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ABSTRACT

Food has been an obvious necessity for humans for survival which is available by the means of agricultural practices. The world population has shown an enormous increase since the past few years Precision defines the exactness of something and agriculture is the land cultivation practice. Precision Farming is a technology derived practice that emphasises on providing precise knowledge about the field for better application of inputs and obtaining a wholesome yield, without any wastage of resources. Precision Framing focuses on providing the real time monitoring and specific data to maximise yield without maltreating the environment. Precision Farming can do wonders to the crop production, bring maximum profit to the farmer, save resources and much more. But along with this there are many constraints we need to work on.

Keywords: Precision Farming, GPS, Remote Sensing

Introduction

Food has been an obvious necessity for humans for survival which is available by the means of agricultural practices. The world population has shown an enormous increase since the past few years. According to the United Nations, as of April 2024 the global population has been estimated to be 8 billion. But why talk about the population? Well, the relevance of population on agriculture matters as for the fact that the over growing population is making less land available for agriculture purposes, hence making it difficult to produce food as per the general requirement. FAO says - “Almost one in three people in the world do not have access to proper food in 2020 – that’s a rise of 320 million people in a year” (Food and Agriculture Organization). Therefore, for the production of food from a limited land area is a big challenge, for which several researches, technologies have been made, out of which Precision Farming is one.

1. WHAT IS PRECISION FARMING?

Precision defines the exactness of something and agriculture is the land cultivation practice. Precision Farming is a technology derived practice that emphasises on providing precise knowledge about the field for better application of inputs and obtaining a wholesome yield, without any wastage of resources. Site specific management (SSM) is another term referred to Precision Farming as the farming is based on the variation based on soil or individual parts of field conditions. Traditional Farming differs from Precision farming as the former counts land as one entity while the latter one sees the land differentially, considering it as a varied body. Precision Farming takes care of whether the inputs are delivered in a desirable amount needed by the sites or not for the beneficial production. In this way, the practice of Precision Farming optimises the use of resources for the need of a particular site of land by the help of data collected by technologies used in it such as GPS, remote sensing, etc.

2. COMPONENTS OF PRECISION FARMING

Prominent components of Precision Farming are GPS (Global Positioning System), GIS (Geographic Information System), VRT (Variable Rate Technology) , Remote Sensing, etc. These tools help to decide what input has to be put where and in what amount such as pesticides, herbicides, water, etc. In this way Precision Farming avoids wastage of inputs. The components are described as:

2.1 REMOTE SENSING

Remote Sensing can be defined as a science that fetches information of an object by measuring by radiations that are reflected and emitted. The technology basically involves sensors (active or passive) that captures the radiation and provides an image of the object. These sensors are usually placed on drones, satellites, balloons,etc.

- Sensors are categorised as active and passive. Sensors that have their own light source and radiate onto the object and then obtain the data by the reflected radiation are active sensors. RADAR ,LiDAR are some examples.
- Sensors that do not have their own light and collect information from the radiation that is reflected from other light sources such as the sun are passive sensors. Radiometer, spectrometer are some examples.
- Some sensors create images of Earth with colours such as red, blue, and green, that fall into the visible range of electromagnetic radiation; such sensors are called optical sensors.
- Sensors that measure distances to targeted objects by using radio waves are called radar sensors. It works by sending waves to an object that is reflected back to the sensor , then the time is measured in which waves are retreated back and this way sensors measure the distance to the target and thus build a map of the existing surrounding.
- Sensors that create thermal images and functions in the spectrum that falls above 14 micrometres and below 9 micrometres, are thermal sensors. Such sensors are used to detect volcanoes, fires, etc as every object generates thermal images whose temperature exceeds zero degree.
- An active sensor such as Radar sensor discharges light to the Earth surface and the radiation is then thrown back to the radar that generates a picture of microwave wavelength (1mm-1m).
- Some sensors do not produce images , they instead estimate the intensity of radiation, called non-imaging sensors. Some examples include radiometer, spectroradiometer,etc.

