Chapter 1

Introduction
CHAPTER 1

INTRODUCTION

This chapter describes about the new technology in cultivation of paddy and wheat in India, Wireless Sensor Network, soil moisture, water level sensor, Digital image processing, plant diseases (Zinc deficiency, Mycovellosiella oryzae, Stripe rust and Barley yellow dwarf) detection and nutrients (Nitrogen and Phosphorus) level monitoring are discussed.

1.1 Cultivation of paddy and wheat in India

Paddy and wheat are the most important crops in the world. India is the second largest producer of paddy and third in wheat in world [1]. Paddy and wheat are the staple foods for approximately semi of the world population. Paddy varieties are grown by following duration short duration varieties (90 – 120 days), medium duration varieties (120 – 140 days) and long duration varieties (140 – 180 days). Spring wheat varieties are grown by following duration (100 – 135 days) and winter wheat crop growing period ranges from (185 – 230 days). The major rice-producing states in India fall in the regions of the middle and lower Ganga plains and the coastal lowlands of the peninsular India. Rice is grown in almost all the states of India. But its cultivation is mainly concentrated in river valleys, deltas and low lying coastal areas.

Growing global population figures and per-capita incomes imply an increase in food demand and pressure to expand agricultural land. Agricultural expansion into natural ecosystems affects biodiversity and leads to substantial carbon dioxide emissions. Considerable attention has been paid to prospects for increasing food availability, and limiting agricultural expansion, through higher yields on cropland [2]. In contrast, prospects for efficiency improvements in the entire food-chain and dietary changes toward less land-demanding food have not been explored as extensively. In this study, we present model-based scenarios of global agricultural land use in 2030, as a basis for investigating the potential for land-minimized growth of world food supply through: (i) faster growth in feed-to-food efficiency in animal food production; (ii) decreased food wastage; and (iii) dietary changes in favor of vegetable food and less land-demanding meat.
The scenarios are based in part on projections of global food agriculture for 2030 by the Food and Agriculture Organization of the United Nations, FAO. The scenario calculations were carried out by means of a physical model of the global food and agriculture system that calculates the land area and crops pasture production necessary to provide for a given level of food consumption [3].

Table 1.1 Countries listed according to their position in global production of rice (2012-2014)

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Table 1.2 Countries listed according to their position in global production of wheat (2012-2014)

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1.2 Wireless Sensor Network (WSN)

A wireless sensor network (WSN) consists of three main components: nodes, gateways, and software. The spatially distributed measurement nodes interface with sensors to monitor assets or their environment. The acquired data is wirelessly transmitted to the gateway, which provides a connection to the wired world where you can collect, process, analyze, and present your measurement data using software. Routers are a special type of measurement node that you can use to extend distance and reliability in a WSN. Recent technological improvements have made the deployment of small,
inexpensive, low power, distributed devices, which are capable of local processing and wireless communication, a reality. Such nodes are called as wireless sensor nodes. Monitoring different parameters of interest in a crop has been proven as a useful tool to improve agriculture production [4].

Crop monitoring in precision agriculture may be achieved by a multiplicity of technologies however the use of wireless sensor network plays a major role [16]. It is also well known that crops are also negatively affected by intrudes and by insufficient control of the production process. The WSN is built of nodes from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors.

Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. In a WSN system, the gateway acts as the network coordinator in charge of node authentication, message buffering, and bridging from the IEEE 802.15.4 wireless network to the wired Ethernet network, where you can collect, process, analyze, and present your measurement data using a variety of software [15].

1.3 Application of WSN

- Large coverage area and high temporal spatial resolution.
- Negative weather conditions do not affect researchers work.
- Sensors nodes are small in size and weight and require no wiring which means that they are easy to install in most locations and application.
- It is possible to have many users view the data simultaneously and also manipulating it.
- Easy and brief deployment in the desired environment.
- Fewer personal are required to perform data collection from remote sites.

1.4 Soil moisture and Water level sensor

The soil moisture sensor measures the water content in the soil. The dielectric constant can be thought of as the soils ability of soil to transmit electricity. The dielectric
constant of soil increases as the water content of the soil increases. Soil moisture probe is made up of multiple soil moisture sensors. This soil moisture sensor can be used to detect the moisture of soil or predict the water around the soil. This module can be inserted in the soil and then adjust the on-board potentiometer to adjust the sensitivity. The output of the sensor is logic HIGH/LOW when the moisture is higher/lower than the threshold set by the potentiometer [6].

