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Precision Farming: an Overview

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When compared to conventional cultivation methods, precision farming increases average yields by precisely calculating the amount of inputs used. It is therefore a comprehensive system created to maximize production through the application of essential information, technology, and management components in order to boost output, enhance product quality, optimize crop chemical use, conserve energy, and safeguard the environment. The technological advancements in precision farming today can supply the means for tomorrow's environmentally sustainable agriculture. Particularly for small-scale farmers in developing nations, accuracy.

NEED OF PRECISION FARMING

The world's food system is currently facing the enormous challenges, and these will only get worse over the next forty years With today's knowledge and technologies, a lot can be accomplished quickly with enough effort and money. However, facing the challenges of the future will call for even more drastic adjustments to the food system as well as funding for research to produce fresh answers to original issues. Major concerns in agricultural growth and development now include the decline in overall productivity, the depletion and degradation of natural resources, stagnating farm incomes, a lack of an eco-regional approach, declining and fragmented land holdings, trade liberalization on agriculture, limited employment opportunities in the non-farm sector, and global climatic variation. Consequently, it is believed that utilizing recently developed technologies will be essential to raising agricultural productivity in the future. Most farmers are aware that the yields in their fields vary depending on the terrain. These differences can be linked to environmental factors, soil characteristics, and/or management techniques. Large sizes and yearly changes in the farm area's leasing arrangements make it challenging to maintain the current level of field knowledge. Thus, all of the farmland must be split up into tiny farms that are worth no more than 50 cents each. The collection and analysis of data can be made simpler and more automated with precision agriculture. It allows management decisions to be made and quickly implemented on small areas within larger fields.

TOOLS AND EQUIPMENT

Global positioning system (GPS)

With an accuracy of between 100 and 0.01 meters, GPS is a navigation syatem that uses a network of satellites to record positional data, including latitude, longitude and altitude.

Farmers can use GPS to pinpoint the precise location of field data, including the type of soil, the presence of pests, weed invasion, water holes, boundaries, and obstacles. With an antenna, receiver, and light or sound guiding panel (DGPS), there is an automatic controlling system. GPS receivers can determine their position thanks to signals that GPS satellites broadcast. Based on performance criteria and past input applications, the system enables farmers to accurately locate fields so that inputs (seeds, fertilizers, pesticides, herbicides, and irrigation water) can be applied to a specific field.Sensor technologies. With an accuracy of between 100 and 0.01 meters, GPS is a navigation syatem that uses a network of satellites to record positional data, including latitude, longitude and altitude

Data from remote sensing are used to track drought, soil, and plant conditions, identify pests and weeds, and distinguish crop species. Large amounts of data can be collected using sensors without the need for laboratory analysis.

Geographic information system (GIS)

GIS connects data in a single location so that it can be expanded upon as needed. In contrast to

traditional maps, computerized GIS maps are more detailed and include multiple layers of data (e.g. yield, soil survey maps, rainfall, crops, soil nutrient levels and pests). Although GIS is a type of computerized map, its true function is the analysis of characters and geography through the use of statistics and spatial methods. Information on field topography, soil types, surface and subsurface drainage, irrigation, chemical application rates, soil testing, and crop yield can all be found in a farming GIS database. After analysis, this data is used to comprehend the connections between the different elements affecting a crop on a specific site. In addition to data storage and display, the GIS can be used to evaluate present and alternative management by combining and manipulating data layers to produce an analysis of management scenarios.

Grid soil sampling and variable-rate fertilizer (VRT)application

Variable-rate technologies (VRT) are automatic and may be applied to numerous farming operations. VRT systems set the rate of delivery of farm inputs depending on the soil type noted ina soil map. In the US, VRT is conceivably the most popular PFS technology. The same principles of soil sampling are applied to grid soil sampling, but the level of sampling intensity is increased. Data mapping is made possible by the location information included in soil sample collections that follow a systematic grid. An application map, or need map, is the end result of grid soil sampling. Samples can be taken from multiple fields within the same zone if they fall into the same range of yield, soil color, etc.. Grid soil samples are analysed in the laboratory, and an interpretation of crop nutrient needs is made for each soil sample. Then the fertilizer application map is plotted using the entire set of soil samples. The application map is loaded into a computer mounted on a variable-rate fertilizer spreader. The computer uses the application map and a GPS receiver to direct a product-delivery controller that changes the amount and/or kind of fertilizer product, according to the application map. The processes like seeding, fertilizers and pesticide application, herbicide selection and application at a variable rate in the right place at right time can all be controlled with information extrapolated from the GIS.

