# Chapter 1

# Introduction

## 1.1 MOTIVATION AND BACKGROUND

Ecosystems are deteriorating or being harmed as a result of pressures, particularly those brought on by human activity. In order to supply the services that both humans and the natural environment need, a healthy ecosystem is crucial. It also has enormous social and economic value. Healthy ecosystems maintain our soil, clean our air, control the climate, recycle nutrients, and give us food. They offer resources and raw materials for making medications and other things. All civilization is based on them, and they support our economy.

In many nations, agriculture is the main cause of pollution. Pesticides, fertilizers, and other harmful agricultural chemicals have the potential to contaminate fresh water, marine habitats, air, and soil. They may also linger in the environment for many years. Pollination is improved through ecological agriculture, which raises crop yields. Utilizing ecosystem services like water filtering, pollination, oxygen generation, and disease and insect control is called ecological farming. What connections exist between agriculture and the ecosystem? A widespread assortment of ecosystem facilities, such as water quality, pollination, nutrient cycling, soil retention, carbon sequestration, and biodiversity preservation, are impacted by agricultural activities. Ecosystem services also have an impact on agricultural output. Agricultural ecosystems are dynamic and intricate networks of climate zones that take a variety of factors into account, including temperature, precipitation, the environment's impact on crop growth through direct or indirect interactions with local plants and animals, soil nutrients, and plant growth.

The first necessity of all living things is food. Earth, Water, Fire, Air, and Space are the primary five (pancha) natural elements (mahabhutas) that nature has given humanity. Each of these elements has unique characteristics and effects on agriculture. All materials and items are a combination of the five found in living things, food, herbs, and agriculture. These five components are absent in the absence of Nature and will provide an inappropriate result if any of the five ingredients are missing in reaction to agriculture's food creation. The principal types of vegetation in the world are plants in THE arctic tundra, high mountains, and frigid latitudes, zones, different types of forests. So, each kind of vegetation includes all five of the fundamental components of nature. Different types of nutrients from the soil are also necessary for fundamental crop

requirements; some of the nutrients are claimed to be crucial for the phosphorus, carbon, hydrogen, magnesium, calcium, oxygen, boron, potassium, nitrogen, iron, zinc, sulphur, manganese, molybdenum, copper, and chlorine all contribute to the growth of green plants. The climatic factors should be considered in agriculture as well. Various parts of the world have dissimilar plant development patterns because of the diversity of climatic ranges.

## 1.2 AIM AND OBJECTIVES

There are numerous factors to keep in mind, and this paragraph discusses a few of them. The movement of residents from rural to urban areas is a crucial element. The current agriculture policies are unknown to many farmers. Due to insufficient incentives and legislation, the government generally ignores agriculture in favor of business. Overall, it can be seen that Indian agriculture needs careful thought. We are only now beginning to experiment with improvements in the agricultural sector at the current technology implementation level. Because it takes so long for farmers to use manual methods for chores like crop monitoring and disease diagnosis, predictions based on these manual methods frequently turn out to be incorrect.

IoT is a method of connecting computing devices, digital and mechanical things, and machines (THINGS) that are given unique identities and the ability to transmit information over a system without the use of person-to-person or person-to-computer communication. Therefore, the Internet of Things is any technology that lessens the work required for humans to perform some daily tasks. The main objectives of the proposed research are explained below.

### 1.2.1 Saving Water.

Water is essential for maintaining human existence. Even though there seems to be an endless supply, water is a limited resource, especially pure water that is essential for human sustenance. Without conservation measures, this essential water supply could run out. As a direct outcome of efforts to preserve water, energy and equipment are also preserved, therefore conservation has economic advantages as well.

### 1.2.2 Saving of Electricity & Decrease Pollution.

In India, conventional (thermal, nuclear, and hydro) and renewable sources are used to produce electricity (Wind, Solar, Biomass, etc.). However, the majority of electricity is

produced by coal-fired thermal power plants, which provide about 75% of all electricity. The Central Electricity Authority said that India generated 103.66 billion units of electricity in December 2020.

