RESEARCH OF THE EFFICIENCY OF OPERATIONAL MANAGEMENT IN AGRICULTURAL FARMS THROUGH THE USE OF AGRICULTURAL EQUIPMENT FLEET MONITORING SYSTEMS

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Abstract

When it comes to managing a fleet of vehicles and machinery in the agricultural industry, a manager's main concerns are the productivity of the fleet as well as the drivers, efficiency and reducing maintenance costs. Precision agriculture refers only to the use of advanced technologies for carrying out agricultural works. That is why it cannot characterize the whole formed by an independent agricultural system. Precision agriculture is a subsystem especially of the sustainable and ecological agriculture systems, but also for the intensive agriculture system. Thus, thanks to the use of information and technology in crop management, it is possible to achieve: monitoring of works on each plot; guidance or self-guidance; precision. Precision agriculture encompasses a set of technologies that combine sensors, information systems, improved machinery and management to improve production. In order to ensure the food supply for the future, adequate quantities and quality of agricultural products are needed. In addition, the ability to track food products from production through processing, storage and retail sales offers the opportunity to respond to changing market conditions, to provides elements for a correct and healthy nutrition.

Key words: monitoring systems, operational management

Precision agriculture, or information-based management of agricultural production systems, emerged in the mid-1980s as a way to apply the right treatment to the right place at the right time.

The main factors that serve precision agriculture are the increase in the degree of soil variation combined with the emergence of technologies such as global satellite navigation systems, geographic information systems and microcomputers (Huzum N., 2013).

The components of precision agriculture are Simulation models, decision support systems (DSS) and geographic information system (GIS); remote sensing and global positioning system (GPS); production maps and precision application of chemical products (Zhalnin E.V., 2013).

Precision agriculture aims to optimize the use of soil, water and chemical inputs (fertilizers and pesticides) on specific local bases and has the following objectives: obtaining large and quality productions, constant in time and space; optimization of economic profits; full implementation of environmental protection; increasing the sustainability of agricultural systems; reduction of the production price per product unit (Cazacu D., Roșca R., 2020).

General presentation of geographical information systems.

The Global Positioning System (GPS) is a satellite navigation system that can provide users with their exact location on the globe, how to get to another place, how fast they are moving, where they have been, how far they arrived, what time it is, and much more (Cazacu D., 2021).

GPS was originally designed to assist the US military with the precise location of troops, vehicles, aircraft and ships around the world. The GPS system consists of three segments: Space, Control and User (Ibanescu A., 2015).

The Space Segment consists of 29 satellites orbiting the earth every 12 hours at an altitude of 12,000 miles. The Control Segment finds the satellites and provides them with position and time information. The User Segment consists of users and their GPS receivers. The number of simultaneous users is unlimited.

MATERIAL AND METHOD

When a GPS receiver is turned on for the first time, it downloads information from all named satellites. This process, the first time, can take up to 12 minutes; but once this information is

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downloaded, it is stored in its memory for future use.

The GPS receiver calculates the distance from each satellite to the receiver using the formula: distance = speed x time. The receiver determines the position using triangulation. When receiving signals from at least three satellites a receiver should be able to calculate the approximate position. The receiver needs at least four or more satellites to calculate a more accurate position. Position can be reported in latitude/longitude, UTM, or other coordinate system.

The Geographic Information System (GIS) is a computer-based tool for mapping and analyzing spatial data. It integrates databases, such as: query and statistical analysis with geographic visualization, analysis of the advantages offered by maps.

These skills differentiate GIS from other information systems and make it useful in a wide range of public and private activities to explain events, anticipate outcomes, and plan strategies.

Many have characterized GIS as one of the most powerful technologies because it focuses on integrating knowledge from multiple sources (eg layers of a map).

The hardware component includes the computer on which a GIS operates, the monitor on which the results are displayed, and a printer to make copies of the results.

Software: GIS software provides the functions and tools needed to store, analyze, and display geographic information.

Data: It is the most important component of the GIS system. A GIS will integrate spatial data with other data resources, and you can even use a database management system used by most organizations to organize and maintain their data, to manage spatial data.

People: GIS users are technical specialists who design and maintain the system but also those who use this system day by day.

Methods: A successful GIS operates according to a well-designed plan and business rules, which are models and operating practices unique to each organization.

GPS is a satellite system that projects information to GPS receivers on the ground that allow users to determine latitude and longitude coordinates while GIS is a software program that allows users to store and manipulate large amounts of data from GPS and other sources.

