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Big data analytics in precision agriculture and constant monitoring of soil and weather

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ABSTRACT

Agriculture has been one of the zones where innovation has not been utilized to the fullest and the usage of Precision Agriculture (PA) is still in its beginning times. One of the most important parameters in the field of agriculture that needs to be monitored constantly is the moisture content of the soil. To maximize the productivity in this field the condition and development of the crops are the most critical variables and these elements rely upon the levels of moisture content in the soil. Different crops need different levels of moisture content, therefore it is very important to monitor and forecasts it. In this paper, a mathematical model is created to compute the surface soil dampness by utilizing both precipitation and evaporation rate obtained by the electromagnetic sensors installed in the ground. Evaporation can be considered to be a linear combination of dynamic evaporation and thermodynamic evaporation which happens due to radiation. Soil moisture content is inversely proportional to the evaporation rate and it is directly proportional to the precipitation rate. Therefore a linear regression model is the best fit to determine the soil moisture content. Constant monitoring can be made possible by the soil mapping software with the sensors which keep reading the data periodically.

Keywords: *Big data, Linear regression, Moisture content, pH, Weather.*

1. INTRODUCTION

1.1 Overview of Agriculture

Agriculture has been practiced for hundreds of years. It has been around since the early years and has experienced noteworthy advancements since the season of the most punctual development. It was the first idea of in the Fertile Crescent of the Middle East and later spread to northern and southern China, Africa's Sahel, New Guinea and a few areas of the Americas. Agribusiness practices, for example, water system, crop rotation, composts, and pesticides have made extraordinary walks in the previous century to address the issues of farmers. Strawberries have a history that backpedals more than 2,200 years. Strawberries developed wild in Italy as long back as 234 B.C. Furthermore, were found in Virginia by the primary Europeans while early pioneers in Massachusetts appreciated eating strawberries developed by neighborhood Native Americans who developed strawberries as right on time as 1643. With the ascent of industrialization in the nineteenth and twentieth centuries, the United States started to sell at soaring rates. The innovation of the tractor, transportation techniques reformed, and refrigeration an imperative part, farmers could create sustenance and levels what appeared before unthinkable.

The historical backdrop of agribusiness records the training of plants and creatures and the advancement and spread of procedures for raising them profitably. Horticulture started freely in various parts of the globe and incorporated a differing scope of taxa. No less than eleven separate locales of the Old and New World were included as autonomous focuses of the root.

Today's food and nourishment system also debilitate the wellbeing of individuals and the planet: agriculture represents 70% of water utilization and creates unsustainable levels of contamination and waste. Dangers related to poor eating routines are likewise the main source of death around the world. Around three billion individuals are either not eating enough or taking the wrong kind

of nourishment, bringing about diseases and wellbeing emergencies. A 2016 report found that yearning is a test for 815 million individuals worldwide and in 2014, 2.1 billion individuals were overweight and fat, 62% of them in developing nations.
The water system, crop rotation, and manures were presented not long after the Neolithic Transformation and grew considerably advance in the previous 200 years, beginning with the British Agricultural Revolution. Since 1900, farming in the developed countries, and to a lesser degree in the developing nations, has seen huge ascents in efficiency as human work it appears to have been supplanted by automation and helped by engineered composts, pesticides, and selective breeding. The Haber-Bosch process permitted the amalgamation of ammonium nitrate manure on a mechanical scale, significantly expanding agricultural yields. Present day farming has raised social, political and natural problems.

1.2 Overview of Big Data

Big data alludes to a procedure that is utilized when conventional information mining and taking care of strategies can't reveal the bits of knowledge and significance of the basic information. Information that is unstructured or time-sensitive or essentially huge can't be handled by social database engines. This sort of information requires an alternate processing method called big data, which utilizes huge parallelism on promptly accessible equipment.

Simply, big data mirrors the changing scene we live in. The more things change, the more the progressions are caught and recorded as information. Take climate for instance. For a climate forecaster, the measure of information gathered the world over about neighborhood conditions is significant. Intelligently, it would bode well that neighborhood conditions manage territorial impacts and provincial impacts direct worldwide impacts, however, it could well be a different way. Somehow, this climate information mirrors the properties of big data, where continuous preparing is required for a monstrous measure of information, and where the extensive number of data sources can be machine created, individual perceptions or outside powers like sun spots.
Information in its crude frame has no esteem. Information should be handled with a specific end goal to be of profitable. In any case, in this lies the characteristic issue of enormous information. Is processing information from local question organization to a usable knowledge worth the gigantic capital cost of doing as such? Or then again is there just a lot of information with obscure qualities to legitimize the bet of handling it with huge information apparatuses? The vast majority of us would concur that having the capacity to foresee the climate would have high esteem, the inquiry is whether that esteem could exceed the expenses of crunching all the ongoing information into a climate report that could be relied on.

