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THE ALGORITHM OF ANALYSIS OF AGRICULTURAL RISKS UNDER INFLUENCE OF INCOMPLETE INFORMATION ABOUT THEIR PARAMETERS

Abstract. The risk analysis algorithms, which are offered by domestic scientists for Ukrainian farmers, are limited in use and are often obsolete. The situation in agriculture of Ukraine changes quickly enough –new agricultural machinery and new technologies appears, this requires a new management.

At the same time, the use of approved decision support systems and risk analysis software systems tested in developed countries is not possible in Ukraine. This is due to the lack of accompanying information providing.

The databases on factors influencing risk are absent both at the national level and at the regional level in Ukraine. Today, the creation of such databases does not solve the problem, as the necessary precondition of modern software systems for risk analysis is the availability of data covering significant time period.

Thus, the problem of the development of algorithm for such an economic-mathematical model of information processing that would be able to work effectively under the condition of a lack of data on factors influencing risks needed for the effective use in the agricultural sector of Ukraine became a topical issue. The developed algorithm of the economic-mathematical model of the system of risk analysis involves the replenishment of the required amount of information by an expert in the field of agriculture and the subsequent automatic operation of the software complex.

The factor of incompleteness of information complicates the work of decision support system, extends the time of information processing.

In the course of the research it is suggested to use both the analytical approach and the simulation model for the formation of the algorithm. The appropriateness of choosing one or another method is determined by the availability of the required amount of reliable primary statistical information. Reducing the time of the task is facilitated by the formation of library working arrays, which is accumulated during the operation of the automatic risk analysis system.

The pilot test of the suggested algorithm of the economic and mathematical model of the system for decision support and risk analysis for the cases of incomplete data on their parameters for Ukrainian farms, which grow grains and leguminous crops, allowed to get the first practical results. As a result of risk analysis the biggest risk for farms which grow grains and leguminous crops is identified, namely, the reduction of sales volumes, while the smallest risk, the impact of which was overestimated by scien-

tists before, is a reduction in the price for products of these farms. Thus, the efficiency of the proposed algorithm of decision support system is proved.

Keywords: system of decision making support, risk analysis algorithm, economic and mathematical model, program complex, imitation design.

JEL Classification D81, C44, C8

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АЛГОРИТМ АНАЛІЗУ СІЛЬСЬКОГОСПОДАРСЬКИХ РИЗИКІВ ПРИ НЕПОВНІЙ ІНФОРМАЦІЇ ПРО ЇХ ПАРАМЕТРИ

Анотація. Алгоритми аналізу ризиків, запропоновані вітчизняним вченими для українських агровиробників мають обмежене застосування і є, часто-густо, застарілими. А ситуація в сільському господарстві України змінюється досить швидко – приходять нова техніки і нові технології, які вимагають нового менеджменту, зокрема, аналізу ризиків.

У той же час, використання апробованих в розвинених країнах систем підтримки прийняття рішень та програмних комплексів аналізу ризиків в Україні є неможливим. Це обумовлено відсутністю супроводжувального інформаційного забезпечення. Бази даних за факторами, що впливають на ризик, в Україні відсутні як на загальнодержавному рівні, так і на регіональному рівні. Створення сьогодні таких баз даних не вирішує проблеми, оскільки умовою роботи сучасних західних програмних комплексів аналізу ризиків є наявність даних за значні проміжки часу.

Тому стала актуальною проблема розробки алгоритму такої економіко-математичної моделі обробки інформації, яка б могла ефективно працювати при умові нестачі даних по факторам впливу на ризики для використання в сільськогосподарській галузі України.

Розроблений алгоритм економіко-математичної моделі системи аналізу ризиків передбачає поповнення потрібного обсягу інформації експертом в галузі сільського господарства і подальшу автоматичну роботу програмного комплексу.

Фактор неповноти інформації ускладнює роботу системи підтримки прийняття рішень, подовжує час обробки інформації.

В ході дослідження для формування алгоритму запропоновано застосовувати як аналітичний підхід, так і метод імітаційного моделювання. Покажчиком доцільності вибору того чи

іншого методу є наявність потрібного обсягу достовірної первинної статистичної інформації.

Зменшення часу виконання задачі полегшується формуванням бібліотеки робочих масивів, яка накопичується під час роботи автоматичної системи аналізу ризиків.