Crop management

Satellite data provide farmers a better understanding of the variation in soil conditions and topography that influence crop performance within the field. Farmers can, therefore, precisely manage production factors, such as seeds, fertilizers, pesticides, herbicides and water control, to increase yield and efficiency.

Soil and plant sensors

Precision agriculture technology heavily relies on sensor technology, which has been reported to be able to provide information on plant fertility and water status as well as soil properties. A thorough inventory of the sensors that are available today, along with features that would be ideal for future sensor development. A widely used method for characterizing soil variability is to survey the field using sensors measuring soil apparent electrical conductivity (ECa), which continuously gather data when pulled over the field surface. Since ECa is sensitive to variations in salinity and soil texture, these sensors offer a great starting point for implementing site-specific management.

Global Positioning System (GPS)

satellite in the Global Positioning System signals that enables GPS receviers to determine a users location. Since this data is given in real time, moving targets can receive continuous position updates. Mapping soil and crop measurements is made possible by having accurate location data at

all times. Users can return to particular locations to sample or treat those areas by using GPS receivers, which can be carried into the field or mounted on tools. The accuracy of uncorrected GPS signals is approximately 300 feet.

Rate managers

Rate controllers are tools used to regulate the rate at which chemical inputs, like liquid or granular pesticides and fertilizers, are delivered. These rate controllers keep an eye on the flow rate, pressure, and speed of the tractor/sprayer as it traverses the field., making delivery adjustments in real-time to apply a target rate. Rate controllers have been available for some time and are frequently used as stand-alone systems.

Precision irrigation in pressurized systems

New innovations that use GPS-based controllers to regulate the motion of irrigation machines are now available for commercial use in sprinkler irrigation. Apart from motion control, efforts are underway to develop wireless communication and sensor technologies that can monitor soil and ambient conditions, as well as irrigation machine operation parameters like flow and pressure, with the goal of improving crop utilization of water and application efficiency. Although these technologies have a lot of promise, more work needs to be done before they can be bought commercially.

Software

Using software to perform a variety of tasks, including display-controller interfacing, information layer mapping, pre- and post-processing data analysis and interpretation, farm accounting of inputs per field, and many more, will often be necessary when implementing precision agriculture technologies.The most popular ones are those that create maps (such as those for soil, yield, or chemicals); filter data collected; create maps with variable rate applications (such as those for chemicals, fertilizer, or lime); overlay different maps; and provide advanced geostatistical features. To meet the demands of contemporary, information-intensive farming systems, all thses options are excellent choices for managing farms through precision agriculture and maintaining records. A small number of businesses with global operations offer integrated software packages that include tools for statistical analysis, record keeping, and the creation of various map types. In addition to yield meters, machinery manufacturers also provide software for creating yield maps, and fertilizer manufacturers offer software for creating maps with variable rate applications. While some of the packages are relatively expensive and difficult for farmers to use, others are much simpler and have fewer options. The farmer can use a variety of options and the packages are more user-friendly. But there are still issues with data. transfer between farmers, and between farmer, co-op and consultant. To overlay maps, mainly soil and yield maps, is also a difficult task so far.

Yield monitor

Yield monitors are made up of multiple parts.They usually consist of a number of sensors and additional parts, such as a data storage device, a user interface (keypad and display), and a task computer housed in the combine cab that manages how these parts integrate and work together. The separator speed, ground speed, mass or volume of grain flow, as well as grain, is all measured by the sensors. When it comes to grains, yield is measured continuously by observing the force of the grain flow as it strikes a sensible plate in the combine's clean grain elevator. An innovative mass flow sensor that was developed recently measures the amount of

energy that returns after being transmitted in microwave beams hitting the stream of seeds flowing through the chutes. In all yield monitors, GPS receivers are used to record the location of yield data and create yield maps. Other yield monitoring systems include devices used in forage crops to keep track of weight, moisture, and other information on a per-bale basis.

