

## Creating Agricultural Productivity Map Models on Different Romanian Soil Textures through the Concept of Precision Agriculture

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**Abstract.** *Precision agriculture (AP)* – is a model that will be applied in all developed countries and aims an input modulate management (seeds, irrigation water, fertilizer, herbicide, insecticide) through soil tillage adaptation to the parcel heterogeneity characteristics. Precision agriculture, as a mecatronics application, leaves room for a new methodology (that aims towards a new agricultural system) that can be the key to many issues.

Crop quality and yield increase is necessary in modern agricultural systems. A necessary requirement for production costs is that they must be lowered as much as possible in order to guarantee market competitiveness. This implies the use of complex management and the control of systems in order to regulate, efficiently a large quantity of physical interactive variables. Recent progress in hardware and software like microprocessors and microcontrollers, lead to complex control and task management integration in agricultural exploitations.

Productivity maps show the production variation in a field and represent an important source of information for the farmer. The production monitor is just a piece from the information gathering system in precision agriculture, with the help of which we can make comparisons of production values on a multitude of time tables. The article presents productivity map models made on soils in different locations in Romania.

**Key words:** soil, productivity, precision agriculture, soil properties, monitoring system, productivity map models.

### INTRODUCTION

In the European economy globalization context, the central problem is competitiveness, and it depends on the sector capacity to innovate. The Romanian agricultural production will not be competitive without an intensive agricultural research. This is because the total dependence on important solutions would always situate us behind competitors, reducing the chances of Romania to achieve a stable role on the European and international market.

In order to make agricultural production in Romania competitive, it is necessary to find optimal solutions for the natural conditions of climate and soil, human resources, biological and technological, material and financial resources, in order to bring profit from chances that appear on the national and international market evolution. It is a well known fact that Romania has a large agricultural area, which situates it in front of many other countries from Europe. It is often forgotten that a large part of the state's soils are poor, acid, with a low content of phosphorus and nitrogen. An efficient way to give value to the importance of natural resources is represented by the arable surface, which is a difficult problem to research in order to find new solutions for a superior way to give value to these “*problem soils*”.

Thus, in order to obtain a high productivity and implicitly a high yield coefficient, regarding UE market demands of product quantity and quality obtained following agricultural terrain cultivation, new ways and methods through which we could gather soil properties have become a necessity; this data will help Romania's agriculture to fit in the concept of precision agriculture. So in the last years a large importance has been granted for obtaining culture maps that reflect the productivity on different parcels and in some cases on the same parcel, maps that will be correlated with mechanical, physical and chemical properties of soils. (Ionescu Gh. - *Agricultura alternativă în Comunitatea Europeană (căi de acces către o agricultură durabilă*, [www.agriculturaromaniei.ro](http://www.agriculturaromaniei.ro)).

Agricultural terrain quality determination represents a complex research action and a quantitative appreciation of the main conditions that determine the growth and multiplying of plants, of establishing the degree of favorability of these conditions for each use and culture. Because the terrain capacity of production is modified under natural factors, and mostly human intervention, quality determination must be permanently updated.

Through quality determination works on agricultural terrains the following points must be solved:

1. Production capacity information on the terrain for different culture plants, tree and orchard plantations, natural meadows;
2. Information about the most rational repartitions of cultures on an area, respectively distributing processes of zoning and profiling of agricultural production;
3. Establishing causes that limit the production capacity and outlining them for their negative effect removal or decrease;
4. Substantiation of economical measures for outlining and comparing land rent differential in order to overtake and redistribute, for ensuring social-economic equity for all workers in agriculture.

## MATERIALS AND METHODS

A production monitoring system is composed out of a production sensor that measures flow rate of cereal from the combine gatherer and shows the information. When a humidity sensor is used the system has the capacity to gather information like hectare optimal humidity, average humidity, etc. This information is updated on a continuous base, usually one time each two seconds. When the production and humidity sensors are combined with a GPS (global positioning system), these give out data about the local production that can be used for production map generation. These maps illustrate graphically the production variation on an area and permit the farmer to take rational decisions.