Before 2024, about 78 percent of India's coal power generation is expected to fail to fulfil pollution standards. The final list of coal thermal power plants and their classification in accordance with the ministry's April 2021 announcement has been made public by the Union Ministry of Environment, Forest, and Climate Change (MoEF&CC). The MoEF&CC revised the 2015 notification in April 2021, creating three categories for coal thermal power plants and setting a "third-time" revised deadline for satisfying emission standards. The list has been compiled by the task force selected to classify the plants after an eight-month delay. Over 50% of the sulphide (SO2), 30% of the nitrogen (NOx), and 20% of the particulate matter (PM) concentrations in the air come from coal thermal power plants.

### 1.2.3 Save Crops Regarding Moisture Deficiency.

Due to the lack of rain, the drought creates an anomalous situation for plant improvement. Defiantly, deficiency of wetness is an ordinary but intermittent feature of weather which is identified in the field of agriculture. The irregular rain all negatively affects crops across an agricultural season or succeeding seasons are the main causes of drought conditions. The cause of drought is generally recognized to be a shortage or irregular distribution of rainfall, but the extent and severity of the disaster depend on a number of variables, such as the form of a plane as well as land water assets, agroclimatic characteristics, crop assortment, etc. Due to its complicated nature and changing features, which appear in various ways in various agroclimatic zones of the world, it is challenging to offer an accurate and widely recognized definition of drought.

A lack of precipitation reduces soil moisture, lowers plane as well as earth water volume, and is to be expected to negatively affect agricultural operations since there isn't enough water available for the crops, especially during crucial growth phases. The relationship between rainfall quantity and the start of drought in India varies according to the different agricultural areas. The states like Assam & Meghalaya where yearly rainwater is 1,000 mm approximately. Still, there is a chance of drought. While in other regions where rainwater is at medium level but if we provide water with fine distribution, we can develop crops at the required level. The occurrence, spread, and amount of drought are all influenced by a variety of variables, such as the

susceptibilities brought on by atmosphere variations, hydrological and land characteristics, the accessibility of water, selection of plants and farming process, threats, etc. Wide-ranging effects of drought are seen across several economic sectors. There is a lot of dependency of civilizations on agriculture output, the drought is just not felt by only drought-affected regions but also the other people who are facing difficulties in their daily life. Thus, drought has a large effect on the financial system by reducing income limits, revenue boundaries, and restrictive services. Drought also creates environmental and social issues.

### 1.2.4 Make Eco-System healthy.

Saving water usage and hence saving electricity in the field of agriculture will reduce the burden of thermal power generation which in turn make Eco-system pollution free. In this way proposed research indirectly diminishes pollution at a great extent. This is a very significant matter to all living animals on the earth to remain healthy.

### 1.2.5 Develop a Remote Sensing and cost-effective system with accurate decision support arrangement.

Smart Irrigation systems are established in various regions of the nation. Due to its effects on the technical and commercial facets of this agricultural industry, irrigation in horticulture is of utmost importance (Fereres et al., 2003). Plant development is improved through irrigation management (Feki et al. 2018). In the cultivation of vegetables, appropriate irrigation may result in qualitative and quantitative gains, but both under- and over-irrigation may jeopardize the crop's performance. Irrigation techniques have an influence on society and the environment in addition to having a direct impact on crop production. Due to urbanization and industrialization, there will likely be less water available for irrigation in both developed and developing nations in the near future. Due to the excessive irrigation-related leaching and runoff that releases agrochemicals into the environment; irrigated agriculture is the largest water consumer and a major source of pollution in many nations. Therefore, it is essential to employ agricultural techniques that reduce pollution, such as effective irrigation management, in order to fulfill social objectives, adhere to legal requirements, and encourage agriculture's sustainable use of resources. The expansion of a distributed in-field sensor-based field-concerned irrigation platform offers the opportunity to increase quality with yield while conserving water, even though it will be challenging to coordinate the

