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DECISION SUPPORT MODULE FOR AUTOMATED CONTROL SYSTEM IN CROP AND PROSPECTS OF ITS USE IN E-EXTENSION SYSTEM

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We consider the concept and architecture of a Decision Making Support subsystem as a component of management information system in the crop in the context of the implementation into e-Xtension system in Ukraine.

***System, decision support, crop, e-Xtension.**.*

Plant is one of the most significant and intensive in material and commodity relations among agro-based industries Ukraine and important for the supply of raw materials for other industries (farming, processing, etc.).

The main areas of innovation in this area is the introduction of precision agriculture [2-3, 11, 14], automated control systems (ACS) in agricultural enterprise [1, 7] and decision support systems (DSS), including the use of artificial intelligence [5, 9]. Currently, there are a number of solutions for automated management with specialization by sector management, including for agriculture, some of them using geographic information (GIS) technology is presented in the table.

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ACS in plant with using GIS technology

Company	Main software	Software for farms	Server decisions	Integration with ERP systems	Addition features
Design Bureau JSC "Panorama"	GIS "Map 2008" (network extension GIS Server 2008)	GIS "Panorama AGRO" 2.4	GIS WebService (version 1.2) GIS Server 2008	For accounting, except share data with existing information-analytical system "Agro Holding", the system of data exchange with the software "1C: Management of agricultural Enterprise"	• A set of cards for the system "Panorama AGRO" (version 2.4) • Databases for "Panorama AGRO" (version 2.4)
"Institute of Modern Agricultural Technologies"	"Agro-Clever"	"Agro-Clever"	–	"Agro-Clever" can be combined with arbitrary system of the customer (eg, accounting) through technology integration	–
Enterprise "Krivbass-akadem-invest"	GIS "K-MINE"	"AgroMINE" (research development)	The network version of the configuration-tion on any latformi and OS	Integrated accounting and management module	Centralized scientific support of NULES of Ukraine, centralized updating of Referenced and process output data

Integrated information systems in plant providing data processing and remote monitoring satellite images, agrochemical research. For agricultural producers in most cases these systems are available as from a financial point of view and because of the lack of specialists able to work with such systems. For these producers more optimal approach is calculated using information services in conjunction with remote subsystems counseling, training and communications, where the system itself is located on a centralized server that serves a combination of such manufacturers. It is such an e-Xtension, created in Ukraine [8, 12]. It has become a feature of the implementation of the settlement and intelligent modules that implement peer functionality.

The use of intelligent modules reduces the development and introduction of new methods of farming and of agrotechnological operations. Placing business logic applications on a centralized server protects against errors of mass remote-update installed systems and provides the flexibility to expand functionality. Most ACS in crop-oriented support account resources, planning and reporting of supporting modules geospatial data and technology for precision farming. Complex systems and services of intelligent and GIS modules and centralized remote access at present largely absent.

The **purpose of research** is development of intelligent decision support module for the integrated Management Information System in crop and its introduction in the e-Xtension.

Materials and methods of research. Creating a system based on the use of accepted standards of design and software development (ISO / IEC 15288: 2005 "Information Technology. System life cycle processes", GOST 3149-95 "System standards database. Language SQL database integrity with the extension" ISO 4302: 2004 "Information Technology. Guidelines for documentation of Computer programs", ISO / IEC 12119-2003 "Information Technology. packages. Testing and quality requirements," ISO / IEC 14764-2002 "Information Technology. maintenance of software security ", etc.). To organize the data and knowledge available ontological approach.

Results of research. Technology support solutions, unlike traditional technologies of the report is not executed fully automatically as done running man. When using DSS processes of formation and use are not separated.

Mainly structured intermediate solutions is consistent with the specific crop, which is characterized by a significant dependence on natural factors and weather indicators are still not amenable to accurate prediction. Thus, the dynamic in different time sections are:

Purpose and limits of land;

- fertility, structure and properties of soils;
- irrigation / water balance;
- the possibility of machinery and equipment;
- weather and climate conditions;
- the economic environment, market conditions;
- the human factor;
- industrial impacts, environmental and so on.

Traditional DSS architecture involves the interaction of database management and database models related to interactivity and standardized output [5] (Fig. 1).