The water level sensor is used for many requirements of liquid level measurement in an industrial application, such as in food, chemical, pharmaceutical and power generation industries. Liquid level monitoring is also required for recharged areas [5]. In addition, the measurement is applied for early warning of dry season in agriculture. There are various methods of measuring liquid level in tank, vessel, container, and water resource.

The methods can be divided into two main categories: continuous level measurement for process monitoring and point level measurement to activate alarm or trip. The level measuring devices in both classes can be intrusive or non-intrusive. Many traditional techniques for liquid level measuring are based upon visual inspections, hydrostatic pressure, mechanical float system or displacer, bubblers, load cell, electrical property, thermal conductivity, capacitance, radiation-based level measurement, microwave, ultrasonic, optical.

1.5 Digital Image Processing

An image may be defined as a two-dimensional function, f(x, y), where x and y are spatial coordinates, and the amplitude f at by pair of coordinates (x, y) is called intensity or gray level of the image at that point. When x, y and the amplitude values of f are all finite, discrete quantities, the image a digital image.

Image processing technique to enhance raw images received from cameras placed on satellites, space probes and aircrafts or picture taken in normal day-to-day life for various applications. The term digital image processing generally refers to processing of a two-dimensional picture by a digital computer. In a broader context, it implies digital processing of any two-dimensional data. A digital image is an array of real numbers represented by a finite number of bits. The principle advantage of digital image processing
methods is its versatility, repeatability and the preservation of original data precision. Digital image processing is concerned primarily with extracting useful information from images. Ideally, this is done by computers, with little or no human intervention. GLCM features extraction is carried out for the real time images taken from the field using wireless camera. kNN and SVM classification is done for the above images. Performance metrics is applied for quantitative analysis of the images.

1.6 Paddy diseases

There are many diseases which affects paddy. The following diseases reduce the production of paddy, quantity and quality.

**Water molds, seeding disease:** Water seeded rice seeds rotted after draining water from field, copper or greenish-brown spots on soil surfaces or above rotted seeds coarse, bristly mycelium radiating.

**Seeding blight:** Brown spot coleoptiles or growing point, seedling suddenly dying.

**Clod damage:** White band leaf blade where soil line was during cold period. Round to oval, dark-brown lesions with yellow or gold halo; as lesions enlarge, they remain round, with center area necrotic, gray and the lesion margin reddish-brown to dark brown.

**Zinc deficiency:** Linear reddish – brown lesions on leaf, purple-brown blotches on older plants leaves yellow to bronze lower leaves floating on water surface, seedlings dying and disappearing below water surface.

**Crown rot or foot rot:** Soft rot of crown area extending into lower internodes, fetid odor of soft rot, tillers dying one at a time, roots dying and turning black, adventitious roots produced at node above crown area. A similar crown discoloration may be caused by misapplication of a hormonal herbicide such as 2, 4 -D to early.

**Pyricularia oryzae:** Leaf blast lesions varying from small round, dark spots to oval spots with narrow reddish-brown margins and gray or white center, spots becoming elongated, diamond-shaped or linear with wit pointed ends and gray dead areas in the center surrounded by narrow reddish-brown.
**Cercospora oryzae:** Long narrow brown or reddish-brown lesions parallel with leaf veins; usually restricted to area between veins; lesions may occur on leaf sheaths. Under very favorable conditions lesions can expand across veins and leaves may be killed.

**Mycovellosiella oryzae:** Long narrow lesions with white center and brown boarders. Very similar to narrow brown leaf spot.

**Microdochium oryzae:** Lesions consist of wide bands of gray dying tissue alternating with narrow reddish-brown bands. Band patterns in chevrons from leaf tip or edges. Sometimes lesions are tan blotches at leaf edges with yellow or golden boarders.

**Stack burn or Alter aria leaf spot:** Round or oval white or pale tan spot with narrow red or reddish-brown margin often two adjacent spots coalesce to form an oval double spot; lesions with small black fruiting structures in the center.

Zinc deficiency and Mycovellosiella oryzae are taken into consideration for this work. The above two diseases cause the major loss in productivity.

