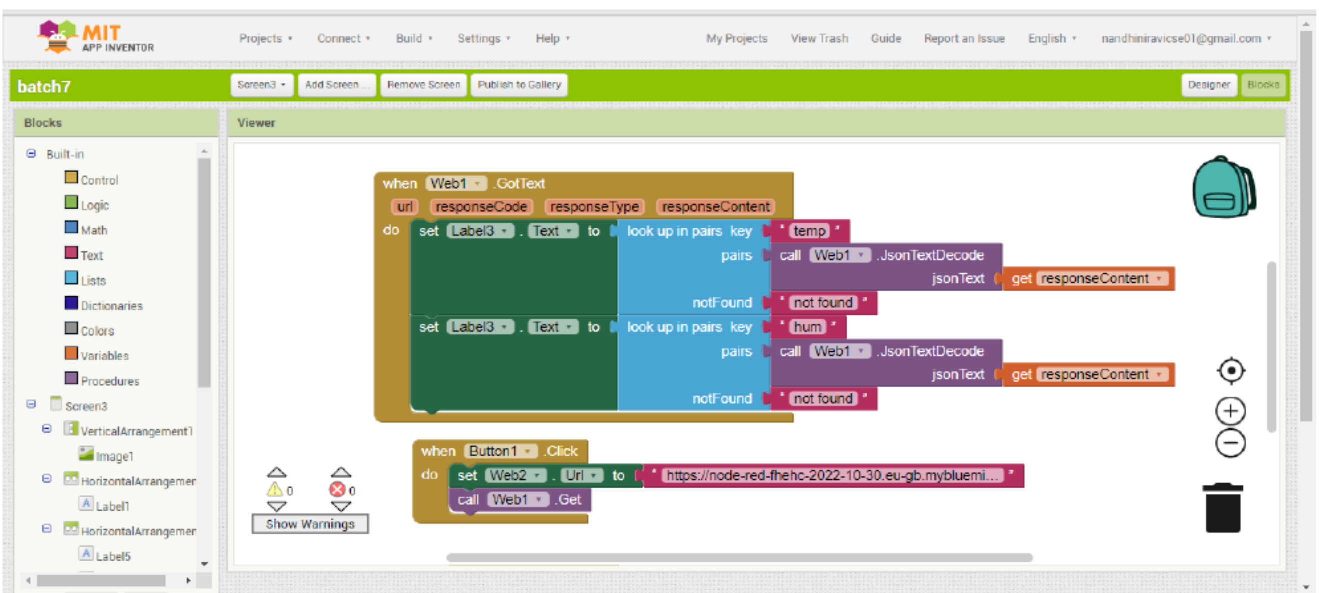




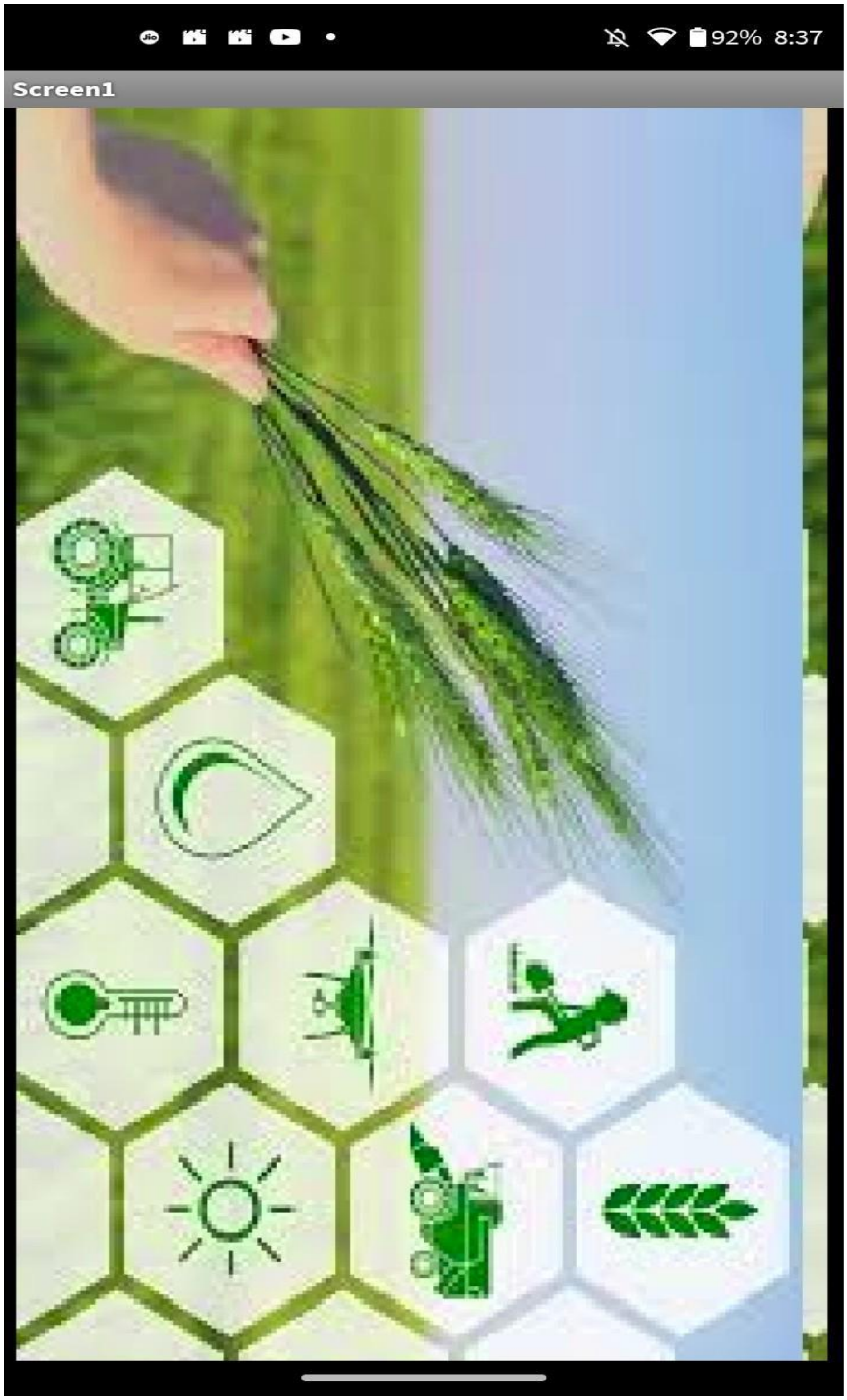
COMPLETE FLOW DIAGRAM:



BLOCK DIAGRAM :



SCREEN 1



SCREEN 2

SCREEN 3


92% 8:37
Screen3
HALL AC
HUMIDITY : 90
TEMP : 86
Switch Board
Light on
Light of

```
ibmiotpublishsubscribe (1).py - C:\Users\Admin\Downloads\ibmiotpublishsubscribe (1).py (3.7.0)
File  Edit  Format  Run  Options  Window  Help
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random


#Provide your IBM Watson Device Credentials
organization = "mzcv61"
deviceType = "abcd"
deviceId = "123"
authMethod = "token"
authToken = "12345678"

# Initialize GPIO


def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    else :
        print ("led is off")

    #print(cmd)



try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #..............................................

except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
```

DELIVERY & OUTPUT

```
*Python 3.7.0 Shell*
File  Edit  Shell  Debug  Options  Window  Help
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:59:51) [MSC v.1914 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
====== RESTART: C:\Users\Admin\Downloads\ibmiotpublishsubscribe (1).py ======
2022-11-18 22:37:40,636   ibmiotf.device.Client      INFO    Connected successfully: d:mzcv61:abcd:123
Published Temperature = 2 C Humidity = 91 % to IBM Watson
Published Temperature = 12 C Humidity = 41 % to IBM Watson
Published Temperature = 57 C Humidity = 79 % to IBM Watson
Published Temperature = 83 C Humidity = 22 % to IBM Watson
Published Temperature = 71 C Humidity = 35 % to IBM Watson
Published Temperature = 73 C Humidity = 93 % to IBM Watson
Published Temperature = 100 C Humidity = 78 % to IBM Watson
Published Temperature = 23 C Humidity = 53 % to IBM Watson
```