If we try to understand how remote sensing works in a simple way then, theprocedure follows as;

- First, the basic requirement is a light source that generates radiation.
- The radiation will travel through a medium of atmosphere.
- The radiation now gets captured by the sensor and data gets transformed to an image or non-image data.
- The information can be collected now from data.
- The collected data is now studied and the changes are applied according to the information gathered.

2.2 GEOGRAPHIC INFORMATION SYSTEM (GIS)

GIS is basically a tool that is based on a computer that analyses, reserve the geographic data. The technology is useful for mapping the various locations, landmarks on the map. As we all know the global example of this technology are the maps by Google. The processed data of sensors studied above are combined with GIS to curate the maps of the current situation and accurate data. Hence, by looking at the map one can monitor the variability a field is having such as lack of what nutrient in what site, excess or toxicity of anything on a site and thus incorporate the inputs according to the data.
So, the data that was collected by sensors about the field or crop is now displayed on the map by the help of GIS technology, and changes can be applied to the required extent. Thus Precision Farming is known for its accuracy and specificity that brings forth us the real time monitoring and specific data.
The technology helps in various ways such as:

- Maps can enlighten us with the information about different factors that affect crop growth such as air temperature, precipitation, soil health, deficiency of any nutrient, humidity, etc. Once the information is accessible, the farmer can put his inputs according to the data which furthermore lowers the cost and also saves resources.
- GIS can also plot the hazardous areas (disaster prone), waste land, etc and avoid any mishap.
- GIS helps in pre-deciding the management one needs to follow or at least gives a blueprint of what needs to be given to the field.

2.3 VARIABLE RATE TECHNOLOGY (VRT)

VRT proved to be a major game changing component of Precision Farming. Variable Rate Technology is a technology that uses automated GIS or GPS enabled equipment to apply inputs to farms with respect to the variation in field. VRT helps to put inputs according to the variability in field, and ensures the amount of inputs such as fertiliser, herbicides, etc in a required amount to a required site. Suppose we have a field which has different sites that lack one or more nutrients, now if a farmer treats this land, he would have to apply different rates of inputs manually but things get easier if VRT takes the command here.
VRT powered equipment is already updated with the maps of the layout of the field and with the data of what lacks where in the field. These VRT powered machines work in the field with an automated system that ensures input: what, how much and where. These VRT powered machines for e.g. seeder, fertiliser, herbicide sprayer, etc apply inputs automatically in needed amounts disparately in the field considering every different site in the field. Hence VRT technology fulfils the requirement of different sites in the field.
VRT can be sensor based or map based, that can be fertilisers, irrigation systems, herbicide sprayer, etc.

2.4 GPS (GLOBAL POSITIONING SYSTEM)

GPS can be defined as a system based on navigation with 24 satellites orbiting the Earth in a particular orbit, which majorly tells position in nearly every weather condition. In order to understand how GPS works, it is essential to know its components:

a. GPS GROUND CONTROL STATIONS

As the name suggests, the stations are on ground and they control the satellites, perpetuating the network of satellites. The station ensures that the satellites do not diverge away from the orbit.

b. GPS SATELLITES

Satellites dispatch signals to Earth that determine the position. They cover everything universally as it orbits around the Earth.

c. RECEIVERS

Signals sent by the satellites are received by the receivers. Usually 3 satellites are required by the receiver to determine the sole location, altitude is determined when the receiver receives the fourth satellite's prompt. The position is determined accurate when signals are earned from 4 or more signals.
GPS can be of many use in agriculture. For instance, if the farmer wants to know the most weed extensive area, GPS can track such locations and then farmers would apply herbicides in that area , managing the weed problem more efficiently and avoiding wastage of herbicides. This technology can also be applied for other inputs as well such as pesticides, irrigation systems, fertiliser, etc.