The main components of a production monitoring system are:

- production sensor – measures flow rate of cereal in time;
- speed sensor – indicates speed, so that the total harvested area in a given time could be calculated;
- humidity content – measures cereal humidity, the value obtained being an average of humidity values obtained during harvesting;
- GPS receptor – signal and position receptor from the system satellites of global positioning;
- Operation interface – receives data from the combine operators and displays processed information in the combine on-board computer ;

- On-board computer – mounted in the combine cabin, receives output data from different sensors and input data from the operator, processes and/or information regarding production on a specialized memory card (flash memory).

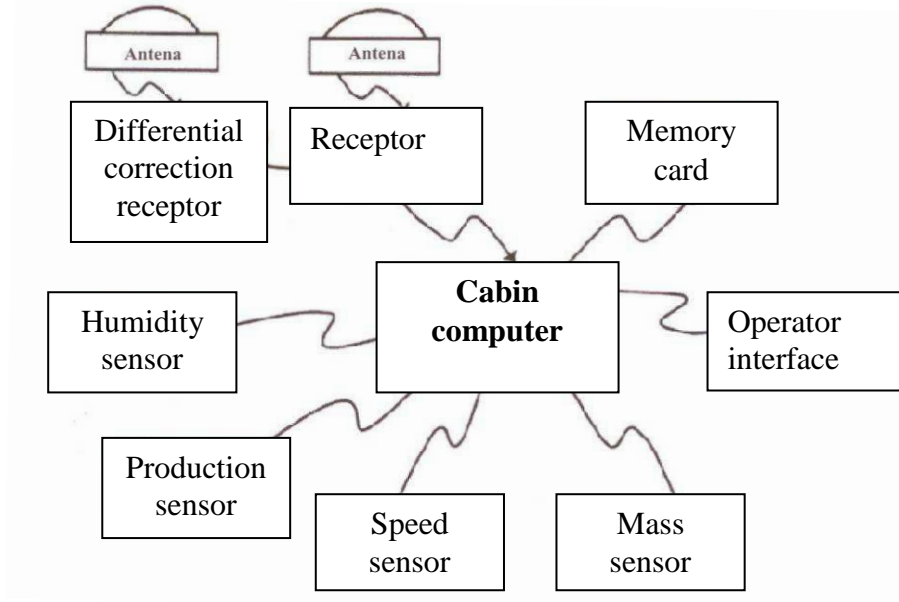


Fig.1 Monitoring production system diagram

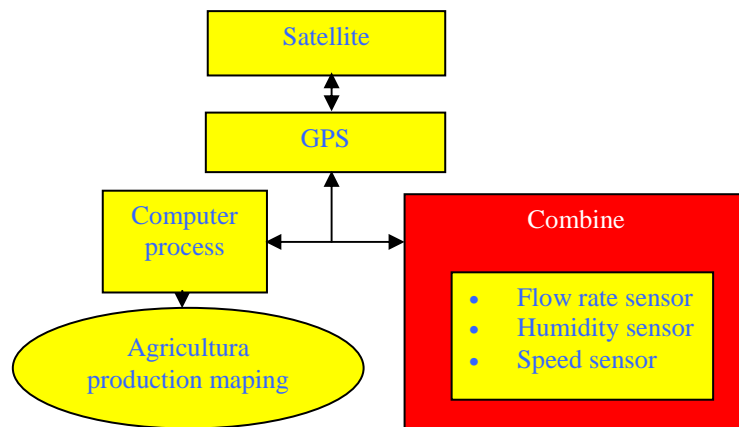


Fig.2 Representation of the informational system and satellite measurement proposed

Production sensors are manufactured by John Deere, Ag Leader, Ag Tech, RDS, Micro Trak, Droningbiere, Acu Grain, etc. Currently, there are four types of market production sensors, each of them using a different technique for measurement.

In the case of presented experiments in this article the **Micro-Trak Grain-Trak & AGCO FieldStar** system was used. The Micro-Trak's Grain Track uses a force transducer for flow rate measurement existent in the cereal elevator. The two systems are different. Instead of the curves from a flat deflector attached to a transducer, the operator console uses a set of "measurement fingers" which are attached to a transducer. These "measurement fingers" are placed in the way of cereals at the elevator exit. The cereals pass through the fingers and are pushed. The created force is transformed in an electrical signal by a transducer. Like other systems, this signal (tension) is sent to the monitor and combined with the humidity sensor

information in order to create a measurement of production. (Trak Gain, User Manual, - Micro-Trak Systems, 11 East lera y avenue P.O. Box 99, Eagle Lake, MN 56024-0099, U.S.A).

