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Software Decision Support in the Cultivation of Crops

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Abstract: One of the key areas of research of the All-Russia Research Institute of Arable Farming and Soil Erosion Control is the creation of normative and reference support for modern farming systems. Within the framework of this direction, the staff of the institute developed the register of technologies for cultivating cereals for the conditions of the Central Chernozem Region which is represented by a software decision support in the cultivation of crops which includes 36 technologies for cultivating 12 grain crops of different intensity levels for 11 predecessors. The electronic version of the register has an application that makes it possible to make scientifically-based choice of technology for cultivation of presented cereal crops based on available natural and material resources in the economy which allows quickly, efficiently and objectively to select the most optimal types of technologies for cultivating cereals in specific farm conditions. In addition, the electronic version of the register contains reference information including more than 120 units of agricultural machinery and more than 200 varieties and hybrids of cereals. The technologies show their purpose, the conditions for effective use, the expected output indicators, the list of technological methods, the need for natural and anthropogenic resources which is very important for production workers. For each culture and predecessor created a database, that includes the necessary normative indicators for all resources. The advantages of this development include the universality of the developed algorithm for the scientifically-based choice of technology for cultivating grain crops which consists in the possibility of adapting the program not only to the conditions of the Central Black Earth Region but also to other regions of the Russian Federation and another countries, provided that the database is adjusted. The electronic version of the register is an important applied tool for agricultural producers of all forms of ownership, agricultural specialists, economists and scientists.

Key words: Agricultural systems, agrotechnology, register, software, efficiency evaluation, cereals, wheat, barley, buckwheat, pea, soybean, central black earth region

INTRODUCTION

According to, the majority of ideas, modern agriculture should be improved within the framework of the implementation of adaptive-landscape systems (KSAA, 2001; Dubachinskaya, 2013; Kotlyarova, 2013; Mel'nik, 2015; Bessonova, 2011; Aleksandrovna *et al*., 2016). Such systems implementation is a very expensive enterprise feasible only for large agricultural holdings and corporations but not for small farms. The latter cannot afford them because of high price of agricultural production.

The way out is further agricultural crops cultivation technologies rather than changing farming systems. There are extremely favorable conditions for this approach now; new varieties of crops have been introduced, highly effective herbicides have appeared, progress in the development of new energy-saving machines for soil conservation tillage and planting crops has been made, grain harvesters for cereals, sugar beet, corn have reached perfection, they can grind and simultaneously scatter by-products across the field.

Naturally, the most effective use of all these achievements lies within science-based application of modern technologies. Also there is a need to move towards the use of information technology (Pershukevich *et al*., 2012). Such technologies may not be permanent, uniform, applicable in all cases. Therefore, it is reasonable to divide them into extensive, normal (typical), intense. It should be noted that there is a negative attitude to extensive technology is not always justified. Any number may be cases when planting crops, annual grass, buck wheat extensive technology on fertile soils after well-fertilized cultivated, relatively clean from weeds fields can produce grain for more than 3 tons/ha, annual grasses-more than 20 tons/ha, buckwheat-more than 2 tons/ha. One can not ignore the aftereffect of fertilizers, tillage, herbicide application under the

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previous culture. On the other hand, the widespread use of intensive technologies raises many questions of environmental plan, the deterioration of the quality of products, changes in cropping patterns towards greater development of the reproductive shoots. Intensive technologies are not always feasible due to falling product prices, lack of enterprise machines for drying grains or plants for timely processing.

MATERIALS AND METHODS

Certainly, the introduction of modern technologies of crops cultivation was the thorough reconstruction of the machines used in production, namely reversible plows, harrows, disc subsoilers, Striegel harrows, wide-planters and sprayers, use of new effective pesticides and tramlines in the cultivation of crops.

In this case, an optimal method for selecting the type of technology is the use of registers technologies consisting of; output indicators of each technology in terms of productivity and quality of products with an indication of items of expenditure; list of processing methods that make up the technology with the inclusion of the specific characteristics of different techniques to ensure the most of their efficiency as well as the recommended technique for such devices; resource requirements necessary for a successful implementation of each round and technology in general (the amount of seed, fuel, pesticides, fertilizers, electricity, labor); approximate economic indicators which afford to assess the economic position with the required technology of agricultural crops cultivation.

It should also be noted that some methods may have several solutions, quite similar in performance what can eventually determine a great number of options technology. In particular, the already well-established elements of the technology are the primary method of tillage, fertilizer application system, preparation for sowing seed, seedbed preparation methods, the system applying fertilizers, seed preparation for sowing, methods of seedbed preparation and planting, agronomic techniques care of crops, ways to protect plants from pests and diseases, harvesting, recycling of by-products. Changing of a single reception process increases the amount of applied technologies. The way out of the situation is the development of standard registers technologies of agricultural crops cultivation containing the most appropriate evidence-based techniques.

Modern agriculture is obvious to be in need of developing specialized software which allows automating its separate stages.

