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INFORMATION TECHNOLOGY FOR AGRICULTURE YIELDS MAPPING

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Precision agriculture means a modern manner of economic exploitation of the arable land taking into account the environmental protection. Romania has a great agricultural potential offered by the relief, and the soil characteristics. Precision agriculture improves yields without significantly altering natural soil characteristics for short medium and long time. Small differences in the soil structure can generate production variability which might have a serious impact of the food quality and price. The information system for agriculture yields mapping proposed in the paper can be an effective tool for developing a precision agriculture.

Key words: flow rate sensor, GPS, information technology, maps, moisture sensor, magnetic speed sensor, precision agriculture.

1. INTRODUCTION

The soil cultivation should be naturally performed without the aggression of the environmental factors of soil, water and air. At global scale, *precision agriculture* [NRC, 1997: Srinivasan, 2006] is promoted by the farm management or agricultural farm association's global leadership. Precision agriculture leads the farmer to promote the optimal technologies according to different plots of the field. The domain of precision agriculture is such an important issue so, in 1997, Springer started to publish a journal with the same title.

The successful implementation of this modern concept on a large scale needs the tackling of problems regarding the efficiency and the interactions among, the specific tools and methods utilized in earth sciences (geology, geography), climate and crops growing. Effective real-time decision – making mechanism should utilized to manage such complex systems [Filip, 2008]. The domain in which the precision agriculture as proved its efficiency are: a)mapping the agricultural crops, b)mapping the soil properties of the agricultural areas, c)managing the harvesting processes in optimum conditions, d)managing the mending processes of the agriculture exploitation areas, e)evaluation the crop developing stages and f)monitoring the crop health condition.

The article aims at presenting an information system for precision agriculture which integrates several information and communication technologies. It will not only manage the soil specific data, but it will also achieve short-term statistics about crop, and ecological and economic performances. Those data have been requested by farmers over the years with the view of facilitating the choice of the best management practices to be followed [Cardei et al, 2003].

The remaining part of this paper is organized as it follows. First, the system technical solution is described. Then several experimental results are presented. Conclusions and further works are eventually presented.

2. IT PLATFORM AND OPERATION

Crop maps are obtained by measuring the production of cereals and continuously monitoring the position oh harvester in the land. To generate crop maps five parameters are necessary: a) flow rate of cereals, b) humidity of cereals, c) harvester speed, d) width of the harvester cut, and e) harvester position for map creating.

A typical information system for agriculture yields mapping should include several technologies such as:

- GPS (Global Positioning System);
- Sensors (for measuring the moisture, magnetic speed and flow rate);
- Input and processing module for sensor signals;
- Display console;
- Memory card device;
- Memory card;
- Computer;
- Specific software for processing the collected data from the field.

Figure 1 described the flow diagram of agriculture yield mapping with the following steps: a) data collection, b) data processing, and c) chemical fertilizer to mend the soil.

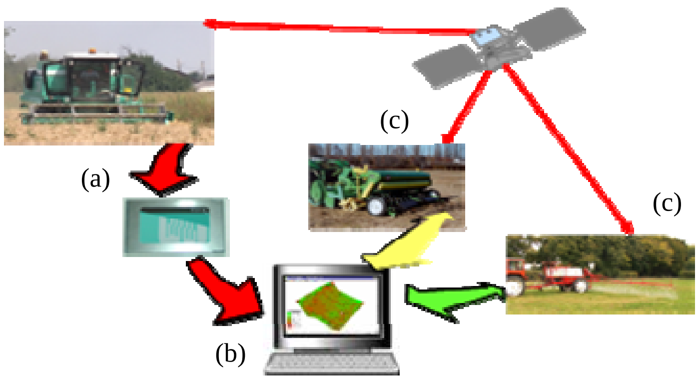

Fig. 1. The flow diagram of agriculture yields mapping

Figure 2 illustrates the components the information system for agriculture yields mapping (the information flow chart from the operator console(a) to performing the productions maps). The information received from sensors(b) are processed by the *input and processing module*(c) and the real time data (moisture and average production, total production, harvester speed, etc.), are displayed on operator console in the harvester cabin. Meanwhile, the information processed and harvester position provided by GPS(d) are recorded on memory card every second.