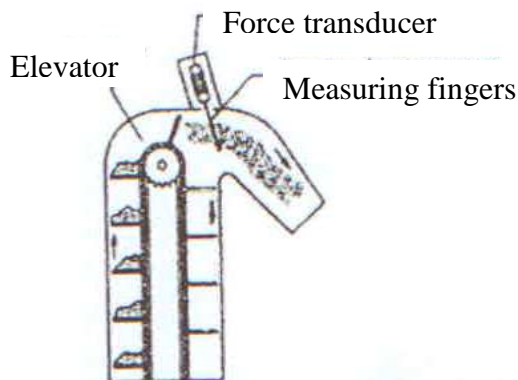


Fig.3. Micro-Trak Grain-Trak & AGCO FieldStar system

The study was conducted in three different locations in order to determin the production capacity of some parcels that have been analyzed a year earlier from a soil property point of view. Thus the Micro-Trak Grain-Trak & AGCO was used in the following locations:

- 1- INCDA Fundulea – soil type: FOREST RED-BROWN, 0.8 ha analyzed surface, wheat crop;
- 2- USAMV Timișoara – soil type ALCALYNE CERNOZIUM, 3ha analyzed surface, wheat crop;
- 3- INMA Bucharest – soil type FOREST RED-Brown, 4ha analyzed surface, rape crop;

Production monitoring system Micro-Trak Grain-Trak & AGCO FieldStar was mounted on different constructive types of combines. The probe gathering method was the grid method, and it consisted of making a normal grid with spacing according to combine working length. Data could be recorded each second, through GPS (GPS V- NMEA 0183 VERSION 2.30 data connection used) connected to the Micro-Trak Grain-Trak & AGCO FieldStar system, a condition absolutely necessary for productivity data recording in the memory card (PCMIA card). The data will be later transfered un a notebook for map designing using MATLAB program.





Fig.4. Images during experiments

## RESULTS AND DISCUSSION

The objective of the study was achieving productivity map experimental models in the specific areas, with the help of the Micro-Trak Grain-Trak & AGCO FieldStar mounted on different types of combines used during probes: C110H combine at INMA Bucharest – rape crop, MDW 527 STS at USAMV Timișoara – wheat crop, and WINTERSEIGR experimental combine at INCDA Fundulea, wheat crop.

On the basis of these data productivity map models were designed.

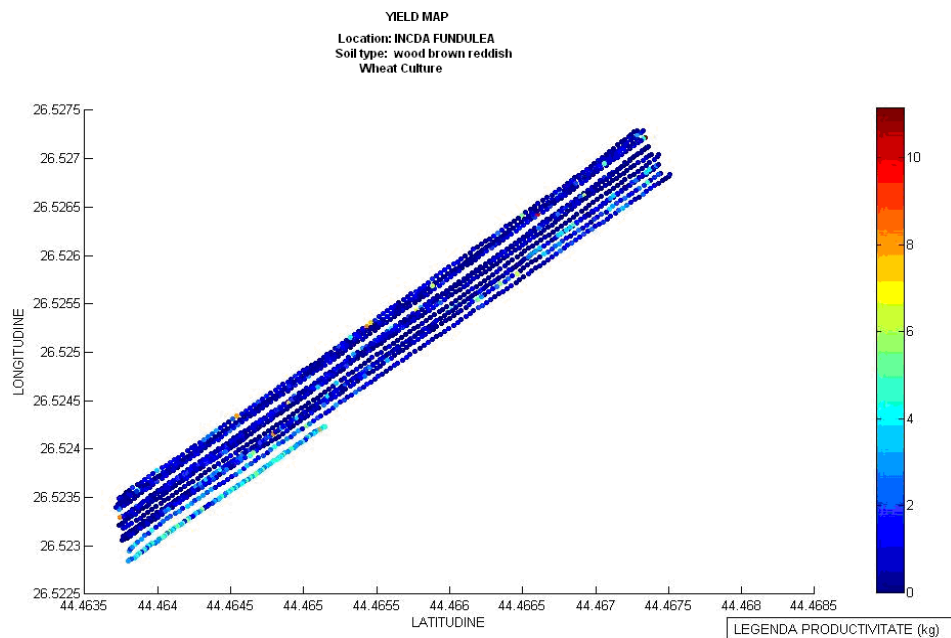


Fig. 5. Experimental model of agricultural map in function of soil productivity (INCDA Fundulea – experimental wheat culture for seeds

