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N, P, K Detection & Control for Agriculture Applications using PIC Controller: A Review

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***Abstract*- The main way of this paper is to review different detection of N, P and K contents, humidity of the soil by using sensors and also monitor the temperature and sunlight in the agricultural field. India is such a country which has capacity to produce three crops in a year such as Rabi, Kharif and zaid crops. Indian agriculture is characterized by agro-ecological diversities in soil, rainfall, temperature, and cropping system. Indian agricultural productivity is very less compared to world standards due to, use of obsolete farming technology. Also due to, lack of understanding of the need for sustainability in the poor farming community has made things worse.**

Fertilizer has been the key input in augmenting food production in India. However, fertilizer use in India is skewed, high in a few states having adequate irrigation & dismally low in the NE states. There is also imbalanced use of N, P, and K. Due to the imbalanced use of plant nutrients is considered as the main cause for decline in crop yield and crop response ratio.

Keywords: Nitrogen, Phosphorus, Potassium (NPK) sensor; colorimetric measurement; nutrients; fiber optic sensors.

I. INTRODUCTION

India is mainly an agricultural country. Agriculture is the most important occupation for most of the Indian families. Over 60% of India's land area is arable making it the second largest country in terms of total arable land. Most of the farming in India is monsoon dependent–if monsoon are good, the entire economy is upbeat and when the monsoon fails, everyone everywhere takes a hit to some extent. Green revolution began in India with an objective to give greater emphasis on Agriculture. Significant increase in the production of food crops, the productivity of land increased tremendously giving huge economic boost to the nation [19]

Irrigation which consumes more than 80% of the total water use in the country needs a proper overhaul if the country has to improve agricultural output and boost the overall economy. Irrigation water is becoming a scarce commodity. Thus proper harvesting and efficient utilization of water is of great importance.

Intensive cultivation as a result of introduction of high yielding varieties in the mid 1960's required higher energy inputs and better management practices. Land preparation, harvesting, threshing and irrigation are operations, which utilize most of the energy used in agriculture. Small and marginal farmers have limited resources especially in rain-fed regions where only animate power is used resulting in low productivity.

The per hectare productivity is much lower than world average. There is an urgent need to increase productivity. Achieving this goal will be possible only if we develop and disseminate eco-technologies. This is the pathway to an "ever-green revolution" in agriculture.

Knowledge of the extent of existing infrastructure and natural resources is one of the most basic pre-requisites to utilize them effectively and in a sustainable manner. The discipline of agricultural engineering endeavors to develop technologies for enhancing productivity and 4 reducing the cost of cultivation.

Farm mechanization is viewed as package of technology to (i) ensure timely field operations to increase productivity, reduce crop losses and improve quality of agro produce (ii) increase land utilization and input use efficiency (iii) increase lab our productivity using lab our saving and drudgery reducing devices besides, being cost effective and eco-friendly [20].

Fertilizer has been the key input in augmenting food production in India. Excess fertilizer usage not only makes the plants dependent on the artificial fertilizers but also erodes the land quality, polluted ground water and in case of surface runoff, pollutes the nearby water bodies. The excessive evaporation cause salts to accumulate on the fields making them lose their fertility quickly.

Lack of proper understanding of the need to grow crops sustainably will push farmers into vicious circle of debts, heavy use of fertilizers, water mismanagement and low productivity.

Agriculture now should shift to knowledge-based from resource-based technology. This scenario along with increasing industrialization and urbanization are putting tremendous strain on the limited and dwindling land and water resources. Unless corrective measures are taken, there may be irreversible damage to the environment and the resource base.

The challenge is to produce enough food on sustainable basis to meet the basic requirements of the ever increasing population while maintaining the natural resources and preserving biodiversity. It, therefore, calls for knowledge and resource conservation based technology and machines for sustainable agricultural production and productivity.

After taking review on all the condition we have decided to design a system which overcomes all the problems facing cultivators. The main aim of the system is to increase crop productivity with less time consumption.