Пілотне випробування запропонованого алгоритму економіко-математичної моделі системи підтримки прийняття рішень та аналізу ризиків за неповних даних по їх параметрах для фермерських господарств України, що вирощують зернові та зернобобові культури, дозволило отримати перші практичні результати.

За результатами аналізу ризиків вказано на найбільший ризик для фермерських господарств, що вирощують зернові та зернобобові культури, а саме на зменшення обсягів реалізації продукції і на найменший ризик, вплив якого практиками до отримання результатів аналізу ризиків перебільшувався – це зменшення ціни на продукцію вказаних фермерських господарств.

Таким чином, доведено ефективність запропонованого алгоритму системи підтримки прийняття рішень.

Ключові слова: система підтримки прийняття рішень, аналіз ризиків, алгоритм, економіко-математична модель, програмний комплекс, імітаційне моделювання.

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АЛГОРИТМ АНАЛИЗА СЕЛЬСКОХОЗЯЙСТВЕННЫХ РИСКОВ ПРИ НЕПОЛНОЙ ИНФОРМАЦИИ ОБ ИХ ПАРАМЕТРАХ

Аннотация. Алгоритмы анализа рисков, предложенные отечественным учеными для украинских агропроизводителей имеют ограниченное применение и, часто, являются морально устаревшими. А ситуация в сельском хозяйстве Украины изменяется достаточно быстро – приходят новая техника и новые технологии, которые требуют нового менеджмента, в частности, анализа рисков. В то же время, использование апробированных в развитых странах систем поддержки принятия решений и программных комплексов анализа рисков в Украине является невозможным. Это обусловлено отсутствием сопутствующего информационного обеспечения. Базы данных по факторам, которые влияют на риск в Украине отсутствуют как на общегосударственном, так и на региональном уровне. Создание сегодня таких баз данных не разрешает проблему, поскольку условием работы современных западных программных комплексов анализа рисков является наличие данных за значительные промежутки времени.

В ходе исследования для формирования алгоритма предложено применять как аналитический подход, так и метод имитационного моделирования. Показателем целесообразности выбора того или другого метода является наличие необходимого объема достоверной первичной статистической информации.

Пилотное испытание предложенного алгоритма экономико-математической модели системы поддержки принятия решений и анализа рисков при неполных данных по их параметрам для фермерских хозяйств Украины, которые выращивают зерновые и зернобобовые культуры, позволило получить первые практические результаты. В результате анализа рисков указано на наибольший риск для фермерских хозяйств, которые выращивают зерновые и зернобобовые культуры, а именно на уменьшение объемов реализации продукции, и на наименьший риск, влияние которого практиками к получению результатов анализа рисков преувеличивалось – это уменьшение цены на продукцию указанных фермерских хозяйств. Таким образом, доказана эффективность предложенного алгоритма системы поддержки принятия решений.

Ключевые слова: система поддержки принятия решений, анализ рисков, алгоритм, экономико-математическая модель, программный комплекс, имитационное моделирование.

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Introduction. Ukrainian agriculture assimilates western agrotechnologies, modern agricultural techniques and innovations, which greatly increase efficiency and reduce losses. The latest technologies also require the management of agricultural producers. One of the tools for effective management is the decision support system. Risk analysis is an indispensable element of such systems, because agriculture is riskier than other areas of human activity. However, despite the considerable efforts of stakeholders, nowadays the state of the information support of decision support systems (DSS) in agriculture of Ukraine is extremely unsatisfactory. The analysis of the risks of any business decisions should be based on the risk factors database. Such databases, available in developed countries, store information that has accumulated even not for years, but for decades both at the national level and at the level of the administrative districts of the specified countries. The only Ukrainian database that meets these requirements is a database of weather-related factors, information on which was accumulated for many decades. Unfortunately, there are no other databases on the factors affecting agricultural risks in Ukraine, both at the national level and at the regional level. Therefore, the analysis of risks in the field of agriculture, the forecasts based on this analysis are based either on the intuition and experience of the head of the holding, of the company, the state institution, or on the incomplete, fragmented data or data, the objectivity of which is not guaranteed. This greatly reduces the reliability of the results of economic analysis, reduces the accuracy of the forecast, which leads to an increase in losses and, accordingly, to an increase in overhead costs for the products of agricultural producers.