7.CODING & SOLUTIONING

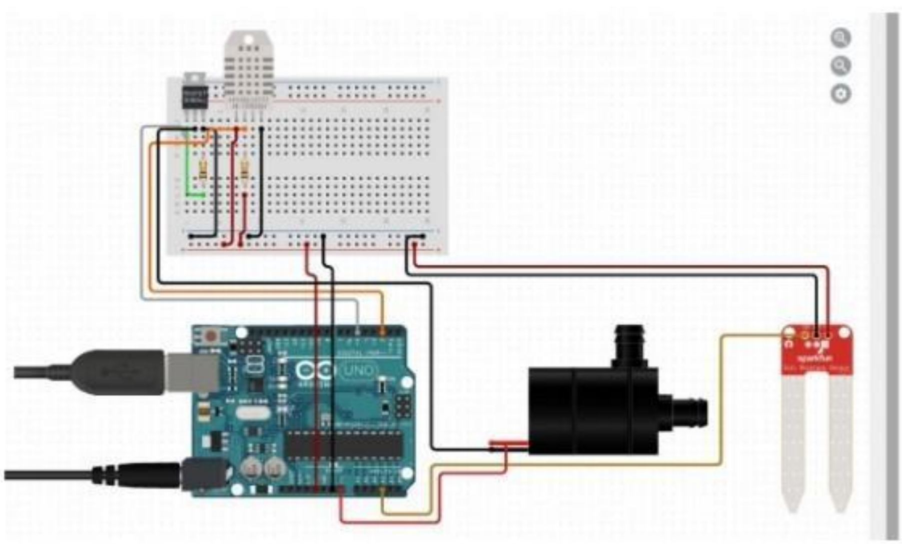
Connecting Sensors with Arduino using C++ code

```
#include
"Arduino.h"
#include"dht.h"
#include"SoilMoisture.h"
#definedht_apin A0
const int sensor_pin = A1; //soil moisture
int pin_out =9;
dht DHT;
int
c=0;void
setup()
{
pinMode(2, INPUT); //Pin 2 as
INPUTpinMode(3, OUTPUT); //PIN 3 as
OUTPUTpinMode(9,OUTPUT);//output
for pump
}
voidloop()
{
if(digitalRead(2) == HIGH)
{
digitalWrite(3, HIGH); // turn the LED/Buzz
ONdelay(10000); // wait for 100
mseconddigitalWrite(3, LOW); // turn the
```

```
LED/Buzz OFFdelay(100);
}
Serial.begin(9600
);delay(1000);
DHT.read11(dht_apin);
//tempraturefloat h=DHT.humidity;
float
t=DHT.temperature;del
ay(5000);Serial.begin(
9600);
float
moisture_percentage; int
sensor_analog;
sensor_analog= analogRead(sensor_pin);
moisture_percentage = ( 100 - (
(sensor_analog/1023.00) *100 ) );
float m=
moisture_percentage;delay(
1000);
if(m<40)
{
while(m<40)
{
digitalWrite(pin_out,HIGH); //openpump
sensor_analog= analogRead(sensor_pin);
moisture_percentage = ( 100 - (
(sensor_analog/1023.00) *100 ) );
m=moisture_percentag
e;delay(1000);
}
digitalWrite(pin_out,LOW); //closepump
}
if(c>=0)
{
```

```
mySerial.begin(9600);delay(15000);Serial.begi
n(9600);delay(1000);Se
rial.print("\r");delay(10
00);
Serial.print((String)"update-
>"+(String)"Temprature="+t+(String)"Humidity="+h+(String
)"Moisture="+
m);delay(1000
);
}
}
```

OUTPUT :



PYTHON CODE

```
import time

import sys

import ibmiotf.application

import ibmiotf.device

import random


#Provide your IBM Watson Device Credentials organization = "mzcv61"

deviceType = "abcd"

deviceId = "123"

authMethod = "token"

authToken = "12345678"


# Initialize GPIO
def myCommandCallback(cmd):

        print("Command received: %s" % cmd.data['command'])
        status=cmd.data['command']
        if status=="lighton": print
            ("led is on")
        else :

        print ("led is off")


      #print(cmd)
```

```
        try:

                deviceOptions = {"org": organization, "type": deviceType, "id":
        deviceId,
        "auth-method": authMethod, "auth-token": authToken}
                deviceCli = ibmiotf.device.Client(deviceOptions)

                #..............................................
        except Exception as e:
        print("Caught exception connecting device: %s" % str(e)) sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as
an event
 of type "greeting" 10 times
deviceCli.connect()

while True:
        #Get Sensor Data from DHT11
temp=random.randint(0,100) Humid=random.randint(0,100)

        data = { 'temp' : temp, 'Humid': Humid } #print
        data
        def myOnPublishCallback():
                print ("Published Temperature = %s C" % temp, "Humidity =
        %s %%" % Humid, "to IBM Watson")

                success = deviceCli.publishEvent("IoTSensor", "json", data,
        qos=0, on_publish=myOnPublishCallback)

                if not success:
                        print("Not connected to IoTF") time.sleep(1)

                deviceCli.commandCallback = myCommandCallback


# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

ibmiotpublishsubscribe (1).py - C:\Users\Admin\Downloads\ibmiotpublishsubscribe (1).py (3.7.0)

File Edit Format Run Options Window Help