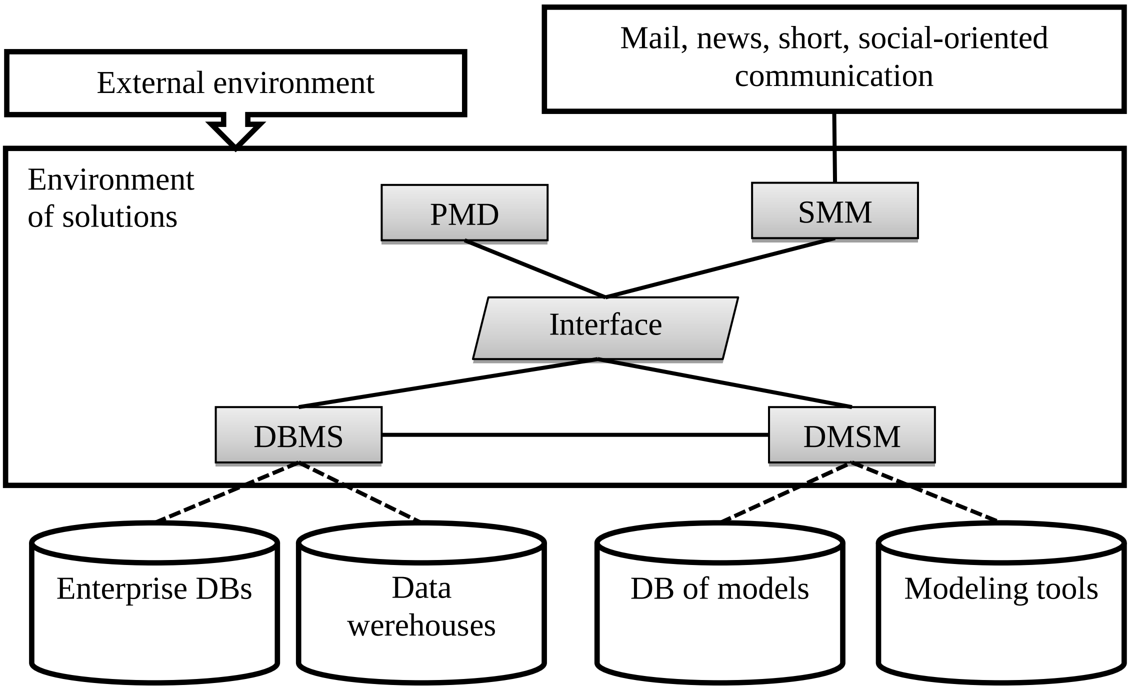

Fig. 1. Main components of modern DSS:

DBMS – database management system; DMSM – database management system models; PMD – a person who makes decisions; SMM – system of messages management

At this time, there are a number of developments analogous to support decision-making related to the subject area of crop. For example, setting the required quantity of fertilizers can be calculated based on the results of field experiments, using standard calculations (nitrogen, phosphorus, potassium) for a given geographic area, soil type and the specified culture.

Despite the high cost of funds and time, methods of establishing norms of fertilizers on the results of field experiments are inaccurate. First, in determining the optimal norms and ratios of fertilizer experiments lay with many options; thus inevitably heterogeneity of soil fertility. Secondly, the amendment coefficients are common because they experimentally proved completely. Thirdly, due to the constant plant varieties, introduction of new technologies and the introduction of new forms of fertilizer field experiment development is slower than production, so the recommendations quickly become obsolete and are only indicative. Some errors arise when planning yields from fertilizer use, because the method does not point unequivocally to a specific value or increase crop yields.

Here is an example calculation rules fertilizer reserves of nutrients in the soil. The essence of this method is that the rate of fertilizer is determined by the difference between the removal of nutrients from the planned yield and their margin in the plow layer soil. At the same time take into account the coefficients of nutrients from soil and fertilizer:

$$N = \frac{V \cdot U - C \cdot d \cdot h \cdot K_g}{K_d},$$

where N – the rate of nutrient you need to make to obtain the planned yield, kg / ha; B – Economic nutrient removal 1 ton yield, kg; Y – yield, t/ha; C – the nutrient content in soil, mg/100 g; d – density taking the soil, g/cm^3; h – the thickness of the soil layer, cm; K_g, K_d – corresponding coefficients using crop culture nutrients from the soil and fertilizers, share unit.