Since, unlike developed countries, Ukraine has no risk-based databases, therefore the use of widely used in developed countries automated information systems for risk analysis of known developers and proven decision support systems without a radical change in their algorithms is impossible in Ukraine. Numerous attempts made by Western companies- developers of software systems for the DSS, analysis of agricultural risks- to enter Ukrainian market were unsuccessful.

The situation is complicated by the fact that practitioners, who require these forecats and taking into account risks, tend to have a low overall competency in the field of economics and computer science. This imposes additional requirements both on the interface of the relevant software tools and on the dialog system, in the case of a lack of data, to replenish the information sources by expert assessments. These are the attempts to replenish information sources by the experts' assessments that may lead to the subjectivity of the analysis results, an increase in the irrelevance of risk assessments, and the unreliability of decision support systems.

Analysis of research and problem statement. were The scientific works of Vitlinskyi V.V., Verchenko P.I., Sihal A.V., Nakonechnyi S.I. [1], Donets L.I. [2], Yastremskyi O.I. [3], Skrypnyk A.V. and Shevchuk Yu.V. [4], etc. [5, 6, 7, 8] were devoted to the risks of the agricultural-economic sector of Ukraine. Unfortunately, the suggest economic-mathematical models are either limited in

scope, or their application is impossible due to incomplete information on the factors that determine risks.

The problem is that modern life brings new realities that complicate the established process of agricultural risks forecasting. According to current conditions and methods of agricultural activities, new types of risks become significant. For example, this is the risk of reducing soil fertility, due to not only the failure in crop rotation, but also to the failure to bring the required amount of mineral and organic fertilizers in the past periods and non-compliance with other measures necessary to preserve the soil. «Saving» money for such works can not only reduce the soil fertility, but, even, reduce the cost of agricultural land, or even to depreciate them completely. In particular, this effect is described in the work of Hrabak N.Kh. [9]. Therefore, the economic activity on land, the information regarding the previous economic activity on which is absent, has an increased risk [9].

Not only Ukrainian scientists, but also scientists from other countries are involved in risks analysis, in particular, the well-known work of Boehm B. [10] became fundamental. The works of such scientists as Tang K. [11], Troccoli A., Harrison M., Anderson David L.T., Simon J. Mason [12], Nitsenko V., Mardani A. [13; 14] and others are devoted to the detailed development of mathematical models for the analysis of weather-climatic risk. The proposed algorithms and methods of risk analysis can not be recommended for wide use in Ukrainian realities. The reason is the inaccessibility of information resources required by the proposed risk forecasting tools to a wide range of practitioners.

In developed countries, the effective programs for calculating risks, taking into account the impact of risks on economic activities, are in use for the long time. For example, the Decision Impact Analysis System, developed by Decision Support Systems, can not only estimate the weight ratios of each type of risk, but also to suggest the best strategy with the option of an interactive version of the options for such a strategy [15]. However, this program is complemented by a database of probable risks and relevant statistical information on each type of risk, not only at the global, but also at the regional level. That is, all modern, widely used in developed countries, automated risk forecasting information systems, decision support systems use databases on risk factors that have been accumulated and systematized for many decades.

The given information points to the complexity of the widespread use of the developments of Ukrainian scientists in area of the DSS on the current stage of agribusiness development and, at the same time, to the inability to use the DSS of developed countries in Ukraine without their significant modification.

Unsolved aspect of the problem. A detailed elaboration of the algorithm of the economic and mathematical model of information processing, capable of being used in the presence of incomplete information on the factors influencing risks, the formation of the databases on the factors of risk and the interaction of individual software blocks remain outside of the scope of our research. Work on the creation of databases on the factors influencing risk requires significant funding and is possible only in case of the involvement of the investor and the promotion of public investment.

The purpose of the article is the development of the algorithm of the economic-mathematical model of information processing, capable of being used under incomplete information on the factors influencing the risks of effective Ukrainian SSR for the needs of agriculture.

Research results. The algorithm for processing incomplete information on risk parameters is suggested to be compose of such stages.

1. An expert in a subject area formulates the widest list of parameters and factors that can affect each specific type of risk.

2. These parameters form a vector of influence on risk. The vector of exposure to risk can be of the simplest, linear, or multidimensional nature. The model for risk effects vector is proposed by the expert in the subject area.