```python
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random


#Provide your IBM Watson Device Credentials
organization = "mzcv61"
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deviceId = "123"
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# Initialize GPIO


def myCommandCallback(cmd):
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try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method": authMethod, "auth-token": authToken}
        deviceCli = ibmiotf.device.Client(deviceOptions)
        #..............................................

except Exception as e:
        print("Caught exception connecting device: %s" % str(e))
        sys.exit()

# Connect and send a datapoint "hello" with value "world" into the cloud as an event of type "greeting" 10 times
```

OUTPUT :

Python 3.7.0 Shell

File Edit Shell Debug Options Window Help

```
Python 3.7.0 (v3.7.0:1bf9cc5093, Jun 27 2018, 04:59:51) [MSC v.1914 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
====== RESTART: C:\Users\Admin\Downloads\ibmiotpublishsubscribe (1).py ======
2022-11-18 22:37:40,636   ibmiotf.device.Client      INFO    Connected successfully: d:mzcv61:abcd:123
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Published Temperature = 57 C Humidity = 79 % to IBM Watson
Published Temperature = 83 C Humidity = 22 % to IBM Watson
Published Temperature = 71 C Humidity = 35 % to IBM Watson
Published Temperature = 73 C Humidity = 93 % to IBM Watson
Published Temperature = 100 C Humidity = 78 % to IBM Watson
Published Temperature = 23 C Humidity = 53 % to IBM Watson
```

8.TESTING

8.1 TEST CASE

Commodity testing has been a go-to method for farmers and organizations to ensure food quality and purity. Commodity testing or inspections are usually done in a warehouse owned by a third party or an organization, which often lacks factors necessary to keep the good in good health.

- Commodity testing only tests a finished product while leaving the raw materials untouched. It is crucial to check each ingredient starting from raw materials all the way through the final product.
- The production unit or the factory where the goods are produced are completely unaware of the do’s and don’ts of the testing methods; this puts the manufacturers in a big quandary about what and what not to modify among many variables of the complex production SOPs. Companies are left to best guess based on the inspection results and often find themselves in a bottleneck when it comes to training employees.
- When the testing processes are confidential, then the instance of a certain produce found ‘unfit’ for consumption, the whole batch of that agri-produce has to be scrapped, incurring a loss to the supplier or manufacturer.
- Commodity testing demands to set up a warehouse to stock the goods, and ship them to the supplier post-testing. Additionally, the warehouse also has to be capable of delivering goods elsewhere and calls for a terrific organization. Many manufacturers aren’t happy with this transfer of accountability, which could be a cumbersome task for the testing party.

In order to ensure maximum quality, there is an acute need for testing systems that could deliver more accurate results while costing farmers a fraction of their profits.

8.2 USER ACCEPTANCE TESTING

The UAT testing process is taken up before planning to release the software into the market. This step ensures whether the software is complete according to the functional specifications defined by the product owner or not.

It is highly essential for the product owner to take up this process else businesses suffer from significant losses due to many post-release issues.

Usually, this process is taken up as the last phase wherein intended users or rather the customer verify if the functionality as outlined in the user story or requirements documents exists. Specifically, the UAT process is taken up with a separate UAT test plan and in a separate testing environment with typically enabling production-like data set up to make the client/end-user clearly understand the developed software.

1. Find Users:

User identification is the first step. Selecting a group of users (who are interested in the product) is essential for conducting UAT. These users are none other than the end-users of the product. These users can be from the company or from outside or both.

2. Document test cases:

There has to be a methodical plan for UAT testers to perform UAT testing productively. As these testers will be going through all the features of the product, their feedback in terms of how they want the product to function should be documented.

3. Prepare the environment:

A test environment is crucial for the success of UAT. Those users who’ve been selected to perform UAT must have the credentials and data to carry out testing effectively.

9.RESULTS

9.1 PERFORMANCE METRICS

1. Commodity Pricing

Without a thorough understanding of commodity prices and how they impact your business, you could quickly descend into the red and end up with more product than the market can sustain. No one can completely predict how commodity prices rise and fall, because the numbers change depending on supply, demand, and other external factors. But keeping your finger on the pulse of these trends will allow you to make better decisions when it comes time to decide how many crops to plant or animals to raise.

