MEASURING INFORMATIONAL SYSTEM BY SATELLITE USED FOR OBTAINING OF SOME EXPERIMENTAL MODELS OF AGRICULTURAL PRODUCTION MAPS IN THE PRECISION AGRICULTURE CONCEPT

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Abstract: Within the article there are presented models of agricultural production maps made from the data obtained by a monitoring system for grain production MICRO TRAK type mounted on different types of harvesters (combines), used in the locations where the experiments were performed. Thus, in the first part of the article the concept of precision agriculture and its usefulness in the current economic situation is presented. In “Materials and methods” there is a description of the technical equipment used to make further experiments, as well as the choice of locations for their achievement. As a result of the conducted experiments, there were experimental yield map models obtained; their analysis and utility of the used system are presented in the concluding part of the paper.

Keywords: maps of productivity, precision farming, geographic information system.

Introduction

Precision agriculture (PA) is a model that is about the application in all highly developed countries and seeks a modulating inputs management (seeds, irrigation water, fertilizers, fungicides, herbicides, insecticides) by adapting the work of soil, sowing, the fertilizers to the heterogeneity characteristics of the plot. Precision farming being the agriculture seen as an application of mechatronics, makes way for a new methodology (it aims at new agriculture) which can be the key to many more problems. The opportunities favorable for the development of precision agriculture are as follows:

- ability to understand the complexity of agricultural systems – a systemic and holistic approach;
- ability to monitor events and systems – computer-controlled data acquisition;
- achievements in the field of computer hardware, software and database fireware;
- improvements in the interpretation and calculation methods, statistics, modeling, simulation, decision support systems – DSS
- development of geographical information systems – GIS
- emergence and development of spatial and statistical analysis – Geostatistical;
- progress in space technology – remote sensing, GPS;
- technical developments in the automation and improvement of agricultural machinery – agricultural mechatronics [1].

Improved crop quality and yield of agriculture is necessary in modern culture systems. A necessary requirement for production costs is that they are as small as possible to ensure market competitiveness. Achieving these goals involves the use of complex management and control systems to regulate, in an efficient manner, a large amount of interactive physical variables. Recent advances in hardware and software such as microprocessors and microcontrollers, are driving the integration and management of complex control tasks on farms [2].

Geographical Information Systems (GIS) is a technique increasingly used in this contemporary world, both in theoretical research and practical in many activities. GIS software is actually a system that has several components such as information reported in geographical coordinates. Entering, storing, handling and analysis is done with computer components, the result is primarily spatially referenced visualization of complex information to real geographic coordinates, and secondly the possibility of conducting analysis and correlation of highly complex, impossible to be done efficiently by classical techniques. GIS techniques allow combining information from different types (numbers, pictures, maps, etc..) hardware and software components, all under the direct coordination and determination of the human component. The database of a Geographic Information System (GIS) is actually a map, ie an organized collection of geographical data in a form to enable processing by electronic computer [3; 4].

The earth by nature through the centuries has been the object of work and means of production while different from all others, it is limited in scope, irreplaceable, stable and indestructible.

Evaluation of land in the market economy is an important operation, since the value of agricultural property has a share capital. It must be taken into account that agricultural lands have a variety of classifications, destinations, categories. As a result, the earth is influenced by a number of factors and causes that can influence it more or less.

The main factors that can influence more or less the value of land are:

- quality agricultural land;
- value growth opportunities through the provision of land reclamation works (drainage, irrigation, fertilization);
- advantages of proximity to transport links, the sources of communication and population centers;
- taste and aspirations of people attracted or not farming;
- form that is exploitable land (personal, leased, in part);
- size, organization, parceling, the nature of the earth;
- of farming system (extensive-intensive);
- manpower available in the locality or area.

Development of the technical progress in manufacturing contributes to increase the soil fertility, and investments are made for this purpose to increase the reliability of natural notes, the notes slowly reaching even potentiating transition.

Production capacity of the land includes both soil fertility and plants to show how the other environmental factors, starting with the weather (light, heat, precipitation), and continuing with the geomorphic and hydrological influence it.