2.5 SOIL TESTING

Soil acts as a base material for a plant to grow, or we can 'call the home of a crop', hence for a crop to grow efficiently the soil has to be fertile and best suited to the crop. In order to estimate the soil's capability to provide nutrients to the plant for its growth soil testing is done. Soil testing is the process of deducing the nutrient value of soil chemically. By soil testing one can know the soil's ability to provide nutrients to plants. Parameters such as soil pH, electrical conductivity, amount of nutrients present in it such as Nitrogen, Phosphorus, etc can be calculated. Soil samples are collected and sent to laboratories for the estimation of overall soil health. This way, farmers get to know what needs to be done to the field , if the soil is lacking in something.
For example, if the laboratory data comes up with the report that the soil is acidic, then the farmer would add lime to the soil or would grow acid tolerant crops to gain productive yield. Hence, this information

which we have already got by the soil sampling helps us to manage the soil more accurately and saves our time, resources and labour as well.

2.6. YIELD MONITORS

- Yield monitors, usually placed on a combine harvester, give an estimate about how much yield is obtained after harvesting.
- Yield monitor consists of a grain flow sensor that tells how much the grain is harvested.
- It also potentially estimates moisture content by grain moisture sensor.
- These informations are exhibited on a screen and also on maps
- Yield monitors considerably look into the yield measurement, by certain factors such as grain moisture, yield , height of stalk, etc one can evaluate the lacking element in the field.
- Calibration is needed every everytime a new grain is added for precision.

3. WHY PRECISION FARMING?

As discussed above, the tools used in Precision Farming have numerous and remarkable services in relevance to agriculture. The accessibility of the knowledge regarding the farmland is known to the farmers prior to the cultivation of the land because of Precision Farming. Additionally, the information can be:

- site specific
- Accurate
- Environment friendly
- Resource saving
- Potential yielding
- works on variability and provides essential pre-known information.

Dr. Ch. Srinivasa Rao, Director of NAARM (National Academy of Agricultural Research and Management) asserted that the drones and Variable Rate Technology for accurate nutrient management were beneficial (THE HINDU BUREAU).
Himanshu Pathak, the Director General of ICAR said that the practice of Precision Farming is not only sustainable but ensures food security at a national seminar (THE HINDU BUREAU).
With numerous advantages, it is very useful in the field of agriculture so why not Precision Farming?

4.CHALLENGES IN PRECISION FARMING

There are some hardships complemented with every successful idea. Here, in Precision Farming, the more fascinating the technology seems there is a grey area too. Some constraints are:

- The tools required for this farming like GPS, GIS, etc demands a wholesome amount of finance which seems to be difficult for the farmers who can't afford. India accounts for about 86.1-86.2% of farmers that are marginal and small farmers. So, affording such technology for them is a challenge in itself.
- Not everyone knows about the practical knowledge of such tools. We are in a shortfall for the technical knowledge of the technology and very scarce opportunity to bring to the lands.
- Our farmers have been practising the traditional farming system since ages, they might face trouble in grasping the new technologies.
- Due to lack of knowledge, illiteracy and many factors a farmer could face difficulty in functioning technology such as obtaining data and analysing the same, on the screen given by a combine harvester.
- Since a major portion of the farmer falls into marginal and small farmers, the land accessibility can also be counted as one of the obstacles.
- The operations involved in operating the system are rigorous, and this can't be completed without guidance and skilled labour.

5. CONCLUSION

Precision Framing focuses on providing the real time monitoring and specific data to maximise yield without maltreating the environment. Precision Farming can do wonders to the crop production, bring maximum profit to the farmer, save resources and much more. But along with this there are many constraints we need to work on.
The knowledge should be imparted to the farmers who can meet the expense of technology. Agricultural institutes can help farmers with technical virtuosity. KVKs (Krishi Vigyan Kendra) can help the farmers with the procedure behind the

technology. Government should provide subsidies on the tools by various schemes and motivate them to learn it. Precision Farming holds much more for agriculture in future, with overcoming the constraints we steadily can bring it to a major platform and see what it holds for us

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