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II LITERATURE SURVEY

Joaquin Gutierrez jaguey, Juan Francisco villa-medina, Aracely Lopez- Guzman, and Miguel Angel Porta-Gandara [1] presented the "Smartphone Irrigation Sensor": In this paper author described that the sensor uses a smartphone to capture & process digital images of the soil nearby the root zone of the crop, & estimates optically the water contents. An Android App was developed in the smartphone to operate the computing and connectivity components, such as the digital camera and the Wi-Fi network. The mobile App wakes up the smartphone, activating the device with user-defined parameters. Then, the built-in camera takes a picture of the soil through an antireflective glass window and an RGB to gray process is achieved to estimate the ratio between wet and dry area of the image.

After the Wi-Fi connection is enabled, the ratio is transmitted via a router node to a gateway for control an irrigation water pump. Finally, the App sets the smartphone into the sleep mode to preserve its energy. The sensor is powered by rechargeable batteries, charged by a photovoltaic panel. The smartphone irrigation sensor was evaluated in a pumpkin crop field along 45 days. The experimental results show that the use of smartphones as an irrigation sensor could become a practical tool for agriculture.

After studying the Smartphone irrigation sensor [1] author have described only irrigation. The irrigation sensor has an inherent advantage over other kind of soil moisture sensors for irrigation purposes. The outcome of others depends of soil characteristics like: density, compaction, gravimetry or mixture of their components among others. The irrigation sensor is of non-contact type, requiring only an in situ calibration to acquire the dynamic range for any soil type.

Deepa V. Ramane, Supriya S. Patil and A. D. Shaligram [2] presented the "Detection of NPK nutrients of soil using Fiber Optic Sensor": In this paper author described Measurement of N (nitrogen), P (phosphorus) and K (potassium) contents of soil is necessary to decide how much extra contents of these nutrients are to be added in the soil to increase crop fertility. This improves the quality of the soil which in turn yields a good quality crop. In the present work fiber optic based color sensor has been developed to determine N, P, and K values in the soil sample. Here colorimetric measurement of aqueous solution of soil has been carried out. The color sensor is based on the principle of absorption of color by solution.

After studying the Detection of NPK nutrients of soil using Fiber Optic Sensor [2] I have conclude that fiber optic sensor is thus developed to detect the deficiency of the nutrients N, P or K in the soil. The Principle of optical NPK sensor is based on the interaction between incident light & soil surface properties. These optical method are reliable, but time-consuming, complex & high cost per test. This resulted in the limitation of the number of soil samples tested for characterizing the spatial variability of soil nutrients in the fields.

Miss Yogita Kulkarni1, Dr. Krishna K. Warhade and Dr. Susheel Kumar Bahekar [3] presented the "Primary Nutrients Determination in the Soil Using UV Spectroscopy": In this paper author described that review of sensor technology for determination of primary nutrients in the soil. Also results of UV spectroscopy for primary nutrient determination are discussed in the paper. Brief review of remote sensing and on field sensing is also described in the paper. Objective of their research is to analyze soil properties for accurately mapping various primary nutrients in the soil. Various soil samples were taken from cultivated farms at the agriculture college, Pune A multi-parametric analytical system for measuring primary nutrients contents in cultivated soil is developed for on field analysis using the techniques as UV Spectroscopy.

After studying the Primary Nutrients Determination in the Soil Using UV Spectroscopy [3] we found the process will be takes place by using the chemical methods.

Bachkar Yogesh Ramdas and Prof.S.G Galande [4] presented the "Green Growth Management by Using Arm Controller": In this paper author described that this system is to detect the soil content like moisture, humidity, phosphorus by using sensors and also monitor the temperature and sunlight in the agricultural field. This system can provide the efficient amount of water through drip irrigation and phosphorus for plant by collecting sensors information .The main aim of this system is to increase productivity of the plant through proper amount of water and fertilizers. This System results in the designing, development and optimization of a real time solution for application to the agricultural monitor and controlling.

After studying the Green Growth Management by Using Arm Controller [4] we found that this system utilizes sensor for phosphate, temperature level detection, Moisture, Humidity, Light intensity of Agricultural environment. It included Real-time valve controlling and pump operation and Agricultural Parameters measurement using Sensor for Agriculture plant. so by using this system productivity of plant increases and efficient use of water through sensor data.

Purvi Mishra1, Sudha Mapara and Preeti Vyas [5] presented the "Testing/Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology": In this paper author described the application of commercial N, P, and K fertilizers has contributed to a tremendous increase in yields of agricultural crops. Growing concerns about environmental pollution by excessive use of fertilizers have led to increasing needs to monitor soil nutrients required for crop growth. The sensor network technology will help the farmers to know the soil requirements which will help them take better decisions and preventive measures at the right time. This will lead to tremendous improvement in the crop productivity. This, in turn, will save their time, labor, and money and make effective use of resources.