There are quite a few methods. Some of them are implemented in the system "Argomine", which was created jointly by the National University of Life and Environmental Sciences of Ukraine and the "KRYVBASACADEMINVEST" company The software package includes a separate power calculation needs fertilizer (Fig. 2).

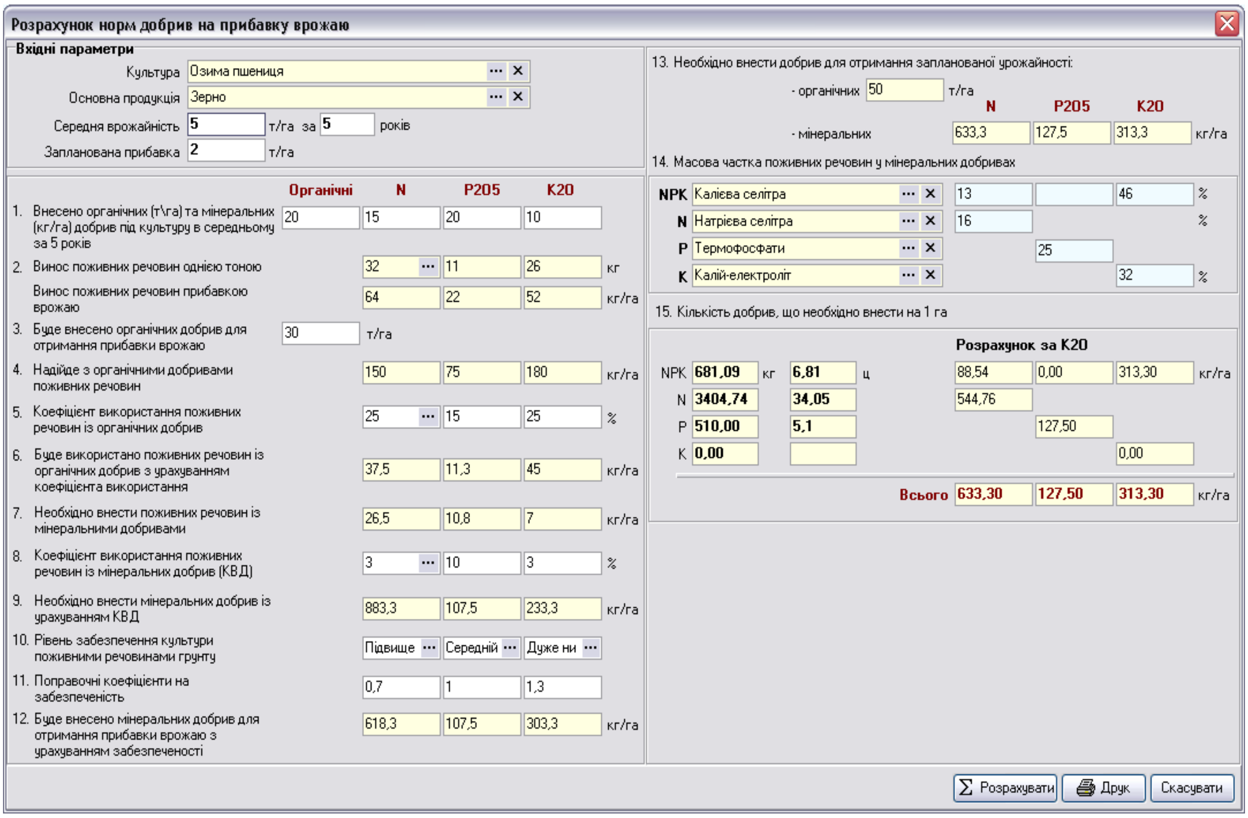

Fig.2. Calculation of norms of fertilizers to increase yield in the system "Agromine"

In general, this system has the following computational modules:

- calculation rules fertilizers on the yield on the planned supply of nutrients in the soil;
- calculation rules fertilizers to increase crop;
- defining standards of fertilizers on the yield of the intended use of norms balance of nutrients for crop rotation;
- assess whether harvest crops through soil Payback's creditworthiness;
- calculation of the balance of humus;
- calculation of nitrogen fixing legume crops;
- calculation yields the flow potential;
- establishing qualitative assessment of soil;
- calculation needs for material and financial resources, etc.

