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INTELLIGENT SYSTEMS AND SUPPORT A DECISION ON THE ORGANIZATION OF GROWING, HARVESTING AND CONVERSION IN BIOMETHANE ENERGY CROPS

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The proposed structure of the knowledge base of intellectual support systems and decision-making on the organization of cultivation, harvesting and processing of biomass into biomethane, the basic task of optimal planning of sowing, harvesting and conversion into biogas energy crops and other organic waste.

Key words: intelligent system of support and decision-making, organic materials, biogas, energy crops, biomethane.

As is known, renewable energy sources (RES) dynamically and consistently increasing. One of the important sectors of renewable energy in the world - is the production and use of biogas energy [1]. A national important task for Ukraine is to increase the production of biomethane and its input to the transmission system for "green tariff". To feed biomethane into gas pipelines in Western countries are already using the technology, through which ensured the separation of CO2 from biogas and biomethane getting content to 95 - 98%. In the domestic market the technology with a great future that at any point of Ukraine is a gas distribution network to which you can connect. It is planned to produce biomethane use not only various waste from large farms, but growing, collection and processing of biogas energy crops Accessibility (EC) farmland. One of the directions of solving this problem is the widespread use of information technologies by which should be made of existing monitoring and forecasting the prospective base of organic raw materials (OS) for its processing into biogas complexes (BGK) to obtain the maximum amount of biomethane.

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The results of the analysis of scientific papers [3, 2, 6, 9, 10] show that at present not fully considered the development and application of intelligent systems and decision support (DSS).

The purpose of research - the study of intellectual knowledge base structure of DSS on the organization planning the cultivation, harvesting and processing of biomass into biomethane.

Materials and methods of research. One of the most important tasks is solved by an intelligent DSS, is the placement of various crops energy crops in designated areas considering the geophysical characteristics of each culture.

The best result, in terms of output biomethane, provide substrates with a high concentration of energy, fresh grass, foliage beet, corn, cereal plants. The lowest yield of biogas from organic substrate is dry straw. [12] Extraction of biogas from it can increase the application of chemical agents, including straw processing solution Ca (OH) 2 combined with extrusion [11].

Today silage maize is an important crop for use in biogas plants. Technology necessary for collection and transportation of the crop is generally always available in the workplace. Corn sylosuyetsya easy to clean and even use does not cause disturbances in the process of biogas plants. Today already there are special varieties of maize for use in biogas plants. The best time to harvest is his willingness silage and getting the maximum amount of biomethane. Typically, corn while collecting should have a dry matter content of 28-35% and in a state between milk ripeness and suitability for flour. In favorable areas for growing PC from different varieties can be sown area of more than 8000 m3 of methane from biomass grown 1 hectare [12]. For this purpose it is necessary to carry out using DSS: choice of varieties and the sequence of their growing during the year with a high yield of each class of organic dry mass of 1 ha; selection of the best compatibility nutrients in their mixing; optimization of the constituents, based on the maximum potential methane among different cultures (eg by improving fat content through the integration of oil crops). In addition, DSS must take into account conditions such as agrometeorological. At the same time ensured Forecasting of DSS to collect EC of several fields of various sizes. To ensure the cleaning company are taken into account logistical and fuel and energy costs.

The process of planning the content and timing of work is divided into several stages, namely early sowing of winter crops and their collection; EC and sowing their next gathering. Each of these stages of planning is different, and their implementation should include in the DSS database and relevant knowledge.

In addition, through DSS justified decide whether involvement in collecting the required number of harvesting systems and vehicles. In this case, the schedule calendar combines the need for the timely collection of EC in all fields is estimated ability to perform his own project Combine Harvester park, and if necessary, explain the rationale and the need to attract additional harvesting of other companies.

The plan works on the basis of predicting the timing of collection EC on certain fields is the first step in working with the help of DSS production program of a project cleaning company.

With the start of direct execution harvesting possible changes in the real volume of the planned harvesting EC. These deviations are caused by various reasons, foremost of which are the events agrometeorological component of the project environment - dew and rain. In addition, as mentioned deviations occur for technical reasons - because of the refusal harvesting and vehicles, as well as social reasons. As a result of work in projects characterized by instability, which requires justification via DSS and implementation of management actions on the collecting company.

