Modelling the architecture of a planning system for agricultural enterprises

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Abstract

The current problem with the use of traditional agricultural information systems is that farmers eventually begin to use smart technology to implement production processes, which has an impact on the company's business processes. The information system begins to receive new data that needs to be processed, stored and analyzed. There is a need to review and modify existing software to solve new problems related to information data management and implementation of management and forecasting functions. It is advisable for agricultural enterprises to use planning information systems, the model of which will be based on data architecture, systems and technologies. This will help improve the quality of planning in agriculture. Modification in the architecture of agricultural enterprise information systems planning can as well positively influence efficiency of use of precise farming systems and smart technologies in the future.

The study substantiates the structure of the information system planning in agriculture and gives its description. The stages connected with improvement in modeling of architecture of the agricultural enterprise information system planning on the basis of possible scenarios of changes in system of data collecting and processing for further administrative decisions are offered.

Keywords

Planning information system, modelling, smart-technology, agricultural enterprises.

1. Introduction

Today effective management of an agricultural enterprise is directly related to the use of modern information systems and technologies. Managers of agricultural enterprises receive information from various sources, analyze it and make appropriate decisions in the management of existing business processes of the company. In the case of information systems planning, users seek not only to obtain reliable data and the results of their analysis, but also to understand the relationship between data, their impact on the system behaviour in the future.

In general, there are a number of problems in the development of systems planning and applications related to the integration of the planning subsystem with other systems used by the agricultural enterprise. There are some differences in the approaches to agricultural planning, which are typical for producers in different regions. Thus, some systems of agricultural enterprises planning are based on the processes associated with the functions of product quality assurance, analysis of its origin and traceability of food. Other systems planning can provide on the output data for forecasting and planning measures to reduce negative environmental impacts. The goal of such systems planning may be to focus on the efficient use and restoration of land, soil and water resources. Often such systems are integrated with higher-level systems in terms of business reporting and planning.

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Some farmers in the planning stages pay more attention to production and economic planning, expecting to reduce costs and losses in operations in the crop and livestock industries. The expected result of the systems planning in this case may be to increase the yield of agricultural products, monitoring and rapid response to climate change, diversification of production, crop rotation planning, and precision farming.

2. Analysis of published data and problem setting

Problems related to the development, implementation and use of information systems for agricultural enterprises planning have been studied in scientific articles by many scientists around the world [1-7, 14]. However, not all tasks related to the intensive use of innovative technologies for data collection and processing in agriculture, building systems planning on this basis, have been considered and displayed in scientific publications.

A review of scientific papers on this issue has shown that a lot of research is devoted to the architecture of information systems for agriculture, including among others systems planning [1,2,8,9]. Scientists use a variety of methods, models and approaches to planning, developing and development of recommendations for the effective use of information systems in agriculture. A lot of scientific research is devoted to the issue of information processing and the creation of hands-on knowledge in agriculture based on it [10-16]. Researchers are raising the issue of information management, which focuses on two interrelated processes: information management and changes in information flows.

The issue of automated management of agricultural planning processes in research is often revealed from the standpoint of using traditional approaches to the development of systems for automation of business operations, data collection and processing. At the same time, it is difficult to answer to what extent such systems are resistant to new challenges related to changes in agricultural business processes, technological level of data collection and processing, planning goals and objectives.

The use of modern technological solutions by the agricultural producer at any stage today or in the future will require changes in the planning module, based on possible scenarios for the development of agricultural enterprises. There will arise the need to implement an effective mechanism for data exchange between existing systems, to establish effective work between the subsystems of operational process management and the planning subsystem. This led to the expediency of substantiating the approach and mechanism of modeling the architecture of the agricultural enterprise system planning on the basis of possible scenarios or modifications of the existing information system.