All calculations are based on reference based on categories of objects subject area (Fig. 3) and the set of algorithms developed based on known techniques.

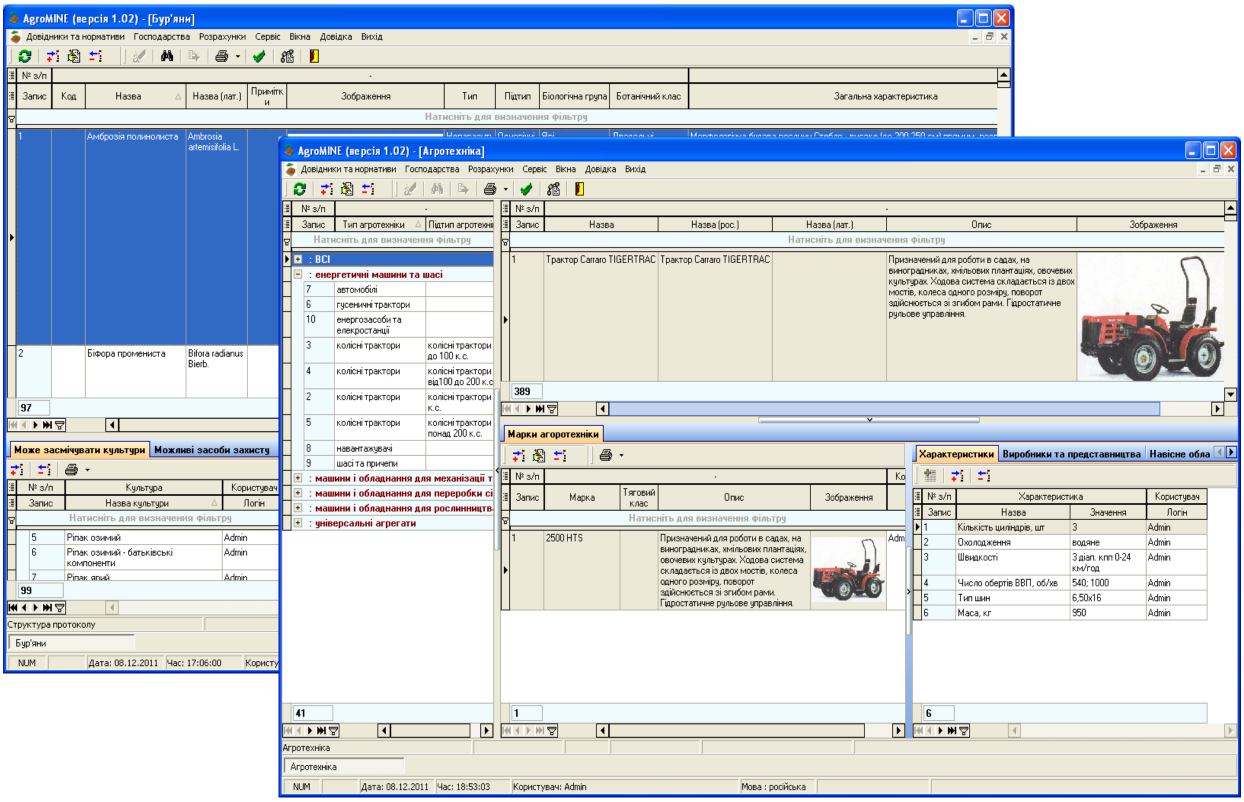

Fig. 3. Fragment of reference base system "Agromine"

Although the development of computational modules for decision support in the areas:

- optimization of enterprise resources (financial resources, land, machinery, fertilizers, plant protection, seeds, etc.);
- planning purchases and sales;
- placement of production facilities, warehouses, sales outlets, logistics.
- product quality assurance;
- preservation and enhancement of the natural potential of land.

Calculations and recommendation shall be in accordance with the time parameters (operational in the medium and long term). So when it comes to implementation agrotechnological operations in accordance with the standards of precision farming, the decision must be produced in real time.

