GIS & GPS USAGE IN AGRICULTURE

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Abstract

This article takes the topic of precision agriculture in big strongly develop farms. It informs about GIS system and its use with GPS system to give much more precise maps of plant culture and for giving precise place of soils samples that are taken from fields. By reading this we can get information what kind of data that is used with precision agriculture systems. This article draws a conclusion that precision agriculture gives farmer less work to do and better results in growing plants. It says that precision agriculture will not only be use by big farms but in near future it will be use by all farmers.

Introduction

A farmer who cultivates a few hectares of field knows exactly where all parts of it are. He knows what is planted on every part, what kind of soil he possesses and how good the soil is etc. A farmer who has thousands of hectares is not able to remember such information. In that situation new technology comes with help. The GIS systems can give all the information about a cultivated or owned field. A person using the GIS technique can pull up all the data in the data base that relates to that one specific location, and make some decisions about a management operation. The Global Positioning System (GPS)\(^{81}\) gives a farmer the method to locate certain data, which can be put into GIS. The GPS can be also used to take the sprayer or manure spreader to a specific location in the field.

Data and the ways of gaining information

Information about each field can be sorted in four groups:
1. Main information that are gathered in Ground and Buildings Registry
2. Information about Soil Structure
3. Information about plant production each year
4. Economic information

The first group consist information like:

- Owner’s personal details,
- Field location (province, district, community, village);
- Field registry number,
- Description of parts that are used (ex. Corn field, meadow etc.).

\(^{81}\) GPS uses a constellation of 24 satellites that are 11,000 miles above the earth's surface. These satellites, called NAVSTAR satellites, emit a signal that is picked up by the GPS receiver. The GPS receiver then interprets the signal and creates a circle of possible locations. The GPS receiver then uses three additional satellite signals to determine your location. Where the four circles of possible locations intersect, that is the location of the GPS receiver. The GPS receiver displays the coordinates.
Classification marks;
- Land area,
- Map of a land.

Descriptive information and text can be inserted to the system’s database directly from Ground and Buildings Registry exactly how is prepared by the District Geodesy and Cartography Centres.

Paper maps of the place where the land is situated, can be taken from proper offices and they must be transformed to vector representation (that is to form comprehensible for computers). This process is takes some time. Transferred maps have disadvantages; they can be out of date so transferring them into computer memory is expensive, moreover, it doesn’t give any proper results. We can also use computer-based farm mapping systems that use GPS to make digital map of a production field. This way gives best results. Field map has plenty details that could not be placed on paper maps, and always is up to date.

The second group consists of information about soil features. To get that kind of information a few typical samples of soil have to be taken from the field and send to the soil lab for analysis of nitrogen, phosphorous, potassium and pH. The samples are mixed in the pail, put into the sample bag and mailed to the soil lab. A week or two later, nutrient and lime recommendations are send to a farmer, from the soils lab. In order to take some samples of soil, we can use a vehicle equipped with gathering machine and the GPS system. If GPS is used to log the geographic location of each soil sample and has each sample analysed separately, then a variety of soil characteristic maps could be generated in a Geographic Information System. Is it good to mix the soil samples? Mixing depends on the field size, the variability, and the need for the information for future decisions according to a given land. If a farmer plans to get a yield monitoring, and variable rate application, then it makes sense to spend a little more money on good soil sampling.
Fig. 3 pH variability.  

The third group of gathering data consists of:

- Name of a plant that is cultured,
- Date of seeding/gathering,
- Date and description (kind of substance that was used, dose) chemical overtures
- Date and description (kind of manure, dose) manure,
- Yield map for each year.

There are two versions of a yield monitoring. The first version provides a direct readout of grain moisture and on-the-fly readout of the instantaneous yield in dry bushels per acre running combine checks across the field. This version does not have any global positioning systems attached. The usefulness of this non-GPS yield monitor provides little more than the electronic equivalent of weigh wagons, but with the on-the-fly readout of grain yield and moisture. This approach does not make any maps of yield. Many farmers simply use the yield monitor’s moisture sensor, without GPS to determine if the field is ready to harvest. If the soil is too wet, they back out and find another place to harvest.

On the other hand yield monitoring is equipped to receive GPS signals and with data card recording which can be used to make a map of each harvested field in addition it totals all of the grain bin and weighs wagon information.

Fig. 5 Combine a components of Yield Monitoring and mapping.
In the fourth group we can recon information about costs:

- Taxes and other payments,
- Seeds,
- Plant protection chemicals,
- Mineral manure,
- Working power,
- Equipment rent,
- Others.

**Benefits of gathering information – Precise agriculture**

Precise agriculture combines technology and farming practices to increase crop yield, limit environmental impact, and profits. The technology component includes: Global Positioning Systems (GPS), Geographic Information Systems (GIS), remote sensing, yield monitors, sprayer controllers, and various other pieces of equipment each with a specific purpose.

All crops have a maximum potential yield, based on the genetic potential level of a plant. This maximum level is rarely achieved. The reason why it can be as obvious as a disease or an insect infestation, or as hard to determine as the lack of water or nutrients at a critical stage of development. The difference between the maximum possible yield and the actual yield can be called the “yield gap”. If a plant has received the optimum amount of water and nutrients when required and was not damaged by any pests or other infestations, then the yield will be at the maximum genetic potential. However, agriculture is rarely perfect. Most likely, a plant will be damaged by:

- less than the optimum amount of water,
- less than the optimum soil nutrients,
- an insect or weed infestation,
- a fungus or other pest infestation.

The greater the yield gap is the more damage costs the farmer terms of lower yield and lower revenue. GIS maps of yield and maps of soil characteristics can be one of the decision inputs that allows a farmer to look at a variety of conditions that affect the growth of the crop, not only as the average for the field, but for every square yard of the field individually. A farmer can generate a prescription map for applying a lime or nutrients to the field and a chemical application map. Applying the proper mix of pH, control of nutrients is possible so that each part of the field could be managed to yield its most profitable level of crop production. The use of digital yield maps and digital soil sampling analysis maps provide a permanent record of the changes in fertility and application of chemicals and nutrients from season to season. This time trace of farming operations provides the farmer with a barometer of profitability.

Precise application of chemicals and nutrients are usually accomplished with using sprayers and sewers equipped with GPS receiver and computer that control a dose of manure.

**Economics of precise agriculture**

Precise agriculture encompasses a wide variety of operations and technologies. The common thread of any applied technology or operation is that it must be economically viable. There is no clear answer whether or not the precision agriculture is economically beneficial. Economics of precise agriculture mainly depends on the size of a farm (greater farm-greater profitability) and growing structure.

- Best profits are gained from high value crops such as fruits, vegetables, and root crops.
- Medium value crops like corn and soybeans potentially provide positive returns.
- Low value crops do not presently offer positive benefits using precise technologies.
Conclusion

Using the GIS systems in agriculture changes the way of taking up decisions in planning a production process. Farmer has more spatial information about his field. He cannot only undertake decisions about the way of using manure or chemical overtures for the whole field but he can do it for exactly defined parts. Precise agriculture is closely connected with modern technologies both software and hardware. The bigger the field is, the more profit agriculture can elaborate. The expense of the whole GIS management system imposes the use of it only big and rich farms. For sure precise agriculture is the right way for the development of large area farms, but in future it is highly possible that small ones will use it, too.

Bibliography

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