3. The purpose and objectives of the study

The goal of the study is to model the architecture of the information system planning in agriculture, resistant to changes in the system of data collection and processing, and the implementation of new approaches to solving management problems. To achieve this goal it is necessary to solve the following tasks:

- to substantiate the structure of the information system planning in agriculture, based on the characteristics of the subject area and planning in terms of changes in information data flows;
- to improve the process of modeling the architecture of the information system of agricultural enterprise planning on the basis of possible scenarios of enterprise development, changes in the system of data collection and processing for management decisions.

4. Substantiation of the structure of the information system planning in agriculture

The information system architecture for agriculture may include data processing architectures, business process support modules, and application architectures (Figure 1). In practice, more agricultural companies already use information systems in planning based on data collected and

received from motion sensors in the field [10], so these features of data handling should be consistent and taken into account as components (subsystems) of the system. At the same time, the value of precision farming technologies is growing [13]. The integration of data collection processes using new technologies and complexes, intelligent data processing systems and management decisions will have a positive impact on the efficiency of the information system planning.

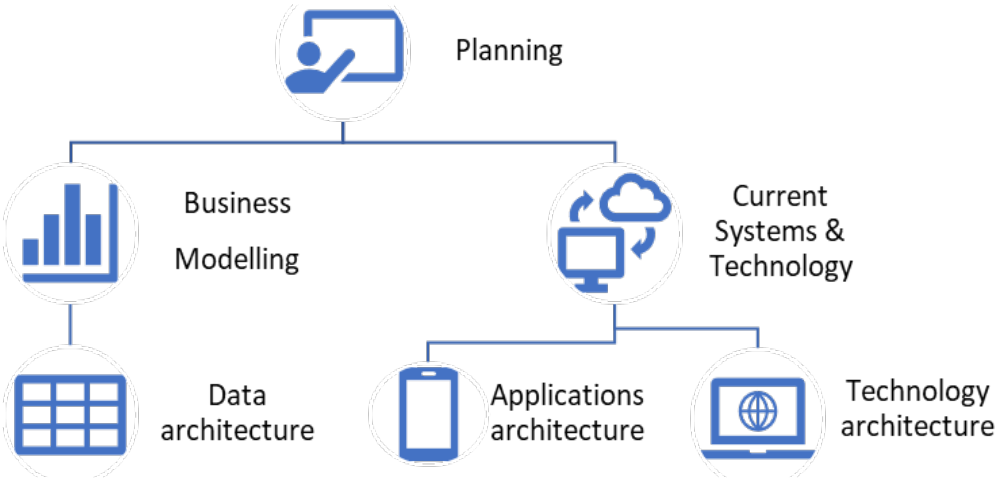

Figure 1: Architecture of an agricultural enterprises planning system

Predicting the emergence of new system features related to data transmission and technical network development is one of the tasks of developing a software architecture model and reducing potential problems.

The core of the agricultural enterprise system planning (Figure 2) is software that contains information on existing production structures and units (fields, crops, farms), resources (land, human resources, fixed assets, agricultural machinery) and business processes in agriculture.

The use of modern technology with built-in data processing and transmission systems (from large tractors to small sensors) will allow operational control over production processes and monitor changes in climatic conditions, crop conditions, integrating these data into a single information system.