With the implementation of each intelligent system (or subsystem) and one of the most important tasks is to organize most intensive data also determines all the business logic. Navigation is an integral part of the system involves the use of geospatial data and technologies for precision farming. The integration of geospatial, analytical and expert in system module requires a single approach to data and knowledge. Among the well-known and promising approaches such an important place ontological [4, 10].

It is known that ontology O as a formal description of some domain, regardless of its true nature can be represented as:

$$O = \langle X,R,F \rangle,$$

where X – finite set of concepts (terms, concepts, knowledge quanta) of a given domain, while $X \neq \varnothing$; R – final set of relationships between concepts; F – set of functions interpretation given to concepts or ways.

Scheme of interaction of these sets and functioning database built using the ontological approach is shown in Fig. 4.

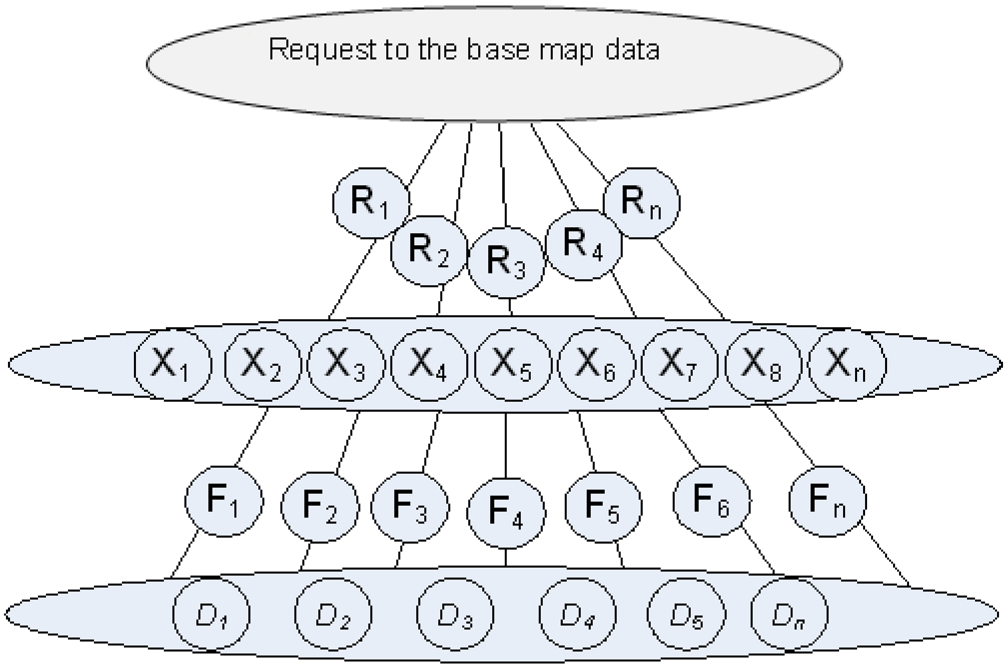

Fig. 4 Scheme of queries to ontological approach

Set of concepts of domain is grouped as a subset:

$$X = \{X_1, X_2 \cdots, X_q,\} \quad q = 1, 2, \ldots, \quad Q$$

by genus-species and other characteristics.

Suppose there is a set of objects that are allocated as part of an image in terms of information content, the nature of the processing and visualization:

$$X = \{x_i / i \in I\}$$

where I – set of indexes i of objects. Thus each element of the set is described as some tuple:

$$x_i = \langle d_{i_1}, d_{i_2}, \ldots, d_{i_n} \rangle; \quad d_{i_1} \in D_{om}(A_{i_1}); \quad d_{i_2} \in D_{om}(A_{i_2}); \ldots; \quad d_{i_n} \in D_{om}(A_{i_n})$$

where d_{i_n} – n-th element tuple whose value describes the i-th copy of the set of objects X; A_{i_n} – attribute name corresponding to the n-th element of the tuple; $D_{om}(A_{i_n})$ – range of values of attribute name A_{in}.

Links and distribution of classes of objects in the set of graphical and thematic spatial data and consider the set of ontological relations between concepts X.