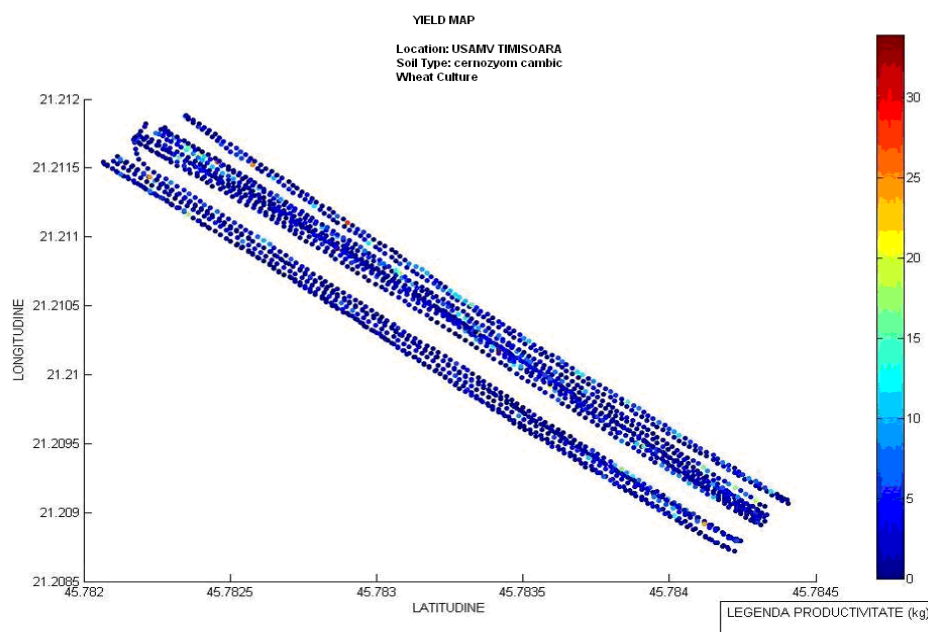


Fig. 6. Experimental model of agricultural map in function of soil productivity (USAMV Timisoara, soil type: cernoziom cambic, wheat culture)

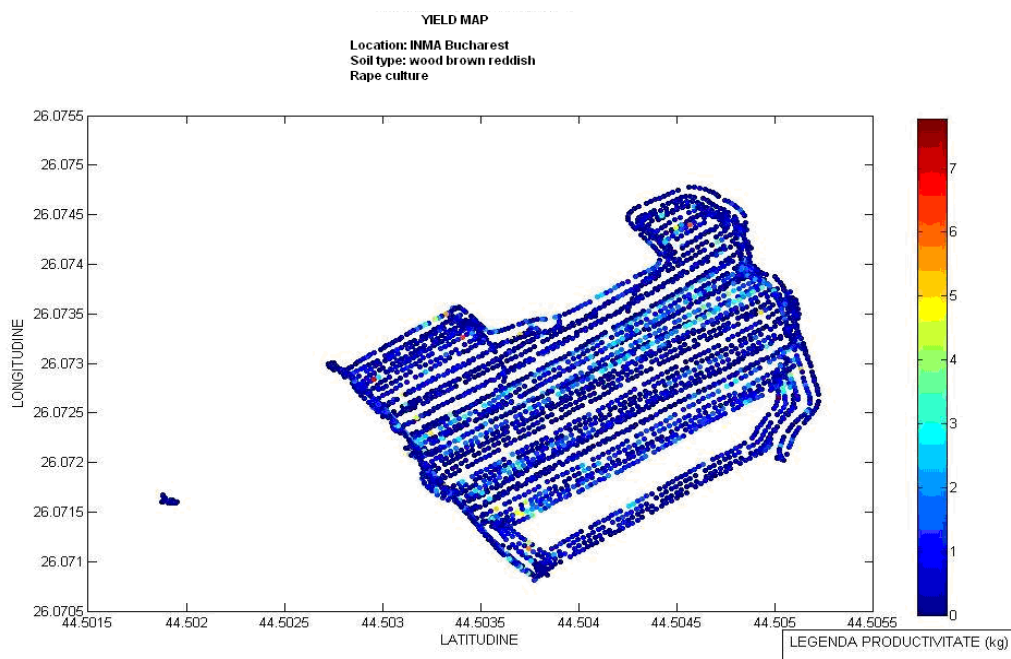


Fig. 7. Experimental model of agricultural map in function of soil productivity (INMA BUCHAREST, soil type wood brown reddish, rape culture)