In a GIS map a collection of data (GIS database) is given. This is called an organized collection of digital map data to shape the world around them, using GIS objects and spatial relationships. Spatial relations between geographical objects are represented by default and should be interpreted by the bound map.

Analogue maps. There are usual maps, drawn on paper or plastic. These, to form a computer-accessible database should be processed, i.e. digitized. This digitization process is to turn each item on the boards of digitization through a program in a pair-digitizer coordinate x, y. All these pairs of coordinates are forming vector type files to generate layers of elements or points, lines or polygons.

Digital maps. After digitizing a map there is a spatial database, in 1:1. The spatial data can be transformed using GIS functions, functions that allow printing or plotting to any scale and in any projection. [3; 4; 5]

Materials and methods

The basic component of a system to monitor the production output is a sensor which measures the flow of harvested grain from the collector machine and displays the information in the cockpit. When using a moisture sensor, the system is able to provide data and optimum moisture per hectare, average humidity, etc. This information is updated on a continuing basis, usually once every two seconds. When the production and humidity sensors are combined with a GPS (Global Positioning System), they provide data on local production which can be used to generate maps of production. These maps graphically illustrate the change in production on the field and allow the farmer to take the right decisions.

The basic components of a production monitoring system are:

- production sensor – measures the flow of grain in time;
- speed sensor – indicates the speed of work in order to calculate the harvest according to the surface taken in the study;
- humidity sensor – measures the moisture of grain, the value obtained is an average humidity obtained during harvesting;
- GPS receiver – signal and positions receiver from the Global Positioning System satellites;

- differential correction receiver – GPS signals are corrected by providing us with more accurate data on the site;
- operating interface – receives data from the combine operator and displays information processed in the on-board computer in the cab;
- tilt sensor – the sensor platform at the end of the combine swath to prevent double counting of output;
- on board computer – installed in the combine cab, receives output data from various sensors and the input data from the combine operator, processes and/or informations on production, on a specialized memory card (flash memory).

Figure 1 presents the diagram of the production monitoring system, and Figure 2 presents the representation of the information system and satellite measurements.