The central component of the production monitoring system is the production sensor, which measures the cereals flow rate from the harvester and displays the information on the operator console. This is mounted on a visible picking device placed in the harvester cabin. Figure 3 which appear on the operator console during the cereals harvesting process. Figure 4 shows the flow chart of data collection up to maps production.

Having recording all the data on the memory card, the information are processed off-line, on laptop or desktop computer by using specific software. Production maps are generated taking into account the errors caused by the harvester displacement [Cardei, et al, 2003; Dobermann, et al, 2003]. Special attention is given to the understanding of the production maps in order to point out the areas with problems (water areas, weeds, excess fertilization, lack of chemical fertilizers, etc.) which finally led to smaller productions. Starting from this information, one can diagnose the specific situation as specify the measures which should be taken in order to reintroduce the damaged areas into the agricultural circuit at their maximum output potential [Lark, 1997].

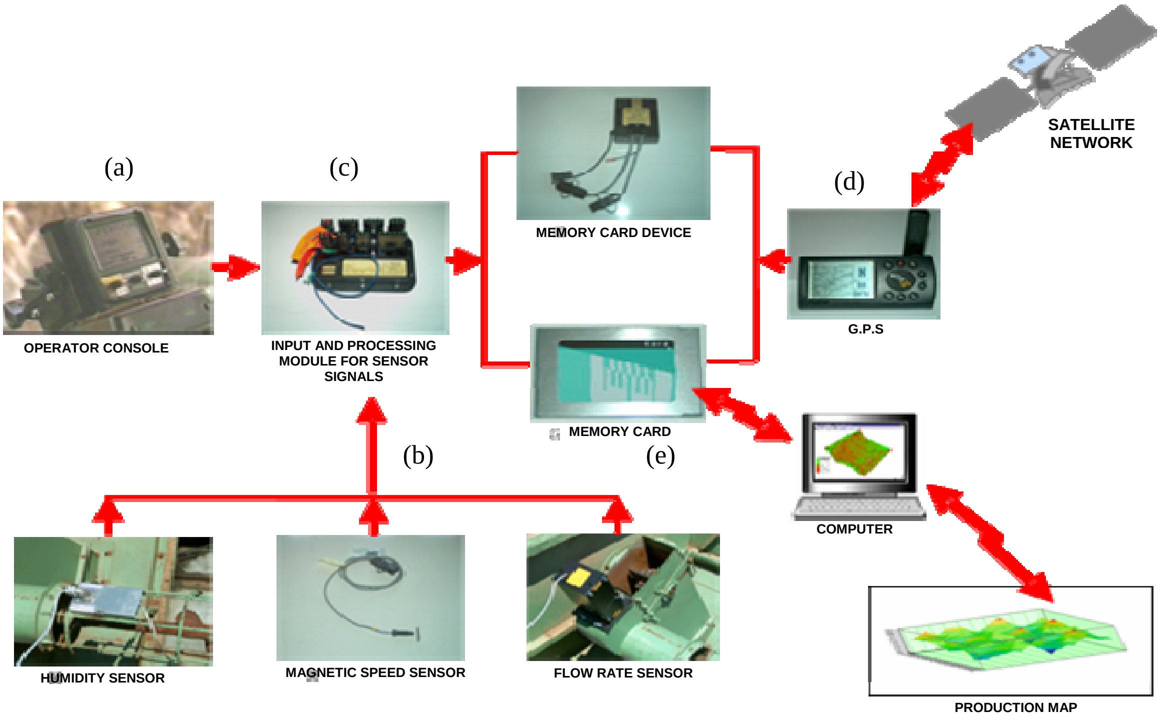

Fig. 2 The components of information system for agriculture yields mapping

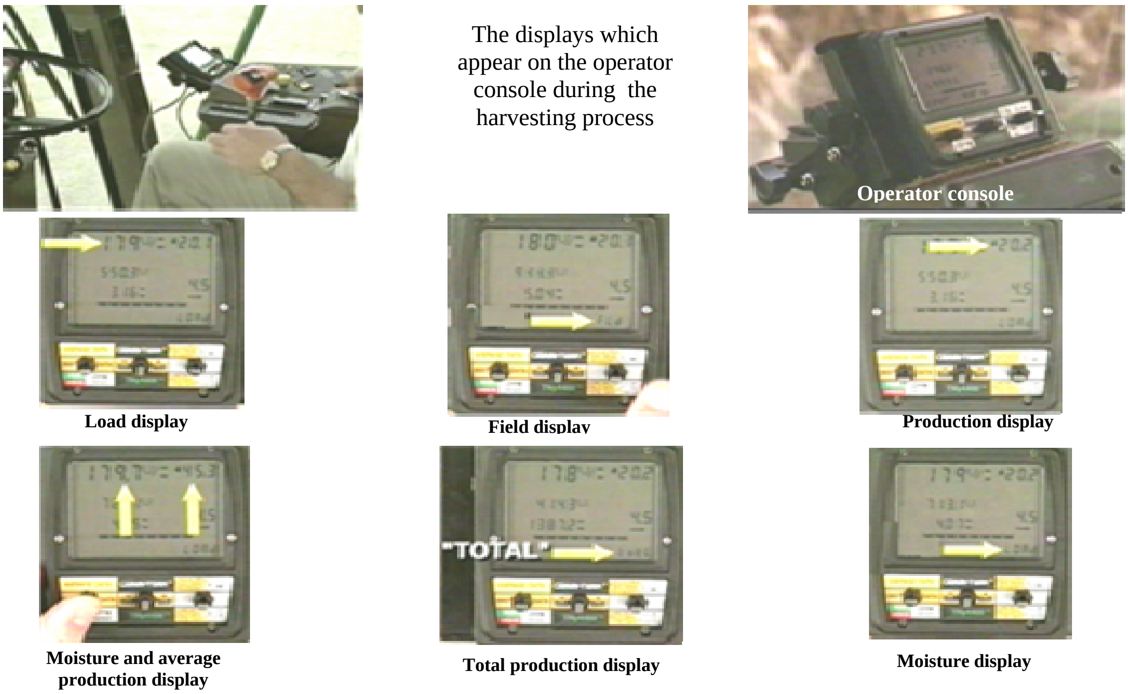