After studying the Testing/Monitoring of Soil Chemical Level Using Wireless Sensor Network Technology [5] I have conclude that the wireless sensor technology can help farmer know the exact time to apply fertilizers & compost to the field to increase productivity, save time, money& energy. This sensor technology will not give measurement of the N, P & K contents in the soil.

Jianhan Lin, Maohua Wang*, Miao Zhang, Yane Zhang, and Li Chen [6] presented the "Electrochemical sensors for soil nutrient detection: opportunity and Challenge": In this paper author described that Soil testing is the basis for nutrient

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recommendation and formulated fertilization. This study presented a brief overview of potentiometric electrochemical sensors (ISE and ISFET) for soil NPK detection. The opportunities and challenges for electrochemical sensors in soil testing were discussed.

After studying electrochemical sensors for soil nutrient detection: opportunity and Challenge [6] we have found that the advantages of potentiometric electrochemical sensors are stimulating the interest of their applications in soil nutrient detection. They have potentials for automated multi-target rapid detection of soil nutrients. As such, they are also faced with the challenge from their reliability.

III TYPES OF SENSORS

There are different types of sensors that can be used to sense various properties of soil.

Conventional soil NPK testing methods have been generally performed by three steps: Soil sampling, sample pretreatment and chemical analysis. To date, soil sampling is manually carried out in a field to obtain representative soil samples at a proper depth. Chemical analysis i.e. actual measurement of NPK is carried out by three techniques viz. Conductivity measurement, Optical method, and electrochemical methods to analyze concentration of primary nutrients [2, 3].

A] Conductivity Measurement Technique:

In conductivity measurement technique two or three electrodes of same material are immersed in soil samples. Materials used can be steel, silver, platinum, graphite or copper. An A.C. voltage is applied to electrodes in sample. Another electrode is connected to multimeter to measure the current changes. The A.C. voltage results in movements of ion which in turn results in variability of current of soil sample. Use of A.C. voltage avoids neutralization of ions. Varying current gives varying conductivity. Variability between electrical conductivity and concentration N, P, and K are observed. As concentration increases, variability in electrical conductivity increases [3].

As per concentration of NPK in soil, conductivity of electrode change. The change in conductivity is converted into electrical signal for further electronic control system [9].

B] Electrochemical Method:

Electrochemical sensors constitute Ion Selective Electrode (ISE) and Ion Selective Field Effective Transistor (ISFET). ISE and ISFET selects particular ion from samples using sensor cocktail. ISEs/ISFETs use different membranes, extraction solutions, and a multi-target system with coated wire field-effect transistor [6, 10].

CW/ FET type of electrochemical sensor uses a platinum wire coated with PVC which acts as the membrane matrix and it uses the cationic glass electrode (CGE) and the valinomycin-based selective electrode (VKE) for detection of exchangeable potassium in extracts from 30 soils [3].

C] Optical Method:

The last type of soil sensor technology is optical sensor. Principle of optical NPK sensors is based on the interaction between incident light and soil surface properties, such that the characteristics of the reflected light vary due to the soil physical and chemical properties.

Laser Induced Florescence Spectroscopy (LIFS) is optical technique in which analyte in the molecule absorbs radiation at a certain wavelength (usually UV and visible regions). [11, 12]. Or Near Infra-Red Spectroscopy (NIR) technique is very widely used for experimental as well as commercial purpose [13]. NIR is a spectrophotometric method that deals with the interaction of near infrared radiation with the sample under investigation. It is based on the absorption of electromagnetic radiation at wavelengths in the range of 780-2500nm.

These optical methods are reliable, but time-consuming, complex and high cost per test. This resulted in the limitation of the number of soil samples tested for characterizing the spatial variability of soil nutrients in a field or fields [2].

IV RESULT AND CONCLUSION

Various types of sensors has been reviewed and it has been found that, overall these techniques have verisimilar and all the process will takes place using chemical laboratory to detect the presence of soil macro-nutrients, however separately measurements of the nutrients still remains an open challenge due to some factors such as expensive spectrometers and other sensor techniques.

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