Precision farming on arable land

Farmers that use PA techniques on arable land are the most advanced and commonly used. CTF is a whole farm approach designed to minimize costs associated with standard methods by preventing heavy machinery from inadvertently damaging crops and compacting soil. Using GNSS technology and decision support systems, controlled traffic methods limit all field vehicles to the minimum are of permanent traffic lanes. Optimizing the application of fertilizers, starting with the three primary nutrients of nitrogen, phosphorus, and potassium, is another significant use of precision agriculture on arable land. These fertilizers are evenly applied to fields at specific times of the year in conventional farming.. This leads to over- application in some places and under-application in others. The environmental cost is directly related to over-application which allows nitrogen and phosphorus leaching from the field into ground- and surface waters or to other areas of the field where theyare not desired. Over- application of fertilizers causes nitrogen and phosphorus to leak from the field into surface and ground waters, as well as other parts of the field where they are not wanted, which directly contributes to environmental costs. Fertilizers can be applied more precisely and optimally in terms of both location and timing when using precision agriculture techniques. The Variable Rate Application (VRA) system, which combines a variable-rate (VR) control system with application equipment to apply inputs at a precise time and/or location to achieve site-specific application rates of inputs, is the technology that gives farmers control over the amount of inputs in arable lands. VRs are determined using pre-measured data, such as that from machine-mounted sensors or remote sensing.

Precision farming within the fruits & vegetables andviticulture sectors

In fruit and vegetable farming the recent rapid adoption of machine vision methods allows growers to grade products and to monitor food quality and safety, with automation systems recording parameters related to product quality. These include colour, size, shape, external defects, sugar content, acidity, and other internal qualities. Fertilizers can be applied more precisely and optimally in terms of both location and timing when using precision agriculture techniques. The Variable Rate Application (VRA) system, which combines a variable-rate (VR) control system with application equipment to apply inputs at a precise time and/or location to achieve site-specific application rates of inputs, is the technology that gives farmers control over the amount of inputs in arable lands. VRs are determined using pre-measured data, such as that from machine-mounted sensors or remote sensing.king of field operations such as chemicals sprayed and use of fertilizers can be possible to provide complete fruit and vegetable processing methods.

A number of novel techniques that consider the tree's actual size, the crop's state, and the surrounding environment have been developed in recent years. Precision Viticulture, or PV, is a relatively new term for the development and application of PA technologies and methodologies in viticulture, compared to arable land. However, a number of research projects are already underway in regions of the world that produce wine due to the high value of the crop and the significance of quality. Maps showing grape quality and yield are crucial during harvest to prevent blending grapes from different

potential wine qualities. Theparcels with greatest opportunities for PV are those which reveal ahigh degree of yield variation. A high degree of variation willmean higher VRA of inputs and, therefore, greater economic and environmental benefit in comparison with uniform management.

Precision livestock farming (PLF)

Precision livestock farming (PLF) is defined as the management of livestock production using the principles and technology from precision agriculture. Animal growth, milk and egg production, disease detection and monitoring, and aspects of animal behavior and physical environment, such as the thermal microenvironment and gaseous pollutant emissions, are among thr processes that are appropriate for the precision livestock farming approach. Systems include feed pushers, robotic cleaners, robotic feeding systems, weighing systems, robotic cleaners, and imaging systems that help stockmen avoid direct contact with animals. Other systems include robotic cleaners and milk monitoring that checks fat and microbial levels, helping to indicate potential infections. There are currently new systems available for data monitoring of feed and water consumption that can be used to identify infections early on. Other advancements include the observation of the expanding herd, where it's critical to measure growth in real time. Acoustic sensors detect an increase in coughing of pigs as an indicator of respiratory infection. Other sensors are now used to provide alerts concerning birthing and fertility. A vaginal thermometer monitors the temperature, imminence of birthing and the breaking of waters, and communicates to the farmer via SMS. Also, a sensor placed on an animal's collar records parameters to detect signs of oestrus and the readiness for fertilization. An SMS message then allows the farmer to plan for insemination.

On-line resources for precision agriculture

There is a wealth of information available over the internet on new technology for farm production. Most manufacturers of farm equipment, GPS receivers, sensors, andother PA technologies use this media to inform growers on new products, technical specifications, trouble-shooting information, software upgrades, and a variety of services.