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# COMPREHENSIVE HARDWARE AND SOFTWARE APPROACH TO DIGITALIZATION OF AGRICULTURAL INDUSTRY

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## ANNOTATION

This article discusses the need for digitalization of the agroindustry, the regulatory framework, the possibilities of GIS systems in relation to the creation of hardware and software systems for digitalization and the existing systems used in the effective management of the agricultural sector.

## INTRODUCTION

In the face of increasing competition in the agricultural market and rapidly changing consumer preferences, solving problems in the agro-industrial complex is possible through the transition to digital agriculture (precision farming, active use of digital technologies to increase labor productivity).

The political situation in recent years has proved more than ever that the agro-industrial complex is the most important sector of the national economy, providing food and, in part, the economic security of the country. But there is also a whole range of unsolved problems:

- First of all, this is an insufficient level of development of the raw material base (production sector), primarily due to the small-scale commodity level, which does not correspond to the course for an accelerated increase in production volumes due to the impossibility of using new technologies, in particular, based on elements of digitalization; low rates of modernization of the industry and renewal of fixed assets (this also applies to the production sector, and, what is even more difficult, this is backwardness in the processing industry, despite the fact that this is the area where it is possible to apply innovations, to obtain the most probable level of profitability of production) ; financial instability;
- Unsatisfactory level of development of the market infrastructure (which devalues the efforts of manufacturers); shortage of qualified personnel (due to the very low attractiveness of labor); low rates of reproduction of natural and ecological potential;
- Limited information support of the agro-industrial complex.

There are decrees of the President and the Government of the Republic of Uzbekistan for the regulatory framework for digitalization of the agro-industry:

-Decree of the President of the Republic Uzbekistan dated April 28, 2020 "On measures for the widespread introduction of the digital economy and electronic government" No. PP-4699;

-Decree of the Cabinet of Ministers on December 17, 2020 "On measures to develop the digitalization system in the agro-industrial complex and agriculture of the Republic of Uzbekistan" No. 794 [4].

## MATERIAL AND METHODS

The basis for the digitalization of the agro-industrial complex and the creation of information systems are geographic information systems (GIS), since they operate on data on fields with contour division, which are dynamically changing and require geolocation positioning to ensure timely updating.

We offer to consider software products of the most popular vector or raster GIS and Internet systems for the use of digitalization and the creation of information technologies in the field of agro-industrial complex.

Company ESRI a recognized leader in GIS, offers the ArcGIS family of software products. The ArcGIS platform is the optimal solution for building a corporate GIS, the foundation of an information system for effective management of large government and commercial organizations.