combination of sensors. Control of the water system, programming of applications, and communication in an efficient manner. Fewer multichannel systems have been included in the numerous additional scientific studies that have examined the possibility of employing input from remote infield systems that enable sensing to adjust variable-rate irrigation systems. Solar panel systems might perhaps be used to quickly address the capacity gaps (again, along with additionally the radio range will then be improved by updating its energy category along with antennas). S. Blackmore (1994) described a novel method called Precision Agriculture to overcome the aforementioned issues (PA). In accordance with his definition, PA is a "complete system aimed to enhance agricultural productivity by carefully adapting soil and crop management to conform to the particular condition found in each field while protecting environmental quality." Similar intense data processing and inquiry techniques are needed for Precision Agriculture (PA). Remote sensing techniques can be used to acquire data on various parameters (for example, satellite images and aerial photography). Direct field characteristics, however, are extremely important to certain people, which has led to a large amount of study on sensors, equipment, and technologies. As a result of the integration of new sensor technologies into wireless sensor devices, the PA parameters of temperature, humidity, and renewable energy sources like solar power may now be measured. Real-time approaches that allow for high-degree control loops can integrate real-time environmental information. A limited number of devices must be connected in specified master-slave configurations for PA-based remote operations utilizing Bluetooth, where the communication range is only a few meters away. There are currently relatively few operational examples of this installation of wireless sensors in PA that can be found in research journals. Environmental programmers just provide basic concepts, according to this particular wireless sensor-based effort. A more informed choice is typically made for PA by using predictive data analysis. Agriculture is typically obliged to carry out operations like planting and harvesting in accordance with a set timetable. But there are numerous forecasts that can be made using precision agriculture that may reduce manufacturing costs through increased productivity, all of which will improve profits by preserving the environment while leveraging the advantage of the farmers (Ambarish G. Mohapatra et al. 2015, 2016 (a), 2016 (b), 2016 (c), 2018). Precision Agriculture (PA) mechanisms cannot be implemented without effective water management systems. Internet-based DSS can be used to increase the system's scalability and provide improved efficiency and control. A PC- and base

station-based strategy, along with a distributed WSN environment, make this viable. The DSS and the control scheme collaborate to manage and regulate irrigation. Additionally, the control room GUI interface uses numerous optimization techniques to make the necessary judgments and then creates the proper alerts for the landowner or farmer to use through GSM/GPRS modem interface. Therein created graphical user interface (GUI) based programming was characterized as sustainable remote usage of field parameters and continuing control and checking the controller for the variable water system. A generalized Decision Support System (DSS) integrated Precision Agriculture (PA) strategy based on IoT is demonstrated in figure1. Hence, it can be studied from the recent developments in modern agricultural practices that multi-farm monitoring and control is required to achieve better yield at lower cost and labor. From the above agricultural approaches, it is studied that there is a major involvement of wireless communication technologies, internet technology, machine learning, and Image processing for crop disease identification, and agriculture engineering in modern agricultural practices (Wiesner-Hanks et al. 2018). Hence, the IoT (ICT) based Precision Agriculture (PA) approach with an integrated Decision Support System (DSS) model will provide a better solution to the common farmers. These can be achieved by integrating IoT and PA technology together with a common smart DSS mechanism. Similar to this, there are several studies with unmet needs in fields like Precision Agriculture's Wireless Sensor Network (WSN), Internet of Things (IoT), Data Analytics, and Decision Support System (DSS) (PA) (Bright Keswani et al. 2019)

## 1.3 OVERVIEW OF IoT-BASED HEALTHY ECO-SYSTEM

It is imperative to raise the quality and quantity of output with the best input in accordance with crop needs in order to fulfil the constantly rising demand of food production. As a result, it is crucial to keep track on crop health during the growing and harvesting seasons. Since chlorophyll enables plants to absorb light and immediately reflects photosynthesis, it is a superior indication of crop health. Different crop stage images are collected and A neural network-based diseases identification model is developed.