Fig. 3. Displays information on the operator console

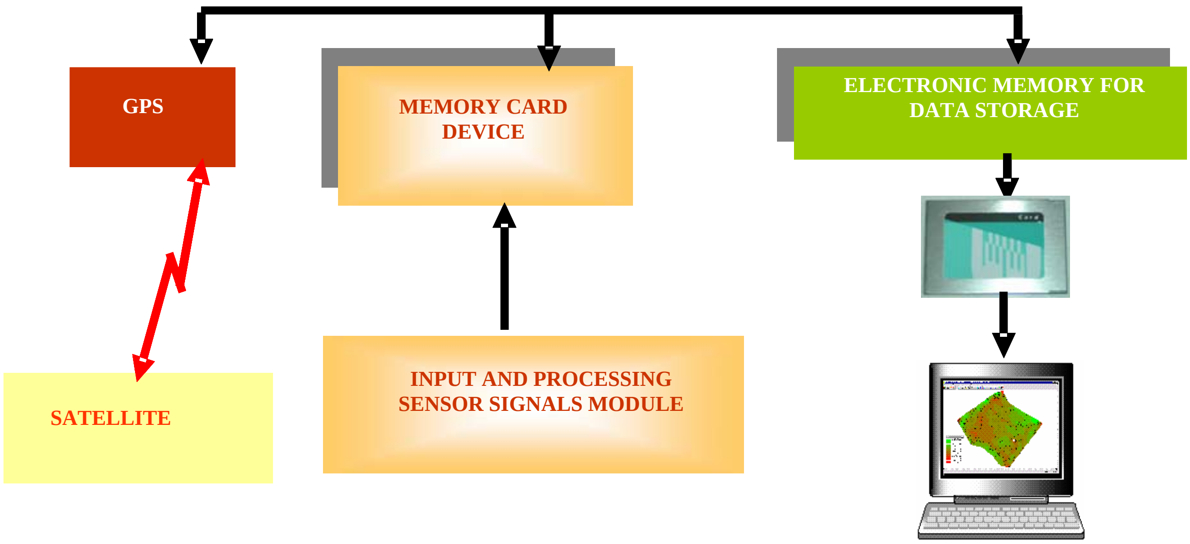

Fig. 4 Electronic data recording

3. EXPERIMENTAL RESULTS

The precision agriculture system was experimented around Otopeni city, near Bucharest, during the wheat harvesting season.

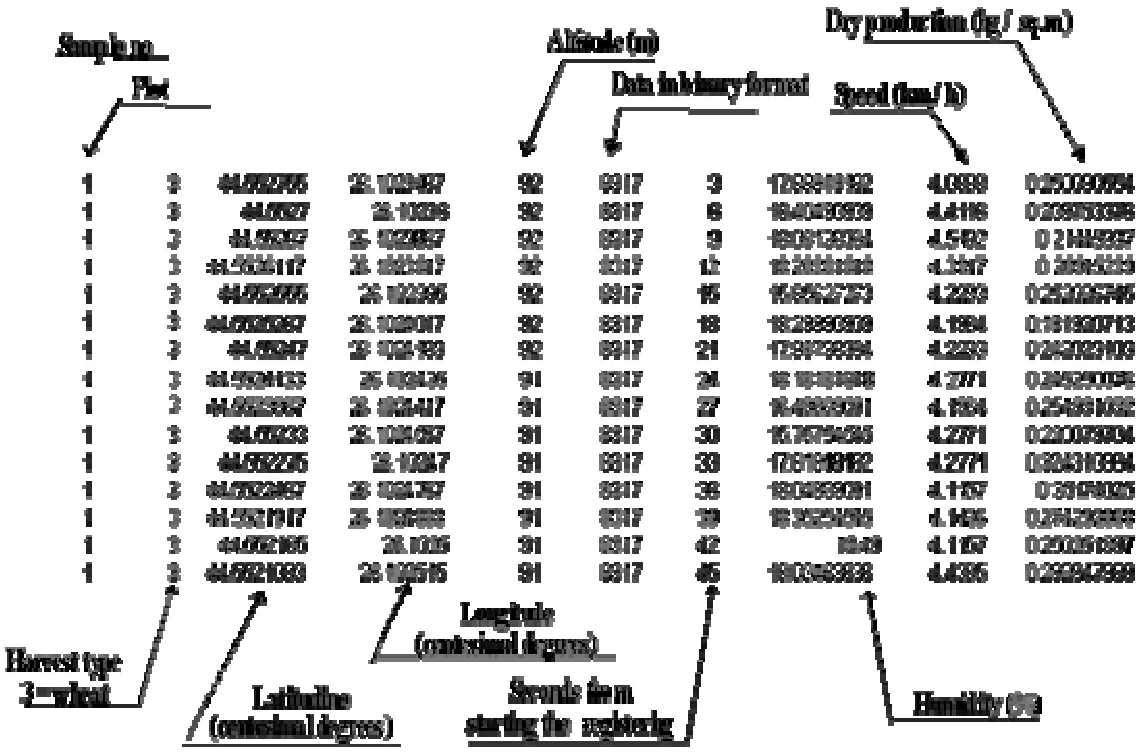

Fig. 5 Data files recorded on memory card

The structure of data file recorded on the memory card is shown in figure 5. An image of the experiment location is given in figure 6.

The proposed technology used the GRAIN-TRAK® equipments produced by MICRO-TRAK® SYSTEMS, MathCAD® Professional software, notebook computer and original programs.