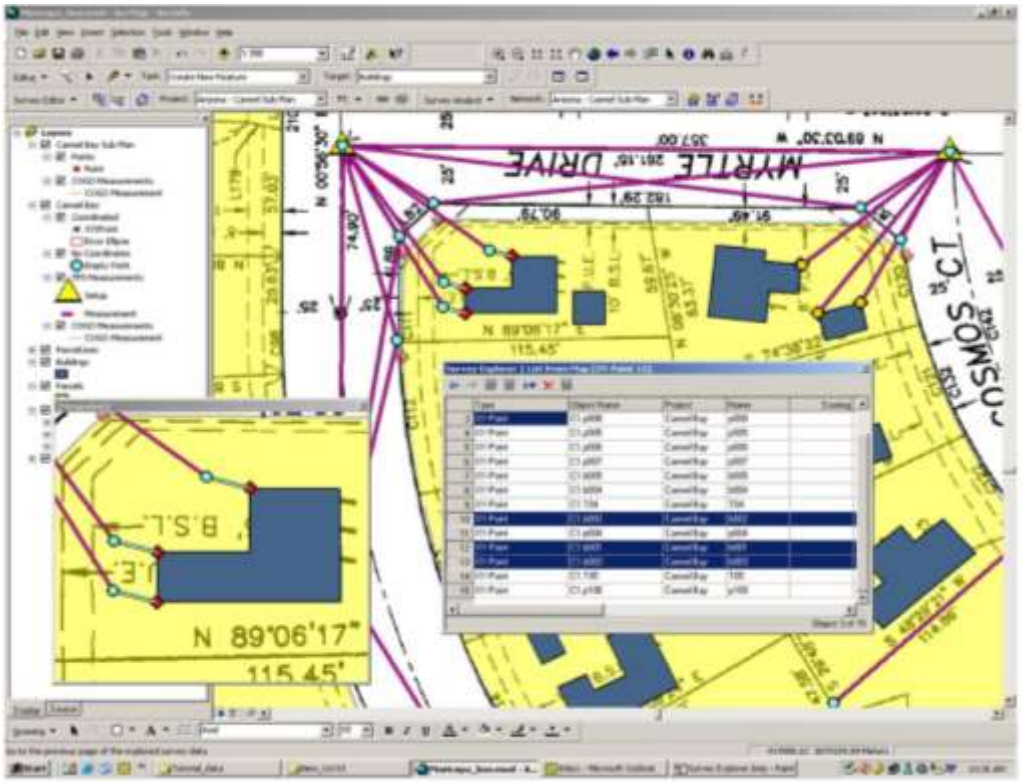


Fig 1. Appearance of GIS ArcGIS.

Universal GIS MapInfo Professional was developed by MapInfo Corp (USA). According to numerous estimates, it ranks second in the CIS in terms of prevalence. As a desktop GIS, this system is aimed at a wide range of users [1, 6].

The system has a wide range of functions for working with non-topological spatial data. The system uses tables to store data. A table is a relational database that stores both attribute and spatial data. Each such table can be represented as a map layer. In GIS MapInfo Professional several types of tables are supported: common vector, raster, external, temporary. To store data, you can also use databases (DB) managed by external database management systems (DBMS), for example, Oracle and Microsoft SQL server.

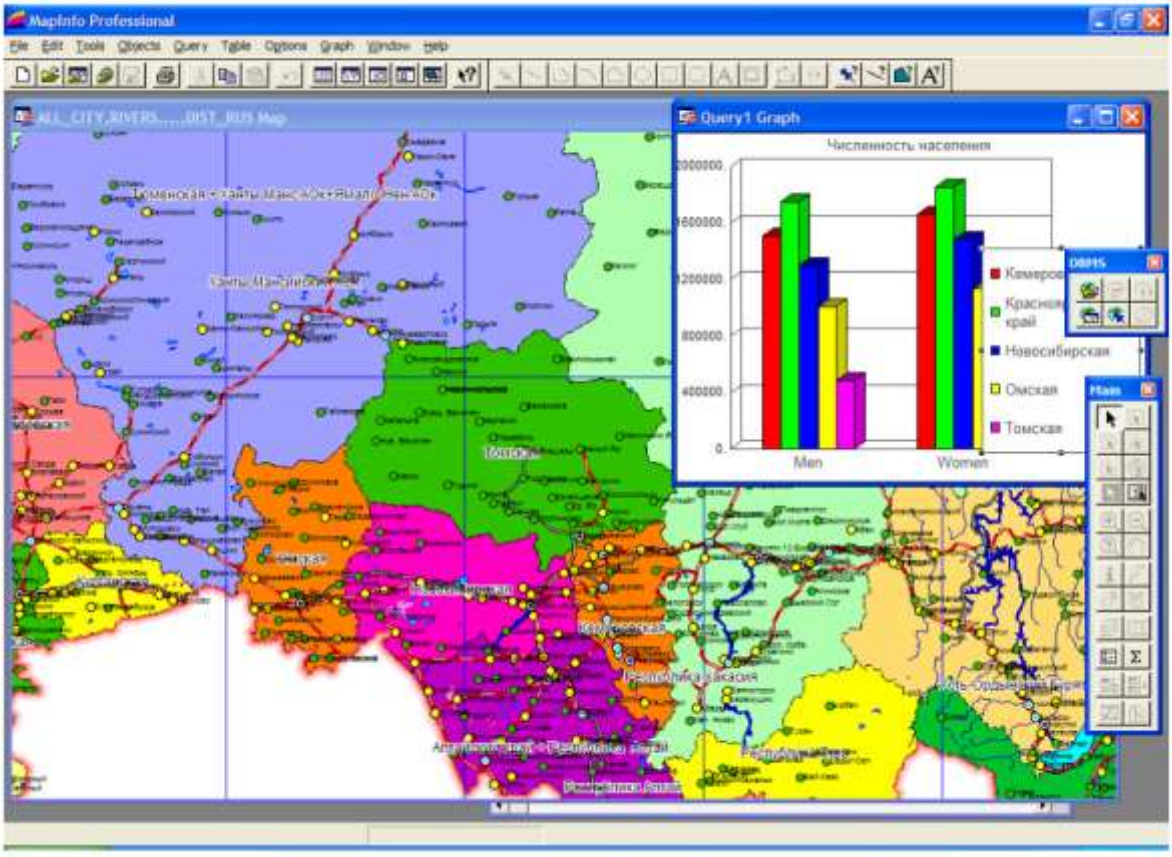


Fig 2. Visualization tools in GIS MapInfo Professional.

