Knowledge base creation for nitrogen fertilization towards crops

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Abstract. The use of intelligent technologies for the systematization of agro-technological knowledge, by creating a specialized software system for storing and presenting knowledge in the field of crop production, represents one of the most promising areas for improving the efficiency of agricultural production planning. The paper deals with the relevant issues of creating a knowledge base for information support system of the operator's activities on the mineral fertilizer application. The increased requirements for modern agriculture to be resource-saving and environmentally friendly stem from the development of this direction. The software LogicGem, an easy-to-use tool for creating, editing, checking and compiling decision table logic, was used to build a knowledge base.

Digitization has become an integral part of society, covering both manufacturing and non-manufacturing sectors of the economy. So is agriculture, which is facing many challenges and problems. Agricultural modernization is based on the transition to smart farming, based on the automated expert systems of decision-making [1, 4].

Numerous ambiguous factors, such as weather conditions, extreme natural events, pest invasion and others, affect the agricultural production. Furthermore, the market for agricultural products is unpredictable. Given these common in agriculture uncertain production conditions, conventional methods of production planning and managerial decision-making are often ineffective. That being said, knowledge-based systems, such as expert systems and artificial intelligence systems, are used to detect patterns and rules in processes that are usually inaccessible with formal research.

Knowledge bases are the most important part of an expert system, as models of expert behavior in a certain area of knowledge using logical inference and decision-making procedures. Thus, knowledge bases are a set of models, rules and facts that allow to analyze and draw conclusions when dealing with complex intellectual tasks related to a certain subject area [2, 5].

The basis of knowledge bases are decision tables. A decision table is a map representing the relationship of condition combinations to action combinations. The data in the condition records, along with the data in the action records, are in the top-to-bottom columns. The data grouped in each column is called a rule. The knowledge representation in the developed knowledge base is conducted by the rules of the product model that is defined by "if" statements and "then" conclusions [3].

The creation of a knowledge base will help to convey the experience and knowledge of the best experts in the field of agrochemistry. Knowledge is not stored in the heads of experienced employees,
but belongs to the industry, is accumulated and transmitted. On top of that, time resources for all manner of explanations and training of employees are reduced [6, 7].

The objective of this work is to test an approach to the creation of expert systems to support management decision-making through knowledge bases.

Throughout the research methods of information systems design were applied: knowledge base creating, simulation modeling and statistical data processing. Materials include production and economic performance of agricultural producers and experimental data on agrochemistry of nitrogen in the soil-plant-fertilizer system and others.

The LogicGem logic processor software tool is designed to provide an easy-to-use way to create, edit, check, and compile decision table logic.

Decision tables, also known as logic tables, have been used for centuries to represent logic in tabular form. Thus, they are still the preferred processing method because they provide a quick and easy way to read, understand, and execute procedures.

The components of the decision table are shown in Figure 1. This knowledge base contains the following conditions: "Is the first crop a fallow?", "Is the first crop a grain crop?", "Is the nitrogen supply low (1-10 mg/kg)?", "Is the nitrogen supply medium (10-15 mg/kg)?", "Is the nitrogen supply high (over 15 mg/kg)?", "Is the soil sod-podzolic?", "Is the soil chernozemic?", "Is the intensification extensive?", "Is the intensification ordinary?", "Is the intensification intensive?". The activity table contains nitrogen fertilizer dosage ratios and grain yields.

![Figure 1. Nitrogen fertilizer dosage selection decision table for cereal crops.](image)

The first combination of conditions and actions puts columns first and rows second as follows: if condition 1 is true and condition 2 is false and condition 3 is false, condition 4 is true, condition 5 is false, condition 6 is true, condition 7 is false, condition 8 is true, condition 9 is false, condition 10 is false, then action 1, then action 8 must be performed. There are a total of eighteen rules in the decision table.

Once the decision table is compiled, there are certain verification operations to be performed. The context menu element Logic has functions that check the structural logic of the decision table. These functions identify and correct repetitive, inconsistent or ambiguous rules. As well as creating, analyzing, and fine-tuning a logic table, these functions serve to create, analyze, and refine the logic table to perfection. The nitrogen fertilizer decision table above has been tested for ambiguity, eliminating ambiguity, and is logically complete.
A compiler is used in the final process of knowledge base creation. It completes the decision table conversion process by encoding the finished table into one of the supported programming languages. The generated program code can be used in the development environment and subsequently compiled into executable code. An example of the Java code generated by LogicGem is shown in Figure 2. Further development of the expert system will utilize the generated code.

The knowledge base will be updated with data on the use of plant protection products on crops, agricultural practices and etc. As a result, an expert system will be developed to support agricultural manufacturers in Western Siberia.

References
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