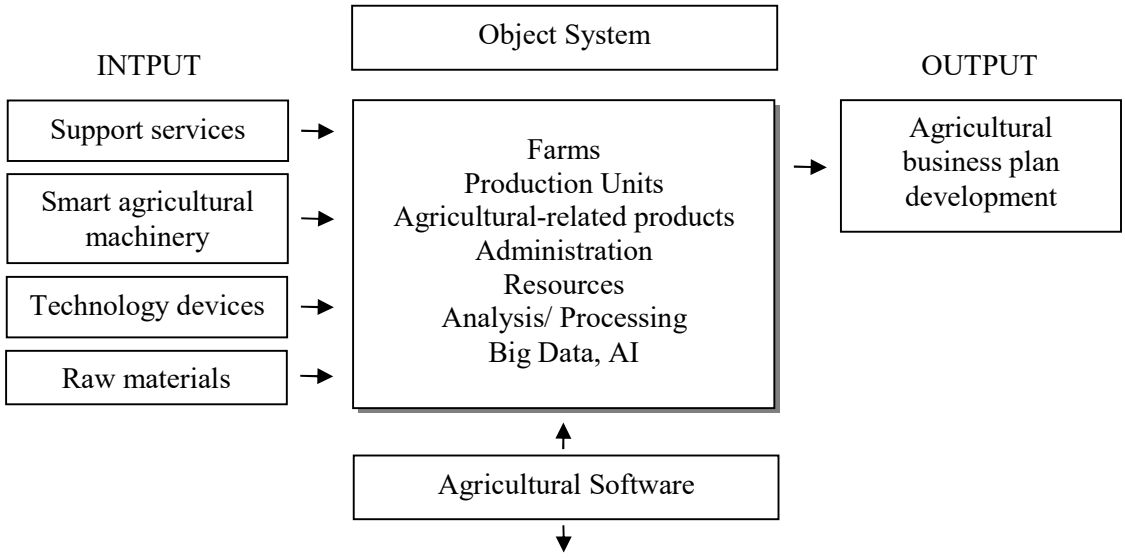

Figure 2: Software components of an agricultural enterprises planning system

Planning software is included and integrated into the Farm Enterprise facility system. The use of common software components and software to support production processes in combination with software applications will ensure the exchange of data and their further analysis.

5. The result of improving the process of modeling the architecture of the information system planning in agriculture

The study found that the use of smart technologies in agriculture as a source of new data in the agricultural industry can lead to new components of information systems and systems planning (Figure 3). These include modules related to data processing in crop production: land accounting, visual analysis of field location, satellite imagery processing, field surveys using mobile applications, results of GPS-monitoring equipment, GIS-technologies and cartograms, meteorological observation, and development of technological maps.

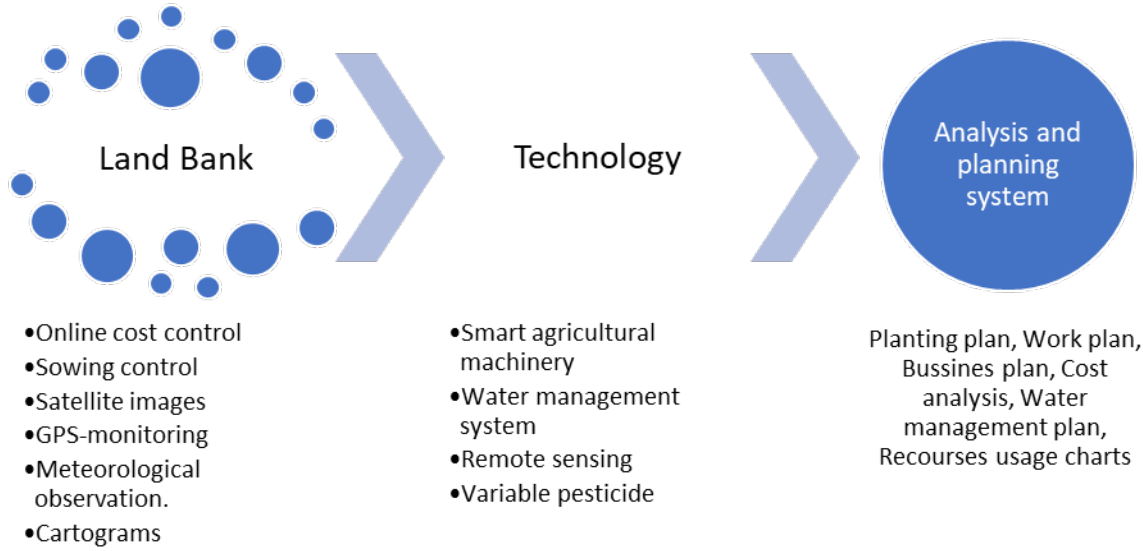

Figure 3: Smart technologies as components of a planning system for agricultural enterprises