With DSS tested projects collecting EC, justified to distributions technology (combines and cars) in the fields. Depending on the availability of means and forecast conditions $u^p \in U$ cleaning company generated set of options $\{V\}$ harvesting performance. Among the existing set of options for determining reasonable $v^p \in V$, which gives a maximum profit (P) from sales of biomethane:

$$P(v^p) = D - (B + Z) \rightarrow \max, \tag{1}$$

$$\text{at } u^p \in U,$$

where *D*, *B*, *Z* – in accordance with the projected income from the sale of biomethane, loss Vp-variant of the collection, transportation and processing for biomethane EC, USD. [7, 8].

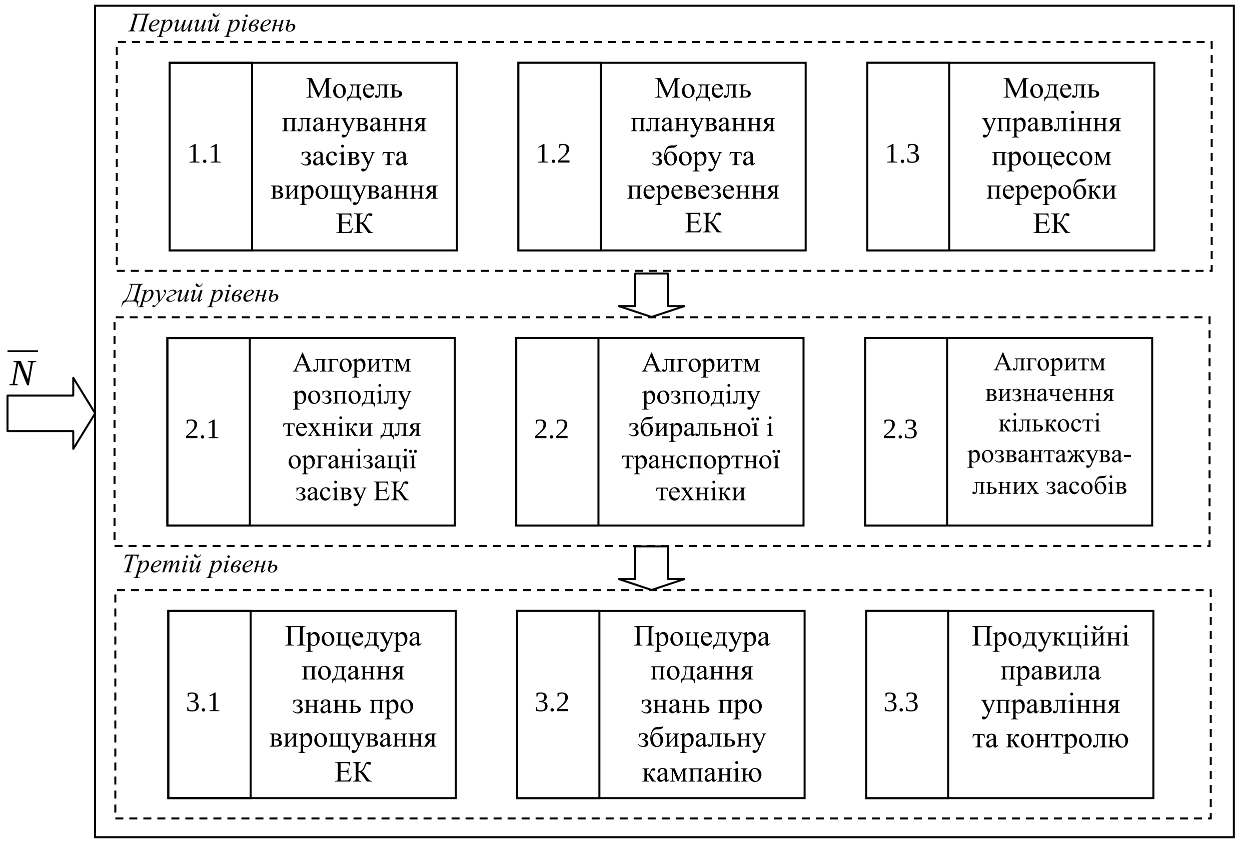
In other words, the expected profit should know the value of expected income and expenses. Calculate them can only be subject to the availability of source data - collected volumes and lost crops, costs for transportation and processing OS and biomethane market value for "green tariff". Expected volume is defined as the sum of projected harvest of individual EC.

Intellectual core of DSS is its knowledge base, because all the algorithms of the system based on its knowledge. According to the principles of building a knowledge base of intelligent systems synthesize knowledge base structure of DSS and its knowledge that it includes.

The purpose DSS is a knowledge base storage units totality of knowledge that are formalized display objects (hardware), their relationships and actions on them, as well as knowledge about the process of solving the harvesting campaign management.

