THE MONITORING OF THE AGRICULTURAL WORKS IN THE PRECISION AGRICULTURE

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Abstract

The precision agriculture, the most advanced form of agriculture, used even in the developed countries of the European Union and the Unites States, but not on large areas, has as its foundation the most modern methods of control of the quality status of the various environmental resources, as well as the application at an optimum moment in time of all technological components, determining a precise control over the possible parameters which could determine the degradation of the surrounding environment. Within a crop field, with the same crop planted at the same moment in time all over the field, standing in the same climatic conditions (because of the limited extension of the specific field), one could observe areas (preferable as small as possible) which have anomalies in the development of the plants, delays in the vegetative process, variable dispersion of individual plants over this limited area, as well as the spectral response of the plants' leaves, calculated using various combinations of vegetation indices (NVDI, RATIO, SAVI, NRVI, etc.). The developed system could be also used for the agricultural fleet management, as well as for the control of the fuel consumption. In the case of some major soil improvement work, the same area can be researched, in order to observe if the improvement actions have had the expected effects on a longer term, not only during an agricultural season.

Key words: precision agriculture, vegetation indices, agricultural GIS, fleet management

The conventional agriculture systems are characterized by the strong specialisation and intensification of the agricultural activities and the minimisation of production costs. The mineral fertilizers and pesticides are used on a large basis in the field crops, also in horticulture, winegrowing, vegetable farming, etc.

The ogranic matters which originate from the animals (the stable compost, the swine mud, etc.) and those of vegetal origin must be usually applied on the farm fields, being a rich source of nutrients for the crops and in the same time for protection of the soil against degradation.

In the crop rotation only some plants prevail, especially the cereals and the industrial crops, the most widespread being the monoculture and the two-year rotation for corn and wheat, with ther application of large doses of minaral fertilizers and other chemicals in order to fight the diseases and the pests.

The work of the soil is intensive, with often usage of large capacity machines which, especially during irrigation, increase the risk of degradation and pollution of the environment. In such farms, the major objective is that to obtain a large profit, the protection of the environmental resources being minimised. There are big farms organized, with large terrain and production processes concentration, as well as capital and manpower, but the social life conditions of the rural environment are largely neglected.

The precision agriculture - the most advanced form of agriculture, which is practiced even in the most developed countries of the European Union and the United States on limited areas, has as its foundation the most modern methods of control of the quality status of the various environmental resources, as well as the application of all technological components at an optimum moment in time, determining a precise control over the possible parameters which could determine the degradation of the surrounding environment.

The concept of „precision agriculture” refers to using the information and technology in managing the crops.

The agricultural systems are tightly bound to the economical, social and environmental problems. Their solving is the most important condition for the implementation and promotion of the durable agriculture.

The operation of choosing the agricultural system is conditioned by the level of technical endowment, the level of professional knowledge,

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also by the mentality, the education as a whole, as well as the respect for nature, for the environment of all those who work in this domain.

MATERIAL AND METHOD

Our study had the purpose, on the one hand, to do the calibration of an Agricultural Geographic Information System, based on the data obtained during the previous year, with correlations between the data extracted from the processing of satellite imagery and those extracted from the field work, on the studied farm areas. On the other hand, our study was also developed in order to find a natural sequel of his first part - the materialization of the actions on the soil and crops, accomplished during the present year.

These actions will be done quasi-punctual, precisely on the limited area which has problems of soil quality or development of the crop plants, and not on the entire field (as it's done in the conventional way). The motivation is that we want to encourage this type of agriculture (the precision one), and we want as well to see that the improvement actions, performed on the specific area, led to its integration within the productivity average of the entire infield.

Using the same coordinate system throughout our agricultural GIS (the Stereographical Projection System 1970), in all the study's phases, makes possible - from the geographical location point of view - the correlation of problems observed in a specific area, of the improvement works performed on that area, as well as analysing the results in that very area after the performing of improvement treatments.

The agricultural machines will possess a GPS receiver for their positioning and the data transmision in both directions will be made through a GSM modem.