### 1.7 Wheat diseases

There are many diseases which affects wheat.

**Common bunt:** Wheat kernels infected by common bunt have a gray green color and are wider than healthy kernels. Diseased kernels can be seen in developing wheat heads but are often not detected until harvest.

**Fusarium head blight:** Symptoms of Fusarium head blight include tan or light brown lesions encompassing one or more spikelets. Some diseased spikelets may have a dark brown discoloration at the base and an orange fungal mass along the lower portion of the glumes.

**Bacterial streak:** Early symptoms of bacterial streak include small, water soaked areas between leaf veins. These water-soaked areas become tan streaks within a few days. When the disease is severe, streaks may merge to form large, irregular areas of dead tissue. When dew is present, the bacteria causing this disease may ooze from the lesions and dry to form a clear, thin film.
**Barley yellow dwarf virus:** This viral disease causes wheat leaves to have a yellow or red discoloration. The discoloration is often more intense near the tip of affected leaves, giving them a flame-like appearance. Barley yellow dwarf often occurs in patches within a field.

**Leaf rust:** Small, orangish-brown lesions are key features of leaf rust infections. These blister-like lesions are most common on leaves but can occur on the leaf sheath, which extends from the base of the leaf blade to the stem node.

**Septoria tritici blotch:** This fungal disease causes tan, elongated lesions on wheat leaves. Lesions may have a yellow margin, but the degree of yellowing varies among varieties. The dark, reproductive structures produced by the fungus are key diagnostic features and can often be seen without magnification.

**Stagonospora nodorum blotch:** The lesions of Stagonospora leaf blotch are normally brown or tan, surrounded by a thin, yellow halo. Lesions caused by Stagonospora leaf blotch are more irregular in shape and often have a darker color than those of tan spot.

**Stripe rust:** Stripe rust causes yellow, blister-like lesions that are arranged in stripes. The disease is most common on leaves, but head tissue also can develop symptoms when disease is severe. Outside the United States, this disease is sometimes referred to as yellow rust.

**Tan spot:** The key diagnostic feature of tan spot is tan lesions with a yellow margin. Mature tan spot lesions often have a dark area in the center. Lesions may merge as they expand, resulting in large sections of diseased leaf tissue. The fungus that causes tan spot survives in the debris of previous wheat crops and produces small, black reproductive structures in the spring.

Stripe rust and Barley yellow dwarf virus are taken into consideration for this work. The above two diseases cause the major loss in productivity.

### 1.8 Plant nutrients

Nitrogen, phosphorus and potassium are known as primary plant nutrients; calcium, magnesium and sulphur, as secondary nutrients; iron manganese, copper, zinc, boron, molybdenum and chlorine as trace elements or micro-nutrients. The primary and
secondary nutrient elements are known as major elements. This classification is based on their relative abundance, and not on their relative importance. The micronutrients are required in small quantities, but they are important as the major elements in plant nutrition.

**Nitrogen**: Nitrogen is the most important nutrient for rice, universally limits productivity of rice and wheat. Nitrogen encourages the vegetative development of plants by imparting a healthy green color to the leaves. There are two stages in the growth of rice and wheat crop when nitrogen is most needed; early vegetative and panicle initiation stages. Application at panicle initiation or early booting stage will help the plant produce more and heavier grains per panicle. Rice plant depends mainly for its nitrogen upon the decomposition of organic matter under anaerobic conditions and in the early stages of growth takes up nitrogen in the form of ammonia which is the stable form of nitrogen in submerged soils.

**Phosphorus**: Phosphorus is particularly important in early growth stages. It is mobile within the plant and promotes root development (particularly the development of fibrous roots), tillering and early flowering. Phosphorus is remobilized within the plant during later growth stages if sufficient P has been absorbed during early growth. Addition of mineral P fertilizer is required when the rice plants root system is not yet fully developed and the native soil P supply is inadequate. It also increases resistance to disease and strengthens the stems of cereal plants, thus reducing their tendency to lodge. It offsets the harmful effects of excess nitrogen in the plant.

**Potassium**: Potassium enhances the ability of the plants to resist diseases, insect attacks, cold and other adverse conditions. It plays an essential part in the formation of starch and in the production and translocation of sugars, and is thus of special value to carbohydrate rich crops. Over 80 per cent of the absorbed potassium by the plant is found in straw. Need for potassium is most likely to occur on sandy soils.