To take into account the nature of the tasks harvesting campaign management knowledge base DSS is synthesized as a set of three levels of knowledge (see. Figure). The first level is intended for storage of process modeling knowledge sowing and cultivation of the EC, collection and transportation of OS and PC management processing, providing a forecast of solving the problem (1). In addition, the first level is constant monitoring of areas with additional OS.

The second level contains the knowledge of distribution algorithms harvesting and transport equipment in fields and algorithms determine the amount of handling mechanisms to BGK. Thus, the second layer is responsible for storing knowledge necessary for solving distribution equipment for the sowing, growing, harvesting, transporting and processing the EC. The third level includes knowledge of procedures for solving problems of planning, control and operational management sowing and harvesting campaign is managing knowledge systems that are necessary to justify decisions made to maximize profits (P).



The structure of the knowledge base of intellectual DSS

The basic knowledge of first knowledge base include: planning model sowing and cultivation EC (block 1.1) planning model collection and transportation of EC (block 1.2) and the model of process control processing EC (block 1.3). The composition of the second level of knowledge includes the following knowledge: the algorithm of distribution equipment for the sowing EC (Box 2.1), distribution algorithm harvesting and transport equipment (2.2 unit) algorithm for determining the number of unloading facilities at BGK (block 2.3).

So, the first and second substantive knowledge includes knowledge of the system. The third level of the knowledge base consists of the following control procedures: solving the problem of planning for sowing and growing PC (block 3.1), solving the problem of harvesting campaign (block 3.2) and procedures for solving the problem of operational management and control (block 3.3). The input data fall into the knowledge base on which conducted its study.

Describe each constituent unit knowledge base.

Block 01/01 contains a logical model of knowledge about planning sowing and cultivation EC on reasonably defined areas. At the same time determined by the type, quantity and quality of EC, the potential volume of biogas (methane), which can be obtained using this OS and necessary expenses. Based on the specified PC using the method of linear programming [1] determined the optimal plan for seeding PC in different parts of the area.

Block 01/02, which contains a dynamic model of planning the collection and transportation of the EC, is used for forecasting performance of technical means of different technological conditions. In particular, based on the logic model determined by the order of states of different technical means made them certain actions, the state of the fields in which we are working. Also modeled fixing objects together, including fixing a certain field by a combine, consolidate certain vehicle combine and unloading facilities with minimal fuel. To solve this problem applies evolutionary method and the method of branches and borders.

Production rules management and control block 1.3 is the foundation for monitoring and managing the process of harvesting and transport operations and processing EC. These rules allow to form recommendations for the implementation of redevelopment works or relearning system.

Algorithm allocation cleaning technique of block 01/02 is intended to form the schedule of work that defines the sequence and dates of sowing EC on fixed fields.

2.2 The block includes allocation algorithm technology, which is designed to determine the options for consolidation combines and vehicles on certain areas in order to minimize downtime harvesting and transport equipment in the field. In addition, the block defined by a 2.2 effective options for securing Combine harvesters fields during the harvesting campaign.

In particular minimizing downtime of vehicles at the storage sites awaiting unloading EC should provide an algorithm for determining the number of unloading facilities contained in Box 2.3. This algorithm is designed for the calculation of the required number of mechanisms and unloading platforms at the storage EC and waiting times for unloading vehicles in line with the number zadanoy unloading facilities.

Procedures for solving management sowing and harvesting campaign of blocks 3.1, 3.2, 3.3 are based on the knowledge contained in the first and second level of the knowledge base and designed to support decision-making in real time. Based on preliminary estimates and actual income from the sale of biomethane, costs of sowing, growing, gathering and transporting EC, as well as export to the fields of organic fertilizers BGK formula (1) is determined by the profitability of the company.

The structure of the knowledge base allows you to store in orderly form of information necessary to solve problems of management sowing, harvesting campaign and process biomass into biomethane. Reproduced knowledge base composition enables the system to use in support of decision-making management process of growing, harvesting and processing of knowledge of different types of operating systems, such as subject and control.

Thus, in a complex dynamic environment characterized by ongoing uncertainty and volatility of many factors, the basis of successful operation BGK is the best decision-making using the proposed DSS on the organization of cultivation, harvesting and processing operating system to obtain the maximum amount of biomethane.

Conclusions

Based on the analysis of problems of management, affecting the efficiency of biomethane synthesized structure the knowledge base of decision support system that best suited to solving problems concerning the organization of planning cultivation, collection and processing of organic raw materials into biomethane for further supplies in distributed gas transportation system for "green tariff".

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