## CONCLUSIONS

The agricultural productivity maps presents the yield variation in an agricultural field and represents a major source of information for the farmer. The yield monitor is just a component part of the informatics system in precision agriculture, with the help of which can be compared the yield values on a number of time periods. Adopting a decision regarding a



culture shouldn't be a farmer's hasty action, because there is needed a minimum period of three years for characterizing an agricultural terrain from the productivity point of view. The farmer shouldn't rush with conclusions, they can be made on short term, but the ones on long term are more solid. The most complicated situation is when in some agricultural fields, during more years of yield mapping there is no consistency from year to year. .

For realizing experimental models of yield agricultural maps, there were chosen three different locations from our country territory, the locations being chosen so that to comprise all the representative Romania's soil types (*medium soil* - INCDA FUNDULEA, Ilfov county, *hard* - INMA BUCUREȘTI, Ilfov county and *very hard* - USAMV TIMIȘOARA, Timiș county) where helped by a yield monitoring system, **MICRO TRAK** type mounted on different harvester type used at experimentations, there were obtained the yield data necessary for making yield maps models.

After analyzing all the yield agricultural maps models results the following conclusions:

- In case of first field from INCDA FUNDULEA, wood brown reddish soil type, experimental wheat for seeds culture, after a primary analysis of the yield agricultural map model there is established a productivity of 4200 kg/ha. Also looking at points grid there is ascertained a medium productivity / m<sup>2</sup> almost even on all terrain, because on this were applied herbicides during the agricultural year.

- In case of second field from USAMV TIMISOARA, CERNOZIOM CAMBIC soil type, wheat culture, after a primary analysis of the yield agricultural map model, there is established a productivity of 3250 kg/ha. Also looking at points grid there is ascertained a medium productivity / m<sup>2</sup> almost even on all terrain, this being treated with herbicides.

- In the third field from INMA BUCHarest, wood brown reddish soil type, rape culture , after a primary analysis of the yield agricultural map model, there is established a productivity of 800 kg/ha. The lower yield per hectare is due to the fact that the analyzed terrain wasn't treated with herbicides, this thing being observed also from the map points grid. Thus there is recorded the interference of some points, respectively some areas in the field with a lower productivity.

In what concerns the used MICRO TRAK GRAIN yield monitoring system comportment, there weren't been recorded significant differences between its yield data records and the total grain mass harvested from a field and weighted with an electronic scale, adjustments being made during tests.

Making decisions base don yield maps is not a simpe action. Type, quantity and quality of some data obtained at a farm is modifying quite dramatically. The farmers will be forced to choose from those data and to decide which information is relevant for their objectives. Farmers have to select priorities, the paces in making decisions including: data collecting, data processing, decision making, implementation of a plan, evaluation.

## REFERENCES

1. Boling, A. A., T. P. Tuong, H. van Keulen, B. A. M. Bouman, H. Suganda and J. H. J. Spiertz. (June 2010). Yield gap of rainfed rice in farmers' fields in Central Java. Indonesia. Agricultural Systems. Volume 103. Issue 5.. Pages 307-315;
2. Ionescu Gh. *Agricultura alternativă în Comunitatea Europeană (căi de acces către o agricultură durabilă*, [www.agriculturaromaniei.ro](http://www.agriculturaromaniei.ro);
3. Țenu Ioan, Vâlcu Victor and Cojocaru Petru. *Studii privind condițiile de implementare a conceptului de agricultură de precizie*. Universitatea de Științe Agricole și Medicină Veterinară Iași;
4. Trak Gain, User Manual. Micro-Trak Systems. 11 East leray avenue P.O. Box 99. Eagle Lake. MN 56024-0099. U.S.A.