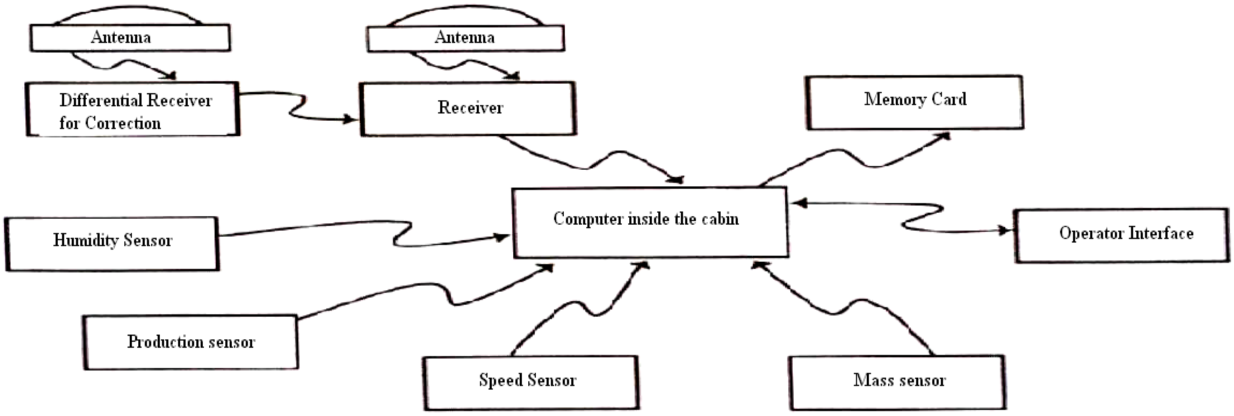

Fig. 1. **Production monitoring system diagram**

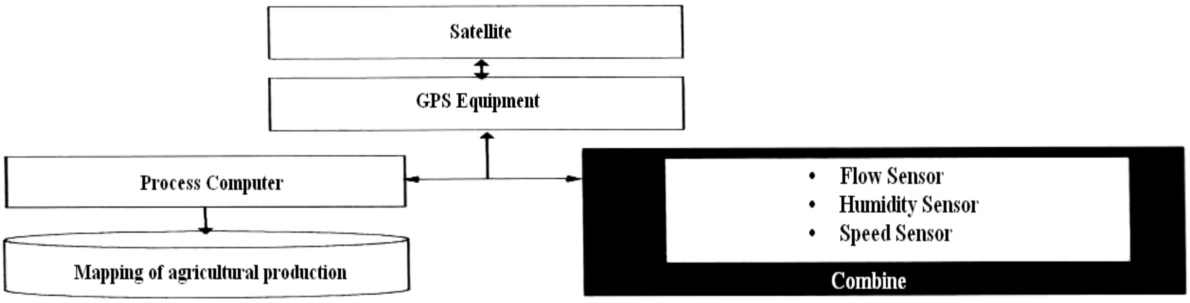

Fig. 2. **Representation of proposed information and measurement satellite system**

In precision farming several types of sensors for measuring the flow of grain are used, manufactured by famous companies in the world, such as John Deere, Ag Leader, Ag Tech, RDS, Micro Trak, Droningbierg, Now, Grain, etc. Currently, there are four types of production sensors on the market, each using a different measurement technique [5].

The Micro-Trak Grain-Trak & AGCO FieldStar is used in the experiments conducted in this article (Fig. 3) (U.S. version) by measuring the flow by means of force transducer with fingers. The Micro-Trak Grain-Trak's uses a force transducer to measure the flow of the existing grain in the threshed / clean grain elevator. Instead of curves of a flat deflector attached to a transducer, the operator console uses a set “fingers of measurement” that are attached to a transducer.

These fingers of measurement are located in the way of grain at the exit of the grain elevator, at the grain passing over the fingers, these being pushed, the created force being converted into an electrical signal by a transducer. As in other systems, this signal (voltage) sent to the monitor and combined with the information from the humidity sensor provides measurement of the production [6]. Like a force acting on the sensor, it generates a frequency that is transmitted to the signal distribution processing module. The module processes this frequency, based on the calibrated flow value and sends it to the console to display information about production. When the production changes in field, the flow of grain (mass) passing through the combine changes, leading to modification of the sensed force by the sensor. This terminal will display the variations in production. The grain flow sensor is mounted on top of the grain elevator of the combine and will fit to the most types of manufacturing and models, with related adjustments that will be made for each combine type.

For optimum accuracy of the flow sensor, the grain elevator chain has been adapted so that the interval between the blades and the top of the elevator is between 1.27 cm and 3.81 cm. Although these distances are approximate, to ensure better accuracy of the recorded data, the distance was set as close as possible to the lower limit: 1.27 cm [5; 7].

Results and discussion

The study was conducted in three different locations to determine the production capacity of some plots which were analyzed a year ago in terms of soil properties. Thus, tests were performed with the Micro Trak Trak Grain & AGCO FieldStar for determining soil productivity in the following locations:

1. INCDA Fundulea - soil type FOREST REDDISH BROWN, the area analyzed was 0.8 ha wheat crop seed.
2. USAMV Timisoara – soil type CHERNOZEM CAMBIC, the surface analyzed was 3 ha wheat crop.
3. INMA Bucuresti - soil type FOREST REDDISH BROWN, the harvested area was 4 ha, rape crop.

Production monitoring system Micro-Trak Grain-Trak & AGCO FieldStar was mounted on different constructive types of combines - Figure 3 (C110H combine, MDW 527 STS combine, WINTERSEIGR experimental combine). The data were recorded every second, using a GSP (GSP V used connexion for data NMEA 0183 VERSION 2.30) connected to the system Micro-TrakGrain-Trak & AGCO FieldStar, absolutely necessary condition for recording the productivity data in the memory card with which this is equipped (PCMIA card). The data were subsequently transferred into a notebook to generate maps using various specialized software.

Fig. 3. **Images during the experiments**

The productivity raw data acquired during work were processed to obtain maps of experimental models of soil productivity, using specialized software. This map was drawn based on the productivity of that parcel, shown in Figures 4, 5 and 6: [7].