In particular, one of these stages is the choice of technology of the crop cultivation, allowing to avoid the wrong decision and predict potential cost-effectiveness of the use of technology.

RESULTS AND DISCUSSION

One of the priority areas of FSBSI All-Russia Research Institute of Arable Farming and Soil Erosion Control research is the development of the precisely such systems of support of agricultural producers in decisions on evidence-based selection of regional crop management technologies. The sequence of the development is shown in Fig. 1.

The main problems in their development are: nonequivalent impact of natural and anthropogenic factors, the absence of any methodology for determining the weighting coefficients of the different factors, the lack of a universal normative database of natural and physical resources, applicable to all regions of our country.

The laboratory staff cropping systems of SSI All-Russia Research Institute of Arable Farming and Soil Erosion Control completed work on the creation of the register of technologies of cultivation of crops for the Central Chernozem. The scientific and technological development of SSI All-Russia Research Institute of Arable Farming and Soil Erosion Control and other research establishments of the region during 1998-2013 adapted for the developed level of natural and material resources of farms of the Central Chernozem Region are the basis for the created register.

On the end of development of the register, work on preparation of algorithm of a choice of technology of cultivation of grain crops depending on a complex of defining factors and to creation of the computer program "Ssoftware decision support in the cultivation of crops" was carried out (Fig. 2). The demonstration version of the program in Russian language is located on the official web site of All-Russia Research Institute of Arable Farming and Soil Erosion Control (http://www.vnizem.k46.ru/5.htm).

Advantages of the developed software are: possibility of convenient viewing and choice of 100 technologies of cultivation of 12 grain crops of various intensity level on 11 types of predecessors; the expanded functional of the program allowing to carry out calculation of economic efficiency of technology automatically; use of a database which allows to form recommendations about use or correction of technologies of cultivation of grain crops in the automated mode; existence of the reference information including the description more than 120 units of agricultural machinery and more than 200

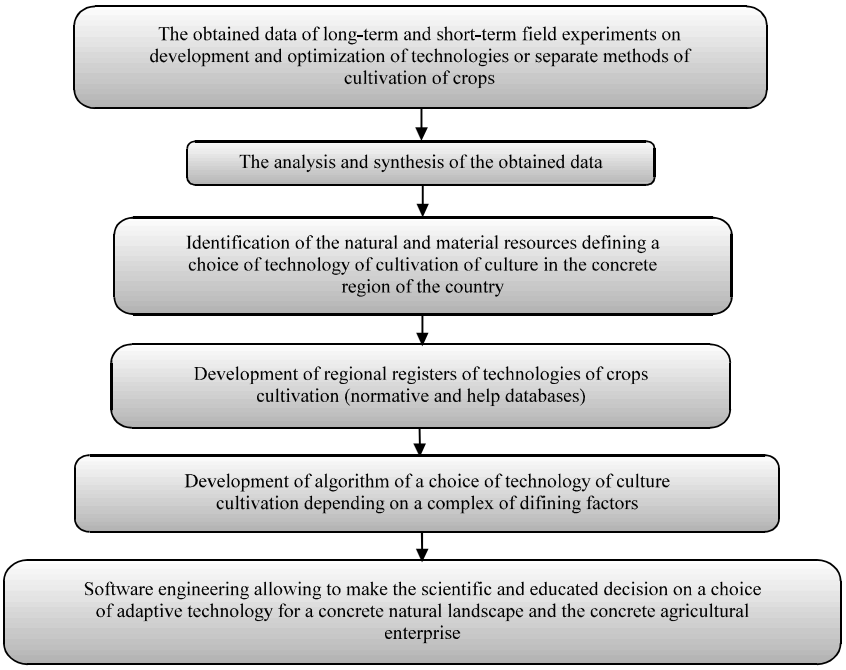

Fig. 1: The scheme of development of normative and help system of support of agricultural producers in a decision making at a scientifically based choice of regional technologies of cultivation of crops

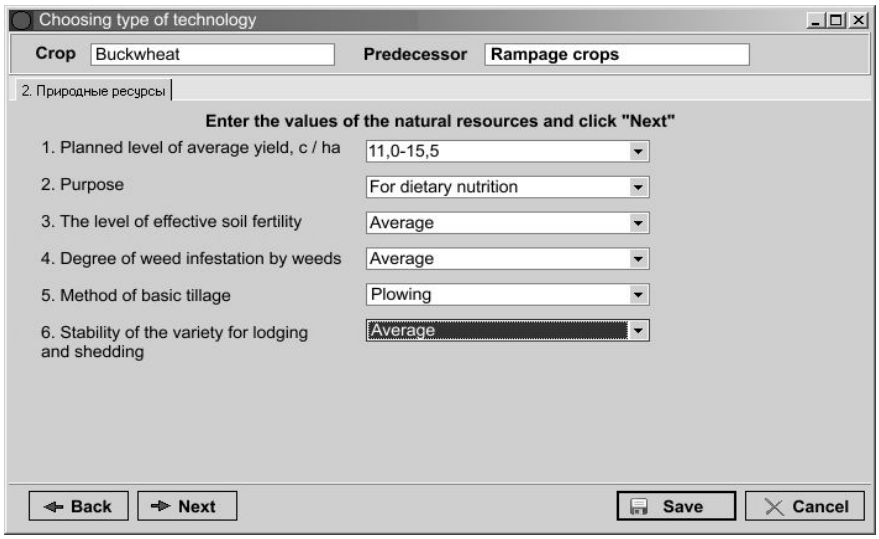

Fig. 2: Screen form "Input of technology type parameters"