For choices regarding precision irrigation, drought resistance, and flood management in agricultural production, soil moisture prediction is a crucial indication. To effectively manage agricultural water resources and encourage crop yield

improvements, precise forecast of soil water regression regular patterns is crucial. In this research different prediction models are developed for predicting soil moisture.

For reliable investigation, the required dataset is taken from the metrological department as well as IoT-based remote sensing system is also developed to prepare an appropriate dataset.

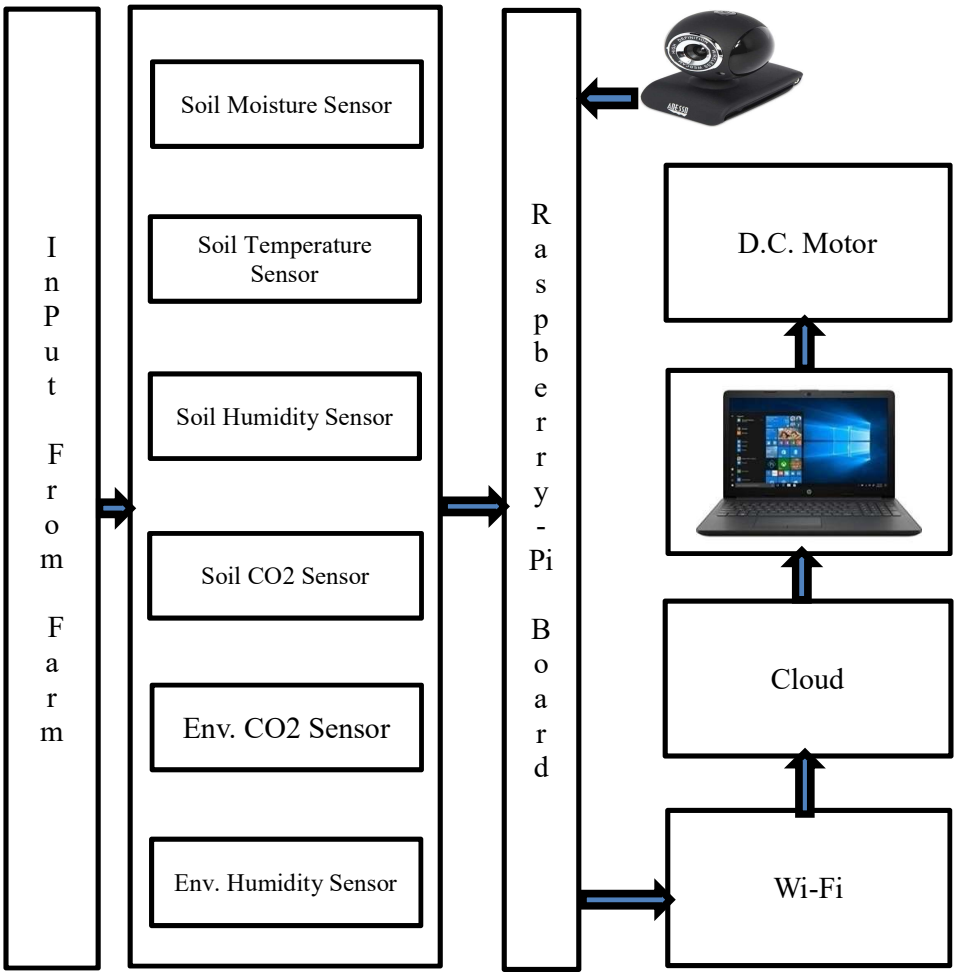


Figure 1.1: IoT based Module

## 1.4 ADVANTAGES AND APPLICATIONS OF IoT BASED ECO-SYSTEM

As shown in figure 1.1, The Internet of Things (IoT) based systems enable numerous benefits in day-to-day operations in the commercial sector (for example in agriculture, industries, transportation, medical, government subdivisions, etc.). Following are a few of its advantages:

### 1.4.1 Effectual Resource Exploitation:

If we are aware of how each technology functions and how it monitors natural resources, we will be able to use resources more effectively.