Big data is informational collections that are so voluminous and complex that conventional information handling application programming are insufficient to manage them. Big data challenges incorporate catching information, data storage, data analysis, search, sharing, exchange, representation, questioning, refreshing, data protection and information source. There are various ideas related to big data: initially 3 ideas volume, variety, and velocity.

Data Analytics (DA) is the way of inspecting informational collections so as to reach inferences about the data they contain, progressively with the guide of specific frameworks and programming. Information examination innovations and strategies are broadly utilized as a part of business ventures to empower associations to settle on more-educated business choices and by researchers and analysts to check or negate logical models, speculations, and theories.

As a term, data analytics dominatingly alludes to a grouping of utilizations, from essential business intelligence (BI), announcing and online analytical processing (OLAP) to different types of cutting-edge examination. In that sense, it's comparative in nature to business examination, another umbrella word for ways to deal with analyzing information - with the distinction that the last is situated to business utilizes, while information investigation has a more extensive core interest. The broad perspective of the term isn't general, now and again, individuals utilize information investigation particularly to mean progressed examination, regarding BI as a different class.

1.3 Overview of Linear Regression

In insights, linear regression is a direct approach for demonstrating the connection between a scalar ward variable y and at least one illustrative factors (or free factors) indicated by X. The instance of one logical variable is called simple linear regression. For in excess of one informative variable, the procedure is called multiple linear regression. (This term is particular from the multivariate linear regression, where numerous corresponded subordinate factors are anticipated, as opposed correspond to a solitary scalar variable.)

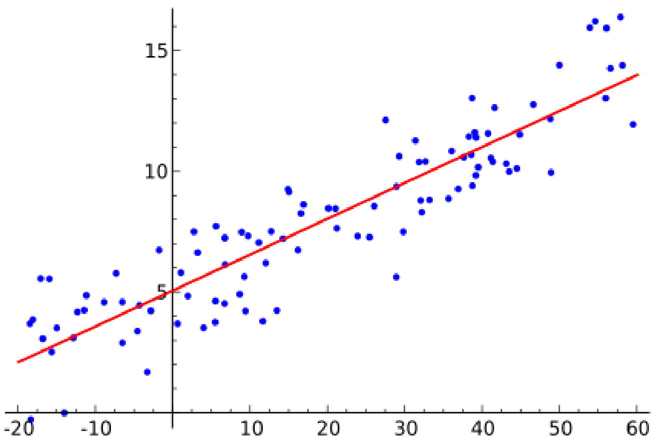

Fig-1 Example for linear regression

In linear regression, the connections are demonstrated utilizing direct indicator function whose obscure parameters are evaluated from the information. Such models are called linear models. Most ordinarily, the contingent mean of y given the estimation of X is thought to be a relative capacity of X; less regularly, the middle or some other quantile of the restrictive dispersion of y given X is communicated as a direct capacity of X. Like all types of regression analysis, linear regression centers around the restrictive likelihood conveyance of y given X, instead of on the joint likelihood appropriation of y and X, which is the area of multivariate examination.

1.4 Overview of Weather

Weather is the condition of the air, portraying for instance how much it is hot or frosty, wet or dry, quiet or stormy, clear or shady. Most weather wonders happen in the least level of the environment, the troposphere, just beneath the stratosphere. Weather alludes to everyday temperature and precipitation movement, though the atmosphere is the term for the averaging of environmental conditions over longer timeframes. At the point when utilized without capability, "weather" is, for the most part, comprehended to mean the climate of Earth.

Surface temperature contrasts cause pressure contrasts. Higher elevations are cooler than lower heights, as most air warming is because of contact with the Earth's surface while radiative losses to space are for the most part steady. Weather determining is the use of science and innovation to anticipate the condition of the environment for a future time and a given area. The Earth's climate framework is a disorderly framework; accordingly, little changes to one part of the framework can develop to largely affect the framework all in all. Human endeavors to control the weather have happened all through history, and there is confirmation for human exercises, for example, farming and industry have adjusted climate designs.