The training of the farm equipment drivers will be an absolute requirement, in order for them to know all the details of operating the GPS hardware and software on bord of the machine; with that in mind, the dialog windows of the GPS device must be as user friendly as they can get, the menus as clear and as easy to access as possible.

In order to describe the technological flow conceived in this study, from the office to the field and then back again to the office, we start from the moment at the end of the previous study, meaning the finalizing of a map of impaired areas for each field. The multi-spectral imagery processing will be made both manual and automatically, with the help of the specific software (in our case, ERDAS Imagine 9.1, developed by ERDAS for geo-spatial programs), and the integration of this map will be made using the software product GIS ArcGIS 9.2. The maps will be generated after multiple processings of the satellite images, also using the classification methods.

The classification is the sorting process of the pixels within a satellite image, which groups the elements of an image in a finite number of individual classes. When a classification is done, the following certainties exist: there is a well defined relation between images acquired at diferent times of the same terrain surface, there is a spatial relationship between the neighbouring pixels, the spectral response of objects is the same in similar acquirement conditions. The digital classification is a semi-automatical process which performs the delimitation of groups of pixels with similar characteristics. In our study, these characteristics are defined by the unconformous stage of the soil or by poor health of the crop plants.

Within the land under crop at a specific moment in time, with the same crop plant, under the influence of the same climatic conditions (because of the limited geographical area), a number of areas (preferable small ones) will be observed with differences in the evolution of the plants, delays in the vegetation process of the respective crop plants, the uneven dispersion of the plants in specific areas of the field, as well as different spectral responses of the plants' leaves; this response is computed using various combinations of vegetation indices (NVDI, RATIO, SAVI, NRVI, etc.).

Using the analysis performed in the first year (the testing year) and the calibrations done in the first part of the study, the connection between various unconformous spectral responses and the reality from the field is well known - in an empirical way, as well as its motivation. On the integrated map of the created Agricultural Information System, all the areas exhibiting problems will have codes and fields in the database, which describe the discovered problem, possibly even the solution to the problem, used by the farm's agronomists.

The manager of the Agricultural Geographical Information System will establish the database structure asociated to the GIS, in collaboration with the farm's agronomists, each of them adding the fields which they think are relevant for the smooth functioning of the information system.

Once the map created, it will be uploaded to each GPS device on the bord of the farm equipment, each machine operator (driver) can have in this very moment an overall view over the problems discovered on the entire farm teritory.

At the next moment in time, the system will either choose for each operator an impaired area to improve, or each operator chooses himself the area he wants to improve, selecting it from the list of areas to be improved, a list placed by the system at the operators' disposal.

The impaired areas will have clear and distinctive names. Their name will contain, by all means, the name of the containing field, both the official (cadastral) name, and the popular one (probably more expressive for the experienced driver of the farm equipment). Also, the name will contain the code of the impaired area; the area codes with be automatically assigned by the information system and the drivers will be able to see them on the GPS device's screen, "stamped" on the screen, on the area which has to be improved using the agricultural techniques.

At the moment of choosing the area (automatically by the system or manually by the driver), this area will become unaccesible to another operator/ machine and will be marked with the specific code "processing". The software can also suggest an optimal route to cover the designated area.

At the end of the performed action over a specific area, the driver of the farm equipment will mark the area as improved, the area receiving another code in the system, which will show the succesfull performing of the improvement operation, and the area will be removed from the impaired area list, so that another farm worker driving another machine wouldn't perform the second time the same improvement technique on the same area.

For an added automatization, the system can send a feed-back with the actions performed by the farm equipment, so that the database can update itself.

The system can efficiently manage the assignment of the impaired area to each farm equipment, depending on the geographic location of the machine at the moment of its assignment. After finalizing an operation, the system will record the location of the farm equipment and will compute the minimum route to the closest area to be improved, that way optimizing the routes of each machine and supplimentary reducing the fuel consumption.