Infological map data model ontology-based differentiation is presented based on the description of objects can imagine infological design process of composition results in a design of individual subdomains. In this case, the design process base map data is a set of sub-processes design optimization for each data model, defined as dedicated subdomain. The optimal solution is sought based on local optimization, leading to better quality of base map data. Her infological model comprises three models cartography: thematic, spatial and graphical.

Decision support in e-Xtension. The purpose of constructing the e-Xtension in Ukraine is to create a scientific advisory system for secured information support activities involved in agricultural production and rural development. The target user groups EDS are: farmers and other participants in the agricultural production, research and educational institutions, teachers, researchers, students, consultants, public and private extension services, agricultural associations, local government, rural and other. Ukrainian model system has several features that are not included in other similar systems:

- multi-Web-access to information and information services (Fig. 5);
- availability of reference databases and knowledge bases;
- module geospatial data (land each user and consolidated);
- subsystem online counseling;
- means of thematic communities;
- structured means of communication between users;
- availability of the subsystem e-learning;
- availability calculation modules for decision support.

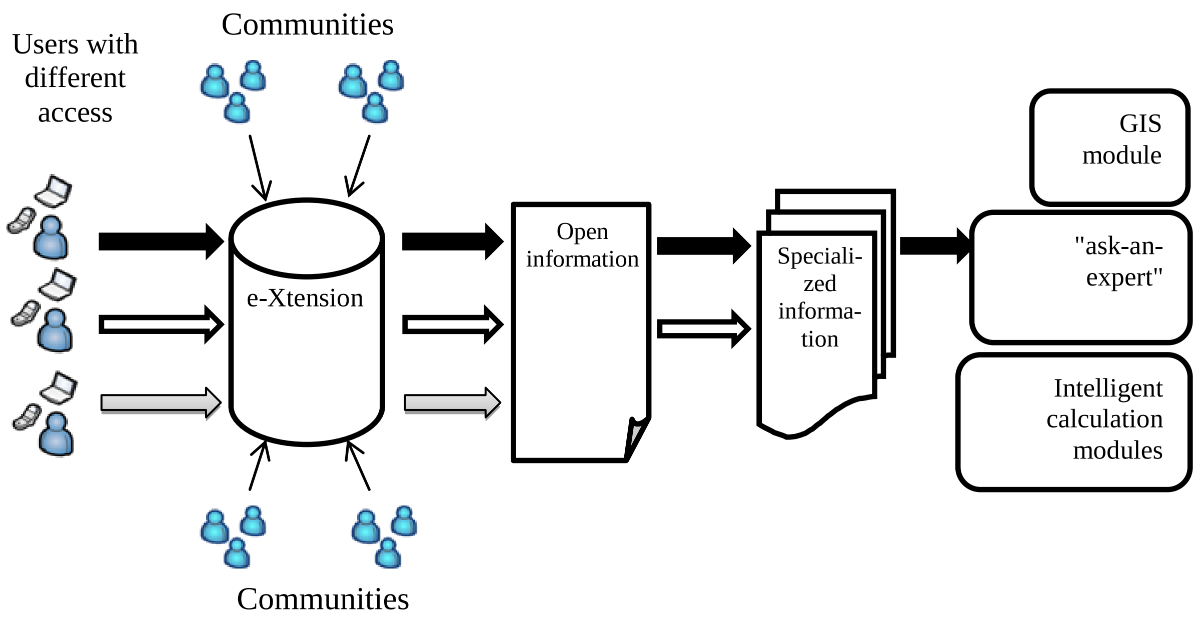

Fig. 5 Business Design SED

The main functions of the module geospatial data is to work with vector maps for various purposes, processing and overlay bitmap images, the use of GPS-navigation devices, building maps for differentiated tillage, etc. [6]. For the purposes of precision farming promising is the use of cartographic data bases and real-time methods of dynamic scenarios with moving objects involved in agricultural production, which is reflected in [13].

Conclusions

Development and implementation of intelligent systems in agricultural production is one of the most popular trends of the IT industry, which is important for Ukraine, which has both a large agro-industrial and IT capabilities.

The approaches developed software modules and decision support systems in crop, along with geospatial and navigation part, can realize the full range of information services in mentions from accounting and monitoring of resources to the production of expert advice when making decisions. Subsequent research will focus on developing intellectual decision support subsystem, navigation unit and introduction of e-Xtension.

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