An agricultural producer can use a portable GPS receiver to determine longitude and latitude coordinates for a water source near a field. GIS: After a chemical spill, maps obtained from a GIS system can reveal sensitive areas that should be protected.

The use of GPS and GIS in agriculture is growing rapidly. Some of the uses are listed below, they are used or may be used in the future:

Soil Sampling: Collecting soil samples on a large property can be organized using GPS and mapping software. Sample locations may be waypoints marked on mapping software.

Then, when the lab results are returned the data can be plotted on maps. Location information can save money and time by allowing only those areas in need to be treated.

Farmers can put tractors on autopilot like in *figure 1*. When they plow their fields a GPS recording is made and then the tractor can be programmed to follow the same route for cultivation, fertilization, pest control and harvesting.

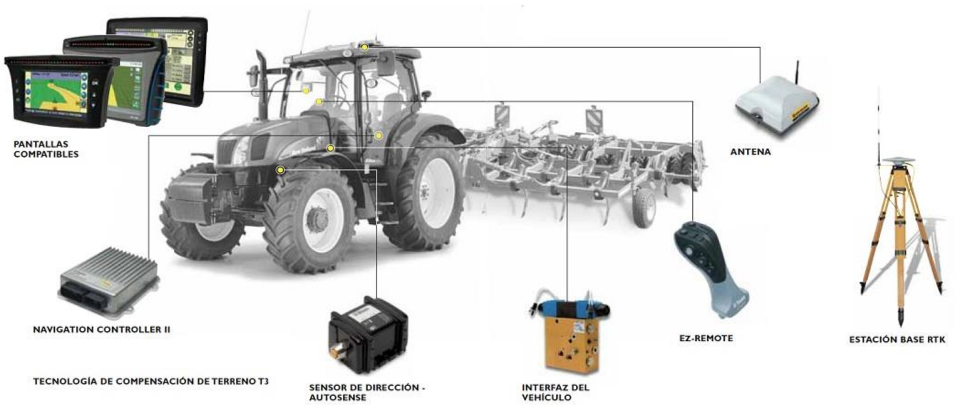

Figure 1 **Guidance systems with an accuracy of 2.5 cm from planting to harvest**

Insects do not attack an entire field. Workers can use a GPS to record locations of insect problems. The data can then be used by the driver to selectively target problem areas instead of treating an entire field. This method saves time, fuel and insecticide.

The position of valuable livestock on a large farm can be monitored through GPS transmitters attached to the animals' necks. When animals are sent to market GPS transmitters can be used to track their location.

Estimates of yield variations on a property can be made using GPS. To do this a property is divided into zones and the yield of each zone is estimated and plotted on a map. The map can then be used to make decisions about the next crop in production.

GIS gives farmers the opportunity to increase production, reduce production costs, and manage their crops more efficiently. From mapping to scientific analysis of production data in the farm manager's office, GIS can make a difference in agricultural production by reduction of agricultural production costs such as fertilizers, fuel, seeds, labor.

Improve sustainability with new biomass and biogas while remaining profitable through traditional agricultural and livestock products.

Because of the financial risks involved in agricultural production, farmers usually insure crops and livestock against potential physical risks such as hail, frost, drought, and disease.

Insurance companies calculate the cost of insurance based on risk assessment tables, which are developed by insurers. Factors that are taken into account in determining the insurance rate include physical risks, as well as the history of a specific parcel of land and the current management of the farm, to assess whether best practices are being used, thereby reducing risks.

Agricultural pest control is based on accurate data on the amount and location of pests or other infestations in a specific area. GIS plays an important role in data collection, interpolation, and analysis.

The data can be collected in a very short time using mobile GIS, analyzed in the farm office with desktop GIS, distributed via the Web with a geospatial server type software.

This data collection, analysis, and rapid distribution process provides farmers with up-to-date information on pest locations, potential risk areas, and control recommendations.

Because pesticides pose a potential risk to the environment, agricultural agencies must carefully manage pesticide requests to achieve an acceptable balance between the economic interests of the agricultural community and the health of the larger community.

Storing this information within a GIS allows officials to better manage the application process, perform water quality monitoring, to investigate the points (sources) of pollution.

RESULTS AND DISCUSSIONS

Using mobile GIS technology, farmers can measure, record, and land characteristics for: nutrient deficiencies and water consumption during regular inspections. When data is collected in this area, remedial measures can be quickly developed and implemented. In the office, recently collected data can only be extracted for a specific field, crop, or pest.

Optional equipment, such as digital cameras and GPS devices, can be easily added to a mobile GIS for enhanced data collection.

Information technology has had a substantial impact on agriculture, particularly through the use of global positioning systems (GPS) in combination with GIS tools.