Raster GIS software of ERDAS Imagine is a complex of software products for processing Earth remote sensing data and working with spatial data. Today this system is the most widespread among raster GIS.

GIS ERDAS Imagine is used primarily for working with rasters obtained as a result of aerial and space imagery. The system is offered in three versions: Imagine Essentials, Imagine Advantage and Imagine Professional [1, 7].

Although this system is raster, it supports many models and vector data formats. According to the architectural principle of construction, this GIS is an open software system [2, 8].

Based on the use of GIS systems, information systems are being created for the digitalization of the agricultural sector. The analysis of the market of existing information systems used in the digitalization of the agro-industrial complex is mainly aimed at studying a specific narrow area of hardware and information systems operating at the moment.

## RESULTS

Cognitive Agro Control is a software and hardware complex that allows you to organize online exchange of basic data of the grain harvesting process, their transfer to the server of the harvest control center, as well as their accumulation for statistical analysis. For this, sensors and RFID tags are installed on the working elements of combines, trucks, grain shipping points (storage bins) in elevator.

The company of "CONCEPT" LLC (Russia) has developed a software module "Operational accounting on cattle farms" for "1C: Manufacturing Enterprise Management" based on "1C: Enterprise 8". Subsystems of the module allow solving tasks for:

- Quantitative and weight accounting of cattle;
- Management of herd reproduction;
- Accounting for milk yield and milk consumption;
- Analysis of herd health;
- Accounting of feed and animal feeding rations;

-Calculation of the salary of employees, taking into account the production indicators of the enterprise.

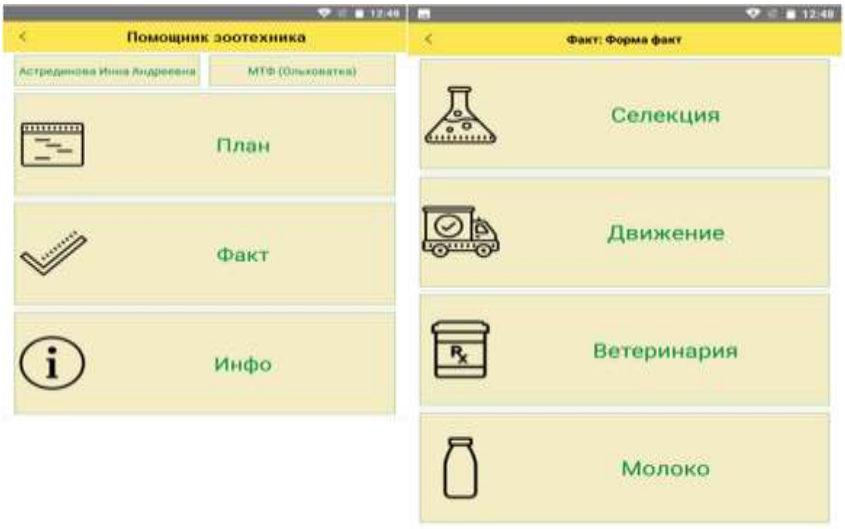


Fig 3. Software module "Operational accounting on cattle farms" for "1C.

Company of Planet technology is a radical improvement in remote field monitoring. “SkyScout” is a new method of obtaining information, making decisions and monitoring their implementation when growing crops. A single platform with services adapted to the tasks of different types of users.