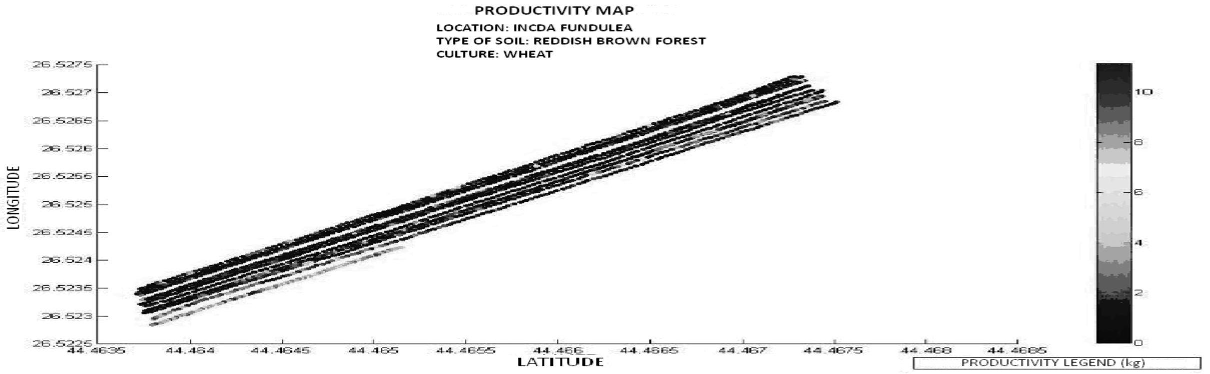

Fig. 4. **Experimental model of agricultural maps based on soil productivity (INCDA Fundulea, reddish brown forest soil type, Experimental culture of wheat for seed)**

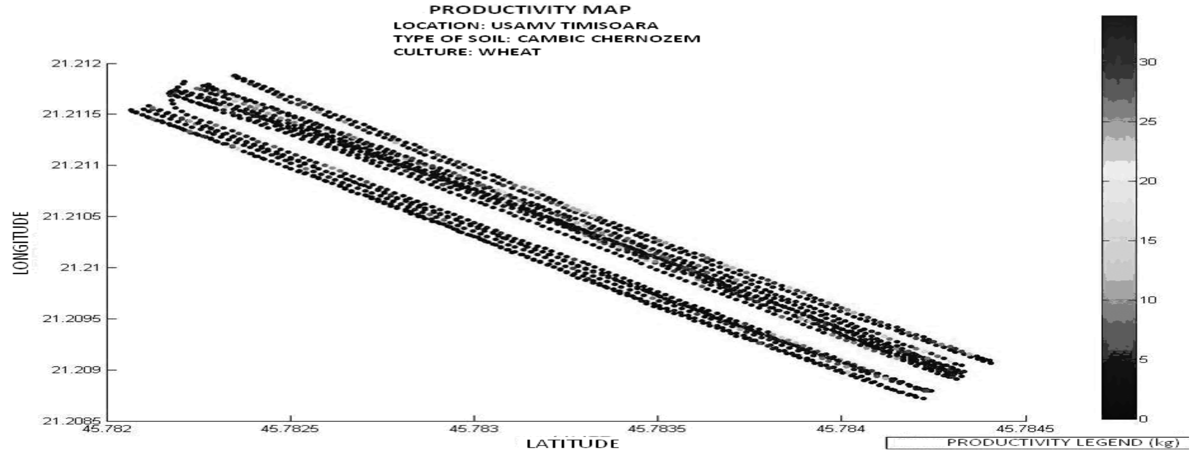

Fig. 5. **Experimental model of agricultural productivity map of the soil (USAMV Timisoara; Type of soil: cambic chernozem; culture: wheat)**