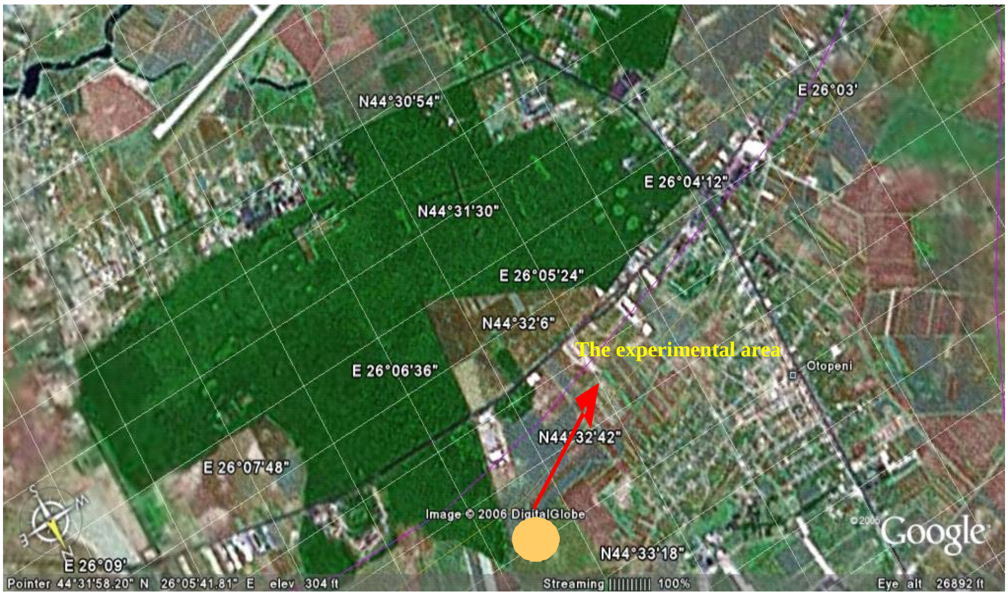

Fig. 6. Experimental area seen from satellite

The experiment no 1

Figure 7 presents the field structures. Figure 8 indicates the production map. Figure 9 presents the production map with clearly marked areas for local soil mending.

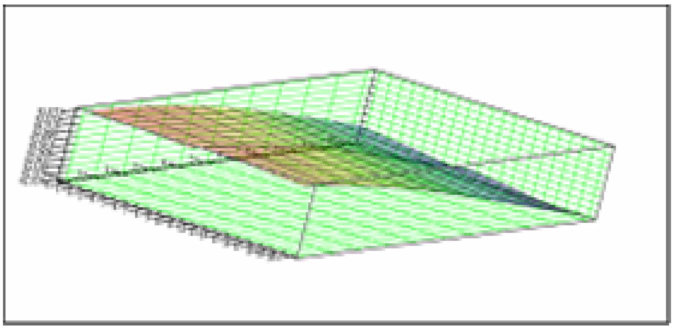

Fig. 7 The field structure

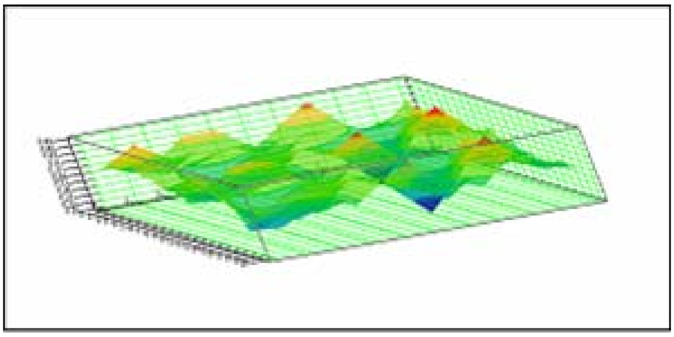

Fig. 8 The production map

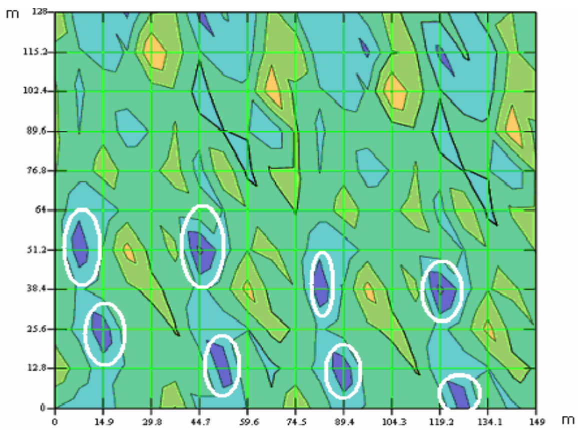

Fig. 9 The production map with marked areas for local mending

The experiment no 2

Figure 10 presents the field structures. Figure 11 presents the production map. Figure 12 presents the production map with areas for local mending clearly marked.