The system must also acknowledge the quantity of fertilizer, for example, which the machine still has in its tank and considering this, evaluate if the machine can finish the operation on the next to be chosen area or if it will be required one or even more supplimentary laps; the system will record a log of the route covered by the farm equipment and, after the refilling of his fertilizer tank at the farm's base, resending it to the precise location where he previously paused the action because the fertilizer had ran out.

The operators, with the help of the devices on bord of the farm equipments, access through the information system, the same database. This allows that the action on the area which remained unworked by the machine X (because of the exhaustion of the fertilizer from its tank), to be resumed by the machine Y, which finalized an operation nearby the area in question and which can have enough fertilizer in its tanks in order to also finish the action on the unworked portion of the respective area.

Another way of operating would be using pulverizing nozzles with variable openings. The nozzle for spreading the fertililzer would open more or less, in direct ratio with the need for fertilization of each area in the field. Advancing through the field towards an area with increased fertilizer necessity, for example, the nozzles would open more and more, increasing the discharge of fertilizer on the ground, in that (impaired) area, but would gradually close when the machine leaves the specific area with problemd in crop plants growth.

That is a method which requires special equipment, such automatized machinery that the human operator (the driver) only acts as an observer and could possibly have a reporting role of the operations.

The system can perform daily statistics regarding the ratio of agricultural works already done, from the total amount, it can appraise how much time there is left until the finalizing of the improvement operations, etc., so that the farm's agronomists could have as many data as possible in order to make the specific decisions regarding the farm and its crops.

After the end of the improvement operations on the impaired areas, there comes a period of time when one could determine in what proportion the works had the supposed benefic effects.

After a period of time there has to be another acquisition and processing of remote sensing imagery, the focus being on the areas which had soil or crop plant problems and benefited from the agricultural improvement works in the previous season. After the processing of the satellite images and the classification operations, a new map will be created, superimposed over the previous one and one can observe and analyze the evolution of the areas which were impaired.

The farm's agronomists will decide if and in what extent the improvement operations were a succes, once again analyzing the spectral responses of the crop plants from the remote sensing imagery.

They can decide to apply additional improvement techniques in some areas or they can conclude that a specific area has reached normal parameters and is now integrated within the general health status of the whole field which contains it.

If in this phase there are improvements decided on some areas (either additional on known areas, or new ones which never got worked on), the procedure is the same as in the first part/ season - the areas are marked, the system gives each of them identifiers and the farm equipment is sent on the field for agricultural improvements of the areas, until they are all worked on.

RESULTS AND DISCUSSIONS

In the end, in the harvesting period, there takes place a monitoring of the productivity and the system generates a profitability map, integrated as well in the Agricultural Geographic Information System of the farm.

The productivity monitoring is done with the help of a device which measures and records the volume of a harvested crop, in real time. There are measured and computed indicators as the grains flow and the cereal humidity. With a precise calibration, this can be one of the very valuable solutions in managing the farm.

A profitability map can be created using recordings of the entry data and of the harvested crops. With its help, the farm's agronomists can determine what areas of the farm terrain are more or less profitable.

The Agricultural Geographic Information System of the farm will also be used in the next agricultural seasons, adding supplimentary information in the database, correlated with one another on the base of global positioning informations.

The more extensive the database will become, the more information will be for the farm's agronomists to decide regarding the crops and soils, their treatment and improvement.

In a certain phase, on the base of some agronomical elements inserted in the system, it can even suggest solutions to the discovered problems, leading to an even more complex system sustaining a larger automatisation.

CONCLUSIONS

This agricultural system can be also used to manage the farm equipment fleet and to control the fuel consumption within the farm.

The treatment of e certain area with in field and not the entire field will result in an economy of fuel, fertilizers and ressources in general.

This system must be permanently managed and updated, especially in the agricultural active periods.

In case of major soil improvement works, the same areas can be researched the following year to see if the improvement operations had the expected effect, and on a longer term than an agricultural season.

ACKNOWLEGMENTS

This work was supported by the the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/107/1.5/S/76888].

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