### 1.4.2 Decrease Human Monitoring:

As IoT devices interact and communicate with one another and do numerous tasks on our behalf, they reduce human effort.

### 1.4.3 Save Time:

Since it requires less human effort, time is unquestionably saved. The main resource that an IoT platform can save is time.

### 1.4.4 Improve Data Gathering:

It improves the ability of the system to collect multiple data/information from different places.

### 1.4.5 Enhance Security:

If we have a system where all of these components are interconnected, we may enhance security and efficiency.

## 1.5 Organization of the Thesis

The first section of the research presentation underlines the significance of a balanced ecosystem. problems brought on by pollutants from thermal power plant electrical generation. Farmers waste a lot of water irrigating their fields, which drives up the cost of electricity in this sector. Additionally, it shows how important agriculture and precision farming are to maintaining a healthy ecosystem. With its fantastic ability to progress agriculture and hence promote a healthy eco-system, it enhances the idea of the Internet of Things.

The next section addresses the most recent studies and historical breakthroughs for identifying crop diseases and forecasting soil moisture. Different ML/DL approaches are used to accurately as well as precise categories the crop according to its disease stage. Numerous cutting-edge statistics-based techniques have been used to forecast soil moisture for intelligent irrigation, increase production, and make efficient use of water resources.

The approaches for crop disease identification used in the suggested research are the topic of the following section. Several agricultural diseases are categorized using deep neural networks and image processing. For the classification of illnesses affecting

maize crops, various models have been developed, and analyzed, and finally, the best one chosen. The most effective model has also been tested for reliability against a number of crop diseases.

The prediction of soil moisture using various ML methods and ANN is the focus of the next section. A prediction model to forecast moisture in the soil is created using an authentic dataset, and it will be examined using several statistical factors.

The ability of the suggested methodology to generalize using self-generated data is represented in the succeeding section. The IoT-based module is made to extract various types of natural data from the ground, and the same research is then used to anticipate moisture.

The conclusion and conversations about the research experience are taken advantage of in the final session. The planned research is contrasted with earlier research. The suggested research highlights that transfer learning is a crucial strategy in machine learning for addressing the underlying problem of insufficient training data. It tries to transfer knowledge from the source domain to the target domain by relaxing the restriction that the training data and the test data must be independent and evenly distributed. This will significantly improve a number of domains that are difficult to improve because there aren't enough training data. The main benefits of transfer learning are resource savings and improved efficiency when creating new models. Additionally, it can help with model training when there are just unlabeled datasets available because the majority of the model will have already been trained.

The given research examined the great precision farming policy. By carefully preserving data and utilizing IoT-based smart DSS, traditional agriculture can advance with good throughput. The recommended approach offers automatic farming parameter analysis and management, which could improve the traditional farming approach.

The suggested plan uses an intelligent decision support system to monitor the environmental and soil characteristics that are specific to each crop (DSS). A decision support system based on artificial neural networks (ANN) is helpful for managing irrigation on farms. For extensive farm data analysis, the complete agriculture data can also be stored in cloud-based systems.

The proposed approach has a high degree of accuracy in detecting illnesses and monitoring crop health. This accomplishment raises agricultural productivity and strengthens the national economy. Specifically, for thermal power plants, the method can directly save electricity and so lessen the load of "Electricity Generation." This

accomplishment painstakingly contributes to lowering pollutants and maintaining a healthy eco-system. According to the proposed research, linear regression is a great way to predict the target variable for datasets with linear data, while support vector machines and neural networks are the greatest options for datasets with nonlinear components. The conclusion of the suggested strategy and some advice for a future IoT-based system round up the thesis.