grades and hybrids of the grain crops allowed to cultivation in the Central Chernozem Region; the universality of the developed algorithm consisting in possibility of adaptation of the program to various regions of the Russian Federation and another countries in the presence of the relevant input data; convenient user interface; existence of the necessary information printing function.

The software uses a specially designed database of grain crops and varieties, predecessors, agricultural machinery, technologies and parameters of their mutual correspondence. The "Entity-relationship" model of the developed database is shown in Fig. 3. As a database management system, we choose to freely distribute Software Firebird 2.5.

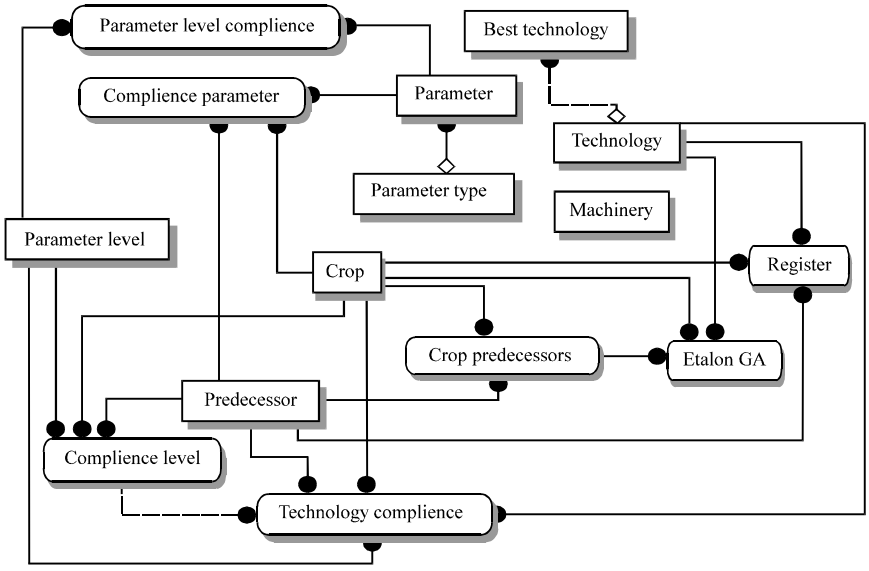

Fig. 3: ER-Model of constructed database

It is necessary to notice that emergence of the modern technologies of cultivation of crops set for research establishments the complex challenge of an assessment of their effectiveness because of application of unwieldy cars which do not allow to apply them in field experiments on small experimental plots. Research institutes were not ready to such experiences because of limitation of release and high cost of small-size technique of this kind.

In such conditions there is a question of change of approaches when studying the modern agrotechnologies in respect of the sizes of a sowing campaign and registration allotment, repetition existence, number of options, volumes in general of experiences.

In our opinion, in the circumstances it is possible to change tactics of an assessment of agrotechnologies by the establishment of indexes of productivity of cultures, profitability of production, a condition of soils and plants immediately on fields of the agricultural enterprises where these technologies are introduced but the condition of soils and predecessors do not differ. This field can be located in one enterprise and can be located near each other. However, in all cases one option has to be controlled. All necessary indexes of a condition of soils (density, hardness, the maintenance of NPK and humus, oddments of pesticides and so forth) and conditions of plants (thickness of standing, number of grains in an ear, quality of grain, existence in grain of oddments of pesticides and so forth) will remain quite reliable. Such comparison demands an objective assessment from the researcher but it is the other party of a question.

CONCLUSION

In the modern conditions perfecting of agriculture will be conducted first of all on the basis of complication of technology of cultivation of cultures but not systems of agriculture. Because of inhomogeneity of climatic, soil, material resources of farms application of a set of options of such technologies differing on intensity degree is inevitable (extensive, normal, intensive). The choice of optimum option is possible on the basis of the modern registers of the technologies and computer programs to them allowing to simplify this process. Such register and the program to it are developed for grain crops in the FSBSI All-Russia Research Institute of Arable Farming and Soil Erosion Control for the Central Chernozem region.

Perfecting of agrotechnologies on the basis of introduction of high-performance cars of new generation significantly complicates process of an assessment of their effectiveness in research establishments that causes need of research of new approaches for a laying of experiences, maintaining them and the accounting of supervision which are not fulfilled now.

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