**Calcium**: Calcium combines with pectin in the plant to form calcium pectate, which is an essential constituent of the cell-wall. It also promotes the activity of soil bacteria concerned with the fixation of free nitrogen or the formation of nitrates from organic forms of nitrogen.
**Magnesium:** Magnesium is an essential constituent of chlorophyll.

**Zinc:** Zinc is higher in upland soil than in submerged soil. Soil submergence causes decrease in zinc concentration in the soil solution. Boron facilitates the translocation of sugars by forming sugar borate complex. It involves in cell differentiation and development since boron is essential for DNA synthesis.

**Sulphur:** Sulphur forms an important constituent of straw and plant stalks. It involve in chlorophyll production, protein synthesis and plant function and structure.

**Iron:** Iron is necessary for the synthesis of chlorophyll. Mainly a problem in upland soils

**Copper:** Copper is an important constituent of plastocyanin (copper containing protein). It is also a constituent of several oxidizing enzymes. Important for reproductive growth.

**Manganese:** Manganese is an activator of nitrite reductase and many respiratory enzymes. Soil is a source of manganese.

**Silicon:** Silicon is an important element for improving plant health and disease resistance. It has the potential to significantly decrease the susceptibility of certain plants to both biotic and a biotic diseases. It is possible that the amount taken up by paddy is equal to the amount of silicic acid present in the water the roots absorb, so that the greater the amount of water transpired, the greater their uptake of silica.

Among the nutrients, Nitrogen and phosphorous are concentrated for this work.

1.9 **Statement of Problem**

In recent days, world population is incredibly growing. Day by day the need of food is increasing. Drought and water scarcity are the major problems that every farmer faces today. Farmers cannot detect the soil moisture, nutrients deficiency and diseases in paddy and wheat fields at the earliest. Nowadays farmers prefer other businesses rather than agriculture so the productivity is going down.

1.10 **Objective of this thesis**

The objective of proposed research is to monitor the growth, identify the disease and plant nutrition deficiency in crops, Further the proposed technique is used to control
the plant soil moisture and water level. This technique saves lot of man power, increases the quality with quantity and feasible for precision agriculture.

1.11 Requirements for designing soil moisture, water level sensor Nutrients deficiency and diseases recognition setup

Software requirements:

- LabVIEW

Hardware requirements:

- Soil moisture and Water level sensor
- WSN Nodes and Gateway
- IP Wireless camera
- GSM Modem

1.12 Scope of the work

The scope of this research work is preventing the wastage of water. Nutrients deficiency and disease symptoms can be identified in the early stage. Recognition of plant disease in earlier which will lead to increase quality with quantity.

1.13 Contributions to the society

Earlier recognition of Zinc deficiency, Mycovelloisella oryzae, stripe rust and Barley yellow dwarf virus disease is reliable in finding the diseases. Nutrients deficiency, Soil moisture and water level in Paddy and Wheat fields, setup finds disease automatically. So Man power is reduced. It prevents regular visit to crop field. The data of diseased plant is sent to the concerned person.

1.14 Advantages

- Soil moisture is identified so that wastage of water can be reduced.
- By finding soil moisture, water given to plants is reduced, so we can give water to more number of plants.
- Nutrition deficiency is identified earlier.
Plant diseases are identified and rectified earlier, so that we can improve the quantity as well as quality.

Data are sent to concerned person and agricultural department throughout the period of cultivation.

1.15 Organization of the chapters

Chapter one deals with a brief introduction about the new technology in cultivation of paddy and wheat in India, Wireless Sensor Network, soil moisture, water level sensor, Digital image processing, plant diseases detection and nutrients level monitoring are discussed.

Chapter two review the literatures of various categories like measuring the soil moisture to enhance the production of all types of crops and also to implement remedial measures using various WSN methods, k - Nearest Neighbour (kNN) and Support Vector Machine (SVM) classification in agriculture are vividly reviewed.

Chapter three discuss the methodologies and its working principles that are used in this research.

Chapter four explain the results and discussion and implementation of real time identification of zinc deficiency, Mycovellosiella oryzae, strip rust diseases and Barley Yellow Dwarf Virus avian using LabVIEW software and interface with wireless IP camera and GSM Modem.

Chapter five contributes to conclusion.