Concentrating on how the weather chips away at different planets have been useful in seeing how weather takes a shot at Earth. A celebrated point of interest in the Solar System, Jupiter's Great Red Spot, is an anticyclonic tempest known to have existed for no less than 300 years. Be that as it may, the weather isn't constrained to planetary bodies. A star's corona is always being lost to space, making what is basically a thin air all through the solar system. The development of mass launched out from the sun is the solar wind.

Weather determining is the use of science and innovation to foresee the condition of the air for a future time and a given area. Individuals have endeavored to foresee the weather casually for centuries, and formally since at any rate the nineteenth century. Weather conjectures are made by gathering quantitative information about the present condition of the environment and utilizing logical comprehension of atmospheric procedures to extend how the air will advance.

1.5 Overview of Soil pH

Soil pH is the amount of the acidity or alkalinity (basicity) of a soil and is accounted for as an incentive in between 0 and 14. A soil test for pH measures the convergence of hydrogen particles in the soil arrangement. A pH of 7.0 is viewed as neutral. A pH esteem beneath 7.0 shows that the soil is acidic, with lower qualities speaking to expanding acidity. A pH esteem over 7.0 shows that the soil is basic, with higher qualities speaking to expanding alkalinity.

The pH scale is logarithmic, so an adjustment in 1 pH unit mirrors a 10 overlay change in sharpness or alkalinity.

Alkaline Soils:

Soils might be soluble due to over-liming acidic soils. Additionally, soluble water system waters may cause soil alkalinity and this is treatable, yet basic soils are principally caused by a calcium carbonate-rich parent material creating in a parched or dry condition.

These kinds of soils are normal in numerous zones of the western United States. The normal pH of these carbonate-containing bone-dry soils is 8.0. Most scene and garden plants do best at pH esteem in the vicinity of 6.0 and 7.2.

Acidic Soils:

An acid is characterized as a substance that tends to discharge hydrogen particles (H+). Then again, a base is characterized as a substance that discharges hydroxyl particles (OH-). All acids contain hydrogen particles, and the quality of the acid relies on the degrees of ionization (letting off hydrogen particles) of the acid. The more hydrogen particles held by the trade complex of a soil in connection with the essential particles (Ca, Mg, K) held, the more noteworthy the causticity of the soil.

2. LITERATURE SURVEY

Another age of cultivators called "precision farmers" are depending on information gathered from flying and satellite remote detecting symbolism to survey the present condition of their fields and oversee supplements continuously. Alongside Geographical Information System (GIS) maps made accessible to agriculturists, this information can educate farmers about particular attributes of the soil, for example, where it is adequately sodden and where it has dissolved over winter, to uncover which factors are restricting harvest development. [1]

Fig-2 Drones used to obtain agriculture data

Aerial or satellite symbolism can clarify why a yield is under pressure and how to analyze the source. By approaching continuous information symbolism, farmers can survey how much manure and pesticide should be connected to particular regions in the homestead, along these lines slicing the need to regard the field as one homogeneous unit. Information imagery portraits diverse wavelengths that are assimilated and transmitted from soils, helping agriculturists screen factors influencing their yields. [2]

Mechanical sensors can be utilized to appraise soil mechanical protection.These sensors utilize an instrument that enters or slices through the soil and records the power estimated by strain measures or load cells. [3]
Electrochemical sensors could give the most critical sort of data required for accuracy farming — soil supplement levels and pH. At the point when soil tests are sent to a soil testing research center, an arrangement of institutionalized lab strategies is performed. [3]

Acoustic sensors have been examined to decide soil surface by estimating the adjustment in noise level because of the communication of a device with soil particles. [3]

Optical sensors utilize light reflectance to portray soil. These sensors can mimic the human eye when taking a gander at soil and measure close infrared, mid-infrared, or spellbound light reflectance. [3]

To summarize the various limitations in the current functioning and operations of the precision agriculture, the following would be the limitations of the currently used systems or methods:
Drones built for agriculture have a flight time of up to 35-40 minutes. Hence constant monitoring of soil properties is not possible. [4]

If drones are used then high-level sensors must be attached to it as they need to obtain data from great heights and penetrate through thick canopies. [5]

Images obtained from drones might not provide proper insights and thus leads to inaccurate results.