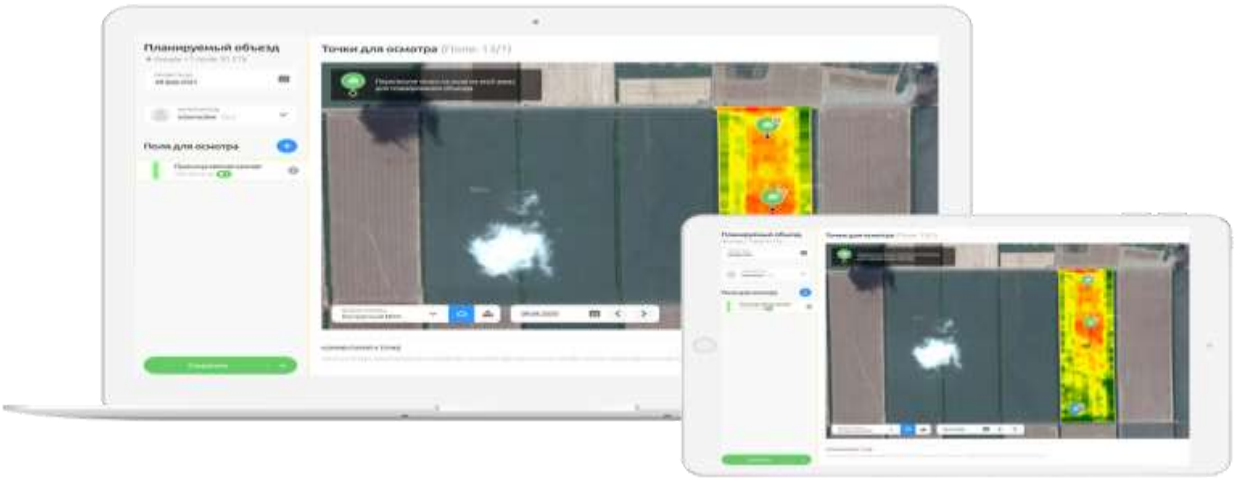

Fig 4. Products of the Interra company for digitalization of the agro-industry.

AQUASTAT - Global Information System for Water and Agriculture (https://www.fao.org). "Agroanalytics-IoT" helps to fully automate planning, control over the implementation and analysis of the results of field work, thereby providing up to 80% of the needs of a modern agricultural enterprise [4, 5].

## DISCUSSION

Based on the analysis, it can be concluded that many of these ready-made systems are aimed at digitalizing only a specific area of the agro-industry. For example, only scouting or only soil analysis or only field work, etc.

But for the conditions of Uzbekistan, there is a need to create a hardware and software system with a complex of digitalization spheres, because some companies are engaged in a complex (for example, growing and picking cotton, grain and other agricultural crops, scouting, soil analysis, field work, agro-notebook, etc.) works on agro-industry.

For this situation, the specialists of the agricultural cluster, together with their Russian colleagues, in accordance with the terms of reference, developed a hardware and software complex “agro.smart-map” for the digitalization of agricultural land, which is implemented in the agricultural sector of Bukhara Agrocluster LLC and includes individual components that ensure the solution of the following tasks :

-Preliminary assessment of the harvest, provides for an agroecological survey carried out directly in the fields by representatives of the farm, line agronomists, scooters, etc. using mobile transmitting devices (tablet, smartphone, etc.). The cloud service software analyzes the data obtained and forms the corresponding cartograms and tabular data, which give an objective idea of the state of crops and their vegetation.

-Monitoring and forecasting of yield is carried out by collecting data from satellite images, from sensors installed on the means of mechanization of farms. Spectral analysis of satellite images and their correct interpretation allows you to detect problem areas on the contours of the fields, assess the associated risks and promptly take corrective actions. Monitoring the readings of sensors of agricultural machinery allows you to tighten control over the implementation of quantitative and qualitative norms of mechanized work, thereby avoiding the risk of deterioration in the yield of grain, cotton or other crops.

- Detection of diseases, detection of pests or weeds, is carried out by means of agroecological examination and is aimed at the timely identification of problem areas and surgical intervention.

-Constant monitoring of the soil - texture, saturation with organic elements, the level of salinity and the degree of soil nutrition, provides for the implementation of an agrochemical survey in the fields, the introduction and updating of data, the formation of locally geo-positioned cartograms in the corresponding software modules of the cloud service.

-Farm management software platforms integrate with various hardware devices that are used in precision farming. Data from these devices are combined in a central console, where they can be conveniently processed and analyzed.

-Data platforms ("Field View", "Farmers Business Network" and others) provide an opportunity for the farmer to receive an individual centralized platform on which data from multiple sources of information are collected together to form a generalized picture of the state.