A variety of news and research sources provide a steady stream of information about commodity and futures markets. Future Source, The Hightower Report, and Inside Futures are reliable sources for general market news and commentary. While Iowa Grain provides expert insight on the grain and livestock markets. These are just a few sources that provide consistent and readily available information on commodity pricing.

2. Working Capital

Otherwise known as the amount of money available for operational expenses, working capital is a farmer’s bread and butter. Your working capital to gross revenue ratio can vary depending on whether you have a farming or ranching operation. The general rule of thumb is to aim for 30 percent or higher for crop farms and 20 percent or higher for livestock farms. Numbers may ebb and flow, but you never want to put yourself in a situation where factors outside of your control force you to make poor financial decisions.

Keeping a close eye on your working capital allows you the freedom to not only make sound decisions in the event of an emergency; it also opens the door for opportunities to invest in things like field analyzers, weather forecasting services, and machine learning technologies.

3. Debt-to-Asset Ratio

Debt-to-asset ratio is a farm management metric that each farmer and rancher should know, understand, and monitor. This ratio measures the degree to which your assets are financed by debt. To calculate this number and gain a better understanding of operational risk exposure, divide assets by liabilities and multiply by 100.

Having a high debt to asset ratio could mean you are treading in dangerous waters. If a vital piece of farming equipment breaks down in the weeks leading up to harvest, this could put you in a position where you don't have the funds to repair or replace it—or have the option to apply for additional financing. Knowing these numbers and maintaining a healthy ratio will allow you the flexibility to take on additional debt in the future, should you need it for a season.

4. Asset Turnover Ratio

The asset turnover ratio measures how efficiently your assets are generating value, which contributes to the measure of gross income. Farms and ranches with a higher asset turnover ratio are using their assets more efficiently, and therefore making better use of their time and resources. This particular farm metric is crucial to understand and track because low numbers could be a sign of poor production management.

Some ways to improve your asset turnover ratio are to increase sales, increase the efficiency of production and sales, sell assets you don't use, and accelerate the collection of money from customers.

Because farming and ranching are known to be volatile industries, taking these steps may help protect you against unforeseen circumstances. For instance, the more efficiently you can run your operation, the higher your profit margin will be. This will give you a financial cushion should your operation encounter low prices, natural disasters, or unanticipated expenses.

10. ADVANTAGES & DISADVANTAGES

ADVANTAGES :

One of the really good things about this branch of farming is that it allows for Soil Sensing. This aspect of smart farming gives room for you as a farmer to test your soil for information and also measure it for a wide range of important and nutritious constituents necessary in securing the good health of your farm produce.

Soil sensing is also employed to appropriately control the application of real-time variable rate equipment. This allows you to understand the scale of your grounds, making you also, in this process, device effective ways of conserving necessary farming resources like water, fertilizer and so on. So, with this, you only have to apply fertilizers and pesticides where you need to apply them so as not to negatively affect your plants. You also get to conserve seeds, fertilizer, water, etc., and still even maximize yields at the end of the day.

You also get to get important information about the amount of air and the levels of air, sound, humidity, and temperature of your environment.

Smart farming is a wonderful option if you want to save the cost of electricity. It allows for the use of solar-powered tools like pumps that save your expenditure. It is cost-effective as it somewhat reduces the spending usually generated by farmers in maintaining their capital intensive techs.

Smart agriculture makes use of AI to improve the process of wireless monitoring, regulation and data collection. With these inputs on your farm, all thanks to smart farming, you can be sure of high-quality crop production and delivery.

DISADVANTAGES :

One huge disadvantage of smart farming is that it requires an unlimited or continuous internet connection to be successful. This means that in rural communities, especially in the developing countries where we have mass crop production, it is completely impossible to operate this farming method. In places where internet connections are frustratingly slow, smart farming will be an impossibility.