By incorporating GPS into standard agricultural practices by farmers, researchers and consultants have been able to improve the accuracy of existing agronomic management activities by implementing them on a smaller scale. Precision farming technologies were their result. Potentially, factors influencing crop productivity can be identified, mapped, and used to provide an implemented solution.

Precision agriculture paves the way to better manage variation where previously, in terms of treatments, a field was normally assumed to be homogeneous.

Precision agriculture (PF) and variable rate technologies (VRT) use spatial databases within field, environmental and management variables to maximize production across the field.

GIS is a familiar tool for managing water resources for agricultural and conservation purposes.

It can help establish water rights for farmers and support applications for irrigation drilling permits.

It can also be used to observe soil water loss through drainage and unlined canals, as well as help determine profitability and prioritize canal projects for irrigation.

In recent years, agricultural farmers have gained access to new technologies, through the use of Global Positioning Systems (GPS-Global Positioning System) and Decision Support Systems, which previously were a monopoly of the military arsenal, are currently new computerized technologies in the world modern civil.

Scientists and equipment manufacturers are trying to modify existing laboratory methods and develop indirect measurement techniques that could rapidly enable soil mapping.

Sensors can be: electromagnetic; optics; mechanics; electrochemicals; acoustics.

Electromagnetic sensors use electrical circuits to measure the ability of soil particles to conduct or accumulate electrical charge.

When using these sensors, the ground becomes part of an electromagnetic circuit and the change in local conditions immediately affects the signal recorded by a data logger.

The electromagnetic properties of the soil are largely influenced by soil texture, salinity, organic matter and humidity. In some cases, other soil properties such as nitrate concentration or pH can be determined with this type of sensors.

Optical sensors use light reflection to characterize a certain type of soil.

Vehicles based on optical sensors use the same technical principle as in the case of remote sensing. Optical sensors have been developed to perform soil mapping at different depths. Mechanical sensors can be used to estimate the mechanical resistance of the soil (relevant sometimes in the case of compaction). These sensors use a mechanism that penetrates or cuts the ground and records the force measured by transducers or load cells.

Electrochemical sensors provide the most important information about soil nutrient concentration and pH in precision agriculture.

Precision agriculture uses interactive systems, which include remote sensing, computer systems, digital cartographic data, software and applications in the fields of SIG/GIS, agrometeorology data and information, pedology, agrochemistry, phytotechnics, etc. GPS receivers mounted on agricultural equipment.

The space component, provided elements that come from GPS and GLONASS positioning satellites and that provide the precise location of sensors located on agricultural equipment, as well as from remote sensing satellites, that provide the right imaging support to analyze the multispectral phenological phases (phenophases) related to the evolution of plants in culture.

CONCLUSIONS

The demands of modern agriculture relate to high productivity and efficiency. The reduction of costs, the reduction of working time and the security of control over agricultural activities in their globality are the essential factors of profitability and competitiveness, both internally and externally.

GPS technology used in agriculture helps maximize productivity, better control input costs (herbicides, plant protection products, chemical fertilizers, seeds, fuel, etc.) and optimize profits. With GPS systems, stakes are no longer needed to mark directions on the ground, and this results in lower labor costs. Chemical application operations are done precisely, thus eliminating overlap errors. This translates into an economy of fuel and inputs, as the rows are parallel, regardless of their shape (straight, curved, round, etc.).

Using satellite guidance systems not only saves inputs, but also saves time. Agricultural fleet tracking systems allow the real-time or historical location of agricultural machines and the employees who use them, from any computer or phone connected to the Internet. The GPS systems that will be used in the research will ensure, without human intervention, in an automated way, the monitoring of the agricultural activity, highlighting who, what kind of work, with what equipment, on which plot, how many hectares, with what consumption carried out an agricultural work. The recovery of the investment in the Agromonitoring system can be followed by increasing the efficiency of the works, controlling the processes based on real data, obtaining savings from the optimized use of resources.

Real-time GPS data collection enables precise location of machinery, including the exact position of the tractor on the plot, direction of travel, working speed, even stops. It is possible to track who is driving the tractor, what implement (aggregate) is behind it and what work it is doing.

The GPS system automatically records and processes the works on the plots. It is easy to see how many hectares of a certain work have been completed and what areas have remained unworked. You can select a certain period to see all the works done, grouped by tractors, tractor drivers, types of work, etc. It is very easy to consult who, when, what work, with what equipment, on what plot, on what surface, with what overlays, what consumption he achieved. GPS systems will also offer the possibility to highlight on the map the overlaps and unworked surfaces.

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