Automation of accounting and planning of efficient use of land for the implementation of precision farming may include:

- creation of an electronic field map based on satellite images with appropriate changes to the system interface;
- development of a mobile application for measuring the real area of the land plot by entering the obtained data into the system, incl. using drones;
- auditing land plots (own and leased);
- monitoring the status of land lease agreements;
- monitoring the condition of crops and estimating the vegetation index on the basis of data obtained from satellite images or using drones;
- identification of problematic land plots, food shortages, rating and comparison of fields;
- determining the properties of soils at any point in the field and entering this data into the subsystems related to analysis and planning;
- formation of crop maps with the possibility of monitoring and planning the optimal plant nutrition system, plant protection products, their watering, etc.;
- yield planning by creating maps with layers of soil properties, sowing of crops, condition of crops, application of fertilizers and plant protection products.

Livestock planning can be based on business processes related to the accounting of livestock via maintaining electronic animal cards. This will allow to analyze the structure of the herd by age and sex groups, determine the optimal composition of livestock in order to increase farm productivity. The

development of a subsystem related to the planning of zootechnical activities will help not only to determine the dates of their implementation by keeping an electronic journal, but also automatically receive a daily report on their implementation or a message on a mobile phone with reminders of planned activities. The subsystem of rations can contain feeding standards, and calculate the individual diet of animals, based on the available feed base of the agricultural enterprise.

The main result of the planning subsystem in livestock farming will be a report on the expected timing and growth of livestock production, detection of unproductive animals, and control over the introduction of reliable data by farm workers.

Achieving the goals of agricultural planning through the integration and improvement of existing information systems can contribute to the development of smart agriculture, labour and cost savings based on the use of modern technology and precision agriculture based on data.

Modeling the architecture of the agricultural enterprise system planning on the basis of possible scenarios of enterprise development, changes in the system of data collection and processing for management decisions and/or modification of the existing information system will involve the following steps:

1. Assessing the current state and determination of a set of scenarios taking into account the transformation of business processes of agricultural enterprises in the short and medium term.
2. Defining the architecture of the software used by the agricultural enterprise at the moment.
3. Assessing the compliance of the software architecture in accordance with possible scenarios, the ability to make changes so that the script can be executed.
4. Identifying the necessary changes in the architecture of agricultural enterprise planning software (introduction of new components, review of existing relationships, etc.) and the elimination of problems and "bottlenecks".
5. Assessing the modelled architecture of the software of planning of the agricultural enterprise.

Development of an efficient and high-quality software architecture, taking into account all possible scenarios, including real-time data processing, will allow effective management decisions to be made in agriculture.

6. Conclusions

The information systems currently used for agricultural planning are numerous and have a variety of characteristics. Information systems with agricultural planning functions are often widely used with the traditional approach of collecting and processing input data.

Our rationale for the structure of the information system includes components related to business modelling, data architecture, application architecture and technology. The core of the system planning can be software that will contain information about existing production structures, units, products, resources, business processes in agriculture, technologies for collecting, analyzing and processing data.

The question of the influence of smart technologies as a source of new data in agriculture on the functioning of the information system planning as a whole is considered. To accelerate the quality and efficiency of planning in agriculture, it is proposed to consider possible scenarios of changes in the system of data collection and processing for management decisions in modeling the architecture of the agricultural enterprise system planning. It is expected that the efficiency and sustainability of the information system planning in agriculture will be reduced without taking into account the forecast of business process transformation based on the use of smart technologies in the short and medium term. The untimeliness of determining the necessary changes in the software architecture of the agricultural enterprise may lead to incomplete or inaccurate data, on the basis of which management decisions will be made.

The findings of this study will be useful to the scientific community in understanding the mechanisms for improving the efficiency of modeling the architecture of agricultural enterprise information system planning. The study considered possible scenarios for the transformation of information systems planning, as well as prospects for the use of smart technologies as sources of data for management decisions.

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