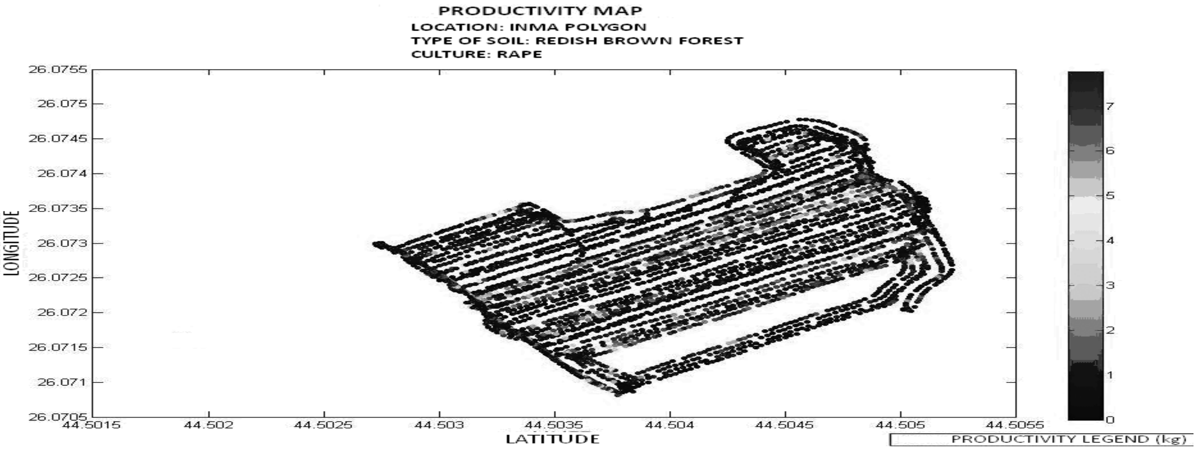

Fig. 6. **Experimental model of agricultural productivity of the soil map (INMA Bucharest, reddish brown forest soil type, crop rapeseed)**

Conclusions

Agricultural productivity maps show the production variation in an agricultural terrain and represent an important source for the farmer. The production monitor is just a part of the informatics system in precision agriculture, by help of which we can make comparisons of productivity values on more periods of time. Adopting a decision regarding a crop must not be made with a rash action by the farmer; at least three years are needed for characterizing an agricultural terrain from a productivity point of view. The farmer must not jump to conclusions, long term conclusions being more solid. The most complicated situation is when in some agricultural parcels following many years of mapping the productivity there is not different from year to year.

In order to make the experimental models of agricultural productivity maps three different locations were chosen in Romania, that represented the three main soil types from this country (medium soil – INCDA – FUNDULEA, Ilfov, heavy – INMA BUCURESTI, Ilfov and very heavy – USAMV TIMISOARA, TIMIS), where by help of a productivity monitoring system, MICRO TRAK type, mounted on different types of combines used for experimentation productivity data necessary for creating the productivity map models where obtained.

After analyzing the patterns of agricultural productivity maps analyzed under the theme and from the corresponding histograms the following conclusions can be drawn:

- In case of plot I from the location INCDA FUNDULEA, type of soil REDDISH BROWN FOREST, crop: experimental WHEAT for seed is found after the first analysis of the experimental model of the productivity map, a production per hectare of 4200 kg. It also finds points of the grid average productivity per square meter very close throughout the land, which is agriculturally herbicided during the year.
- In case of plot II from the location USAMV TIMISOARA, CAMBIC CHERNOZEM soil, WHEAT crop, is found after a first analysis of the experimental productivity map model, a production of 3250 kg per hectare. It also finds points of the grid average productivity / m^2 very close throughout the land, this being herbicided.
- In case of plot III from the location INMA Bucharest, soil type: REDDISH BROWN FOREST, culture RAPE is found, after a first analysis of the experimental model map of productivity per hectare a production of 800 kg. The production per hectare is lower because the analyzed plot was not herbicided and there have been flooded areas during spring due to heavy rains in this region, observed from the grid points on the map. Thus is found the interference of some areas respective points in the plot with a lower productivity.

Regarding the monitoring system behaviour used, MICRO TRAK GRAIN, there were no significant differences between the recordings of the total productivity and mass of cereal harvested on a parcel and weighed with an electronic scale, with adjustments being made during probing. Also adjustments were made for the harvested cereal humidity that was compared with the humidity displayed by the humidity sensor from the monitoring system mounted on the cabin bunker level [7].

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