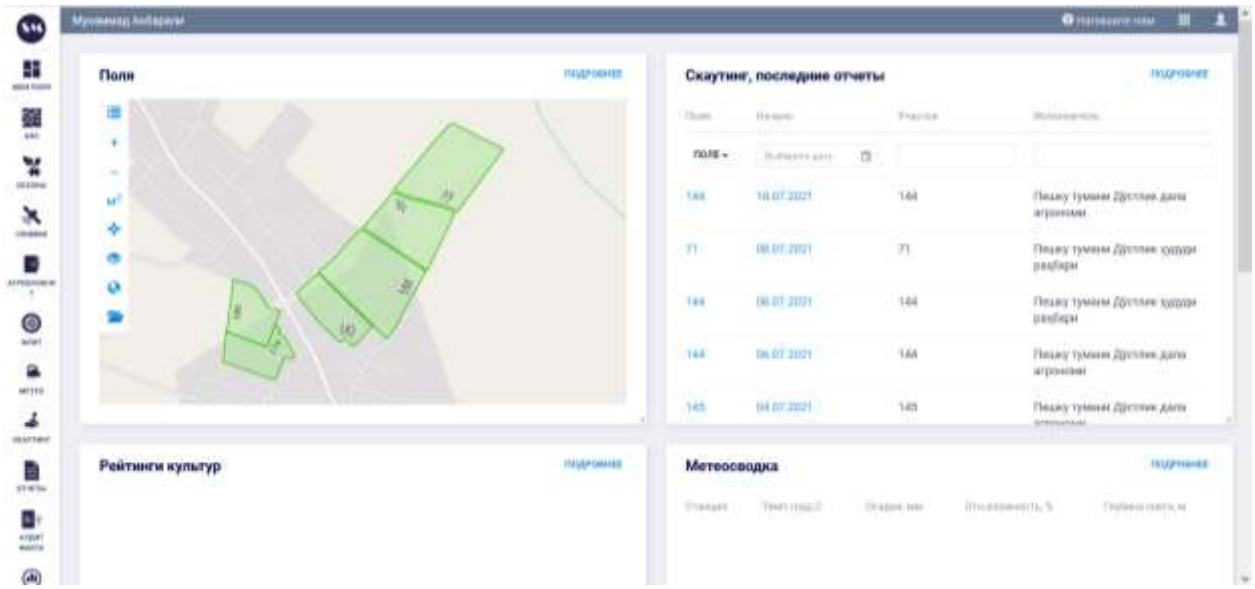


Fig 5. Interface of the agro.smart-map system

## CONCLUSION

In conclusion, the following can be noted.

At the moment, the market of software products is represented by a variety of GIS-based solutions that allow organizing the planning and monitoring of work in various areas of production activities of an agricultural enterprise. However, in order to implement measures for the comprehensive digitalization of the agricultural sector, ensuring effective and high-quality interaction of information systems included in the infrastructure of the analytical dispatching group (situation center), it seems appropriate to ensure the creation and further evolution of a specialized hardware and software platform, taking into account the specifics of production and organization of business processes.

## ACKNOWLEDGEMENT

В ПО agro.smart-map реализована схема цифрового дистанционного мониторинга сельскохозяйственных угодий, которая позволяет вести оперативный мониторинг состояния посевных площадей, планирование агротехнических мероприятий, контроль техники, работающей на полях, вести полевые журналы.

The agro.smart-map software implements a scheme for digital remote monitoring of agricultural land, which allows for online monitoring of the state of sown areas, planning agrotechnical measures, monitoring equipment operating in the fields, and keeping field in log files.

The purpose of the system is to generate primary accounting data based on the digitalization of the agricultural sector, automate accounting processes, and reduce the influence of the human factor.

As a result, when using automated systems, control over the sowing processes and vegetative growth of crops for each crop and areas, the implementation of agrotechnical measures is provided, monitoring of equipment, fertilization, and forecasting of yields is carried out.

The system allows in a single information space to form historical databases for each contour, for equipment, human and material resources, for monitoring equipment operation in the fields, for annual crop rotation, for multilayer maps (contours, satellite images, seasons, agrochemical analyzes, scouting), provides collection and generalization of information received from mobile devices, drones, GPS systems, as well as meteorological data from stationary, mobile and virtual weather stations[3].

As a result, detailed information about the previous and current state of fields and crops is generated.

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