If electrochemical sensors are used then the soil samples must be sent to a soil-testing laboratory, a set of standardized laboratory procedures is performed. These methodologies include test arrangement and estimation.

Vehicle-based optical sensors utilize an indistinguishable standard method from remote detecting thus gives mistaken yields. [6]
Most sensors and instrument controllers require a specific time for estimation, combination, as well as alteration, which diminishes the suitable task speed or estimation thickness. [7]

More precise soil property maps are expected to effectively actualize site-particular administration choices. The deficient testing thickness and the high cost of traditional soil inspecting and examination have been restricting components. [8]

3. PROPOSED SYSTEM

Our proposed system is aimed at enhancing the overall efficiency of the Agriculture system through modernization brought about by the implementation of certain big data techniques. The usage of these modern day techniques for the exchange of information and communication would significantly reduce the clerical work performed by some of its highly trained personnel thereby bringing about better management of human resources within the Agriculture system.

Precision agriculture, also called site-specific crop management (SSCM), precision farming or satellite cultivating, is a strategy for cultivating that includes utilizing innovation to gather continuous information on climate, soil quality, and product improvement to enable cultivators to settle on better decisions all through the way toward planting, treating, and collecting.

For precision agriculture to be fruitful, producers must use data accumulated from a progression of mixes between dissimilar frameworks to examine and watch edit fields. These may incorporate temperature and soil dampness sensors, GPS cultivating applications and modules for robotized hardware, and even automation utilized for aerial imaging. Much of the time, this information is bolstered into a dashboard of a product stage where it can be legitimately sorted out and kept up.

Precipitation adds to a soil's acidity. Water (H2O) mixes with carbon dioxide (CO2) to frame a frail acid— carbonic acid (H2CO3). The powerless acid ionizes, discharging hydrogen (H+) and bicarbonate (HCO3). The discharged hydrogen particles supplant the calcium particles held by soil colloids, making the soil to convert to acidic soil. The uprooted calcium (Ca++) particles mix with the bicarbonate particles to shape calcium bicarbonate, which, being solvent, is filtered from the soil. The net impact is expanded soil acidity.

Precision agriculture creates a lot of information that has a tendency to be mind-boggling in nature, going anyplace from temperature readings to pH and other chemical levels. Along these lines, farmers will generally look for outside help of expert examiners to help them legitimately comprehend the data and decide its application in the basic leadership process. As more information is gathered, farmers increase more prominent learning to refine their agriculture designs.

We program precision agriculture software for site-specific spatial data mapping through GIS / GPS software technology and integrate with electromagnetic sensors in and around the area of agriculture lands which picks up the information about the pH level of the soil, soil moisture content and weather data and also make future predictions. This will keep reading these data periodically. RFID-based traceability systems for the sensors can provide a constant data stream on the soil. Electromagnetic sensors utilize electric circuits to quantify the capacity for soil particles to lead or collect the electrical charge. When utilizing these sensors, the soil turns out to be an integral part of an electromagnetic circuit and changing nearby conditions instantly influence the signal recorded by an information logger.

Once the field is harvested it will again give the data about the soil which help us in decision making whether or not to plant the corps in that area. If the weather changes drastically and it becomes inhospitable for agriculture, we will be aware of such a situation. Integration of soil mapping software with the sensors will help in constant monitoring of the condition of soil and also keep track of soil fertility and soil moisture content along with weather data. This will help the farmers to take a wiser decision while planting the crops season wise and prevent degradation of moisture content in soil and retain fertility of the soil. In turn, it increases the revenue generated.

The usage of big data in decision making will sure improve the economy in the agriculture sector. It is more efficient than the current system. It also saves time and money to implement the proposed system. A better agricultural industry can be built around the big data system.

There is a linear dependency between the weather data, pH value and the year. The pH level of soil indicates that there has been a reduction in the moisture content of the soil over the years. Hence a prediction would be very helpful.

Fig-3 Electromagnetic sensor

We propose to solve this problem by building a linear regression model. The model will take the weather data as the predictor variable and soil moisture content as the target variable. This will enable us to predict the degradation of moisture content.

4. CONCLUSION

The proposed system aims to help farmers to analyze the condition of the soil as the model helps them in determining the moisture content present in soil and pH level of the soil. Farmers can gain insight regarding the soil. They can choose the right crop to grow in the right season, determine the required quantity of fertilizers to be added to maintain the fertility of the soil. These practices can lead to increased productivity.

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