As pointed out earlier, smart farming makes use of high techs that require technical skill and precision to make it a success. It requires an understanding of robotics and ICT. However, many farmers do not have these skills. Even finding someone with this technical ability is difficult or even expensive to come by, at most. And, this can be a discouraging factor hindering a lot of promising farmers from adopting it.

An entirely new branch of agriculture, "smart farming" or IoT-based "smart agriculture" has now been introduced. This is a result of the continuous advancement we have been experiencing in the technology sector. Normally, one wouldn't expect that, in agriculture, you would find such things as IoT and other popular smart techs. But, in this quite fascinating branch of farming, also commonly referred to "intelligent farming", farmers have the freedom to make use of sensors and many other high tech materials like the Internet of Things (IoT)/cellular that are designed by highly intelligent scientists to make things easier, not for farmers alone, but for the world population at large (Ravindra, 2018; Guerrini, 2015).

These high tech materials can help you to mark your grounds, sense the soil your plants are grown on, monitor the number of nutrients they get, conserve such essential resources as fertilizer and water that your plants need to healthily grow, and also sustain a safe environment.

11. CONCLUSION

Climate change poses a growing threat to sustainable development. The expected effects of climate change could seriously compromise the ability of the agriculture sectors to feed the world, and severely undermine progress toward eradicating hunger, malnutrition and poverty. Action is urgently needed to prepare the agricultural sectors for the prospect of rapidly changing environmental conditions. As the agriculture sectors are partly responsible for the accumulation of greenhouse gas in the atmosphere that are responsible climate change, it is also important to reduce agricultural emissions. Even without climate change, world agriculture and food security are face daunting challenges. Population growth and rising incomes in much of the developing world have pushed the demand for food and other agricultural products to unprecedented levels. Without heightened efforts to reduce poverty and improve agricultural productivity, many low-income countries, especially those in sub-Saharan Africa and South Asia, will find it difficult to ensure access to adequate quantities of food for all.

Agriculture production systems and food systems must undergo significant transformations to meet the interlinked challenges of achieving sustainability, ensuring food security and addressing climate change. Increasing resource efficiency is essential to increase and safeguard food security in the long term and making a significant contribution climate change mitigation. With the increased risks from the impacts of climate change, efficiency and resilience have to be considered together at every scale and from environmental, economic and social perspectives. Climate-smart agriculture is a dynamic approach that guides the needed changes towards addressing the challenges of climate change. It is not a new agricultural system, nor a set of practices. It articulates globally applicable principles for managing agriculture for food security under changing climatic conditions, which can serve as the basis for policy support and recommendations by multilateral organizations.

12. FUTURE SCOPE

The Growing Use of Smart Farming Worldwide

In the coming years, smart farming is projected to create a massive impact on the agricultural economy by bridging the gap between small and large-scale businesses. The trend is not only pertinent in developed countries — developing countries have also realized its immense importance as well.

In countries such as China and Japan, wide-scale deployments of smartphones and internet of things (IoT) systems have led to a rapid adoption of precision agriculture solutions. The governments of several countries have also realized the need for, and the advantages of these technologies, and thus, their initiatives to promote precision farming techniques are expected to drive the growth of the market further.

Types of Precision Agriculture

According to the report, in 2017, the hardware systems solution segment held more than 72% of the total global smart farming market. The precision crop farming application currently holds the largest market share of over 31%.

Where Precision Farming Is Taking Off

Regionally, North America is at the forefront of the global smart agriculture market, with high market penetration in the U.S. However, Mexico is expected to have the highest market growth in the coming five years.

The Asia-Pacific region is projected to display the fastest market growth from 2017 to 2022. The region presents an immense scope for market development, owing to the increasing urban population size, growing market penetration of internet in farm management, and favorable government investments.

Automated Farming Trends

A change in the global aging demographic has triggered the adoption of automation in farming practices. Automation and control systems manufacturers have witnessed a definite surge in their sales due to this profound change in the farming industry.

13.APPENDIX

Git hub & project Demo Link

https://github.com/IBM-EPBL/IBM-Project-54411-1661959433