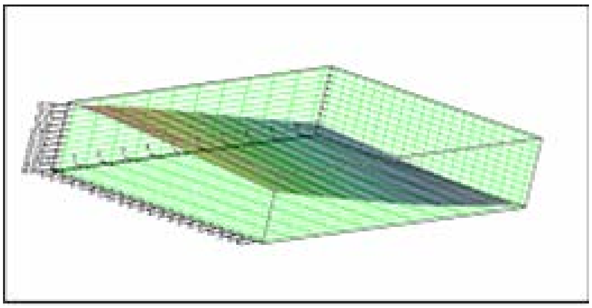

Fig. 10 The field structure

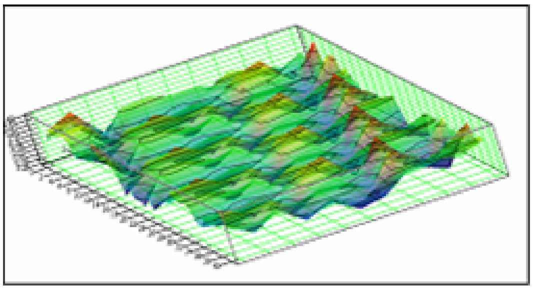

Fig. 11 The production map

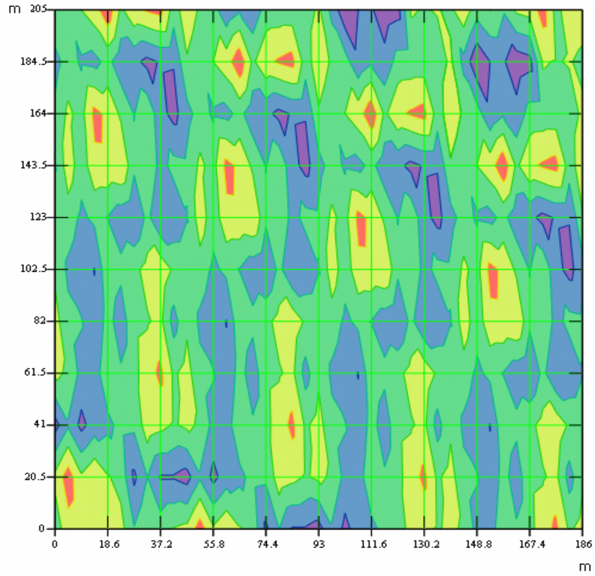

Fig. 12 The production map

4. CONCLUSIONS

1. The positive effects of the agriculture yields mapping consist in:
   - local meandering of agricultural surfaces which indicate zonal deficiencies;
   - economy of substances spread on the poor agricultural areas;
   - fuel economy;
   - turning the working process in a friendly agriculture environment;
   - optimization of the harvesting process in time and space.
2. The structure of the field and the shape of its surfaces allow the applying of the precision agriculture.
3. The structure of crops in Romania is directed to straw cereals and it allows application of precision agriculture.
4. The necessity of environment conservation by reducing the pollution is an important argument for promoting the precision agriculture.

The recent results of technical development of low cost GPS systems, geographic information systems (GIS) [Arcinfo, 2009], equipments and sensors which are needed to identify the state of the crops and soils show a growing awareness in agriculture and related sciences. The actual demand for modern crop management is dominated by the economic pressure and by the social request to increase the transparency of environmental impact of agricultural land [Vasiliu, 2007]. The enhancement of the decision processes in crop production by direct access to information becomes a very important accomplishment [Otter-Nacke, 2003]. The large scale application of the methodology presented in this paper is the right way for sustainable development.

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