3. The automated system, based on the data on the parameters, checks the adequacy of the risk description suggested by the expert. For this, «instantaneous» values of these parameters will suffice.

4. The outcome of the processing of the adequacy of the risk description is to accept or to reject the mathematic identity of the risk vector of risk influencers proposed by the expert in the subject area and established as a result of verification of the available values of these parameters.

5. The expert checks the outcomes of the processing of the adequacy of the risk description. If the expert verifies the results of the processing — this stage is considered as completed, and if no — the stages 3—5 are automatically repeated.

6. The completion of the processing of the adequacy of the risk description means that you can proceed to the stage of mathematical processing and risk analysis. At this stage, the impact of the expert from agriculture on further analysis is excluded. And a specialist in the field of economics and mathematical modeling forms and adapts algorithms to take care of the task. This allows to abstract from the subject field and to objectivize the solution of the problem.

7. The economic-mathematical model of each particular risk is formed.

8. The adequacy of the parameters of the risk vector used for the economic-mathematical model is determined.

9. The accuracy of the results of the work of the economic-mathematical model is analyzed.

10. The obtained functional dependencies are checked for discontinuities.

11. In the absence of discontinuities, an approximation of the obtained functional dependence is made with the help of parametric modeling.

12. The indicated approximated functional dependence serves as the basic mathematical expression formed by a specialist for each of the risks for the risk analysis model in agriculture.

The implementation of stage 4 of the algorithm for processing incomplete information on risk parameters should begin with the development of an algorithm for estimating unknown risk parameters.

We analyzed the methods of forming an algorithm for estimating unknown risk parameters. Here, both analytical approaches and simulation modeling can be applied. Analytical approaches usually require more primary statistical information and lack of lacunae in this information [16].

To simulate the simulation, you need to create a pseudorandom sequence generation subroutine and their subsequent step-by-step verification. This subroutine may be based on the famous Monte Carlo method.

The subroutine, in this case, can use the algorithm of the problem solved by Neumann and Ulam while working on an atomic project [17]. This task arose as a result of the lack of information, and its analytical solution in those times and circumstances was difficult to overcome.

In this case, the algorithm for solving the problem will be as follows (Fig.1):

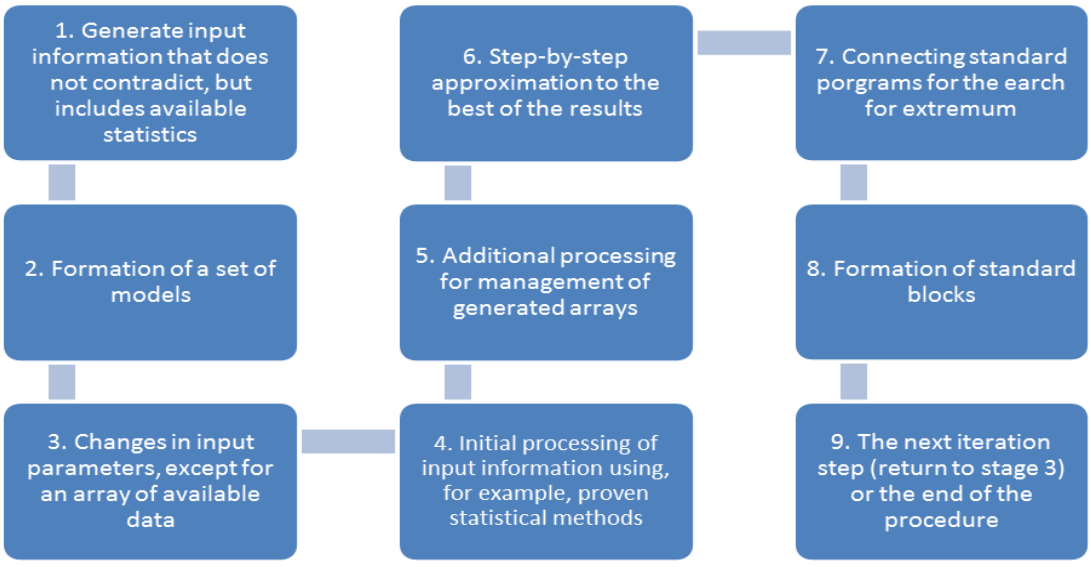

Fig. 1. Simulation algorithm for problem solving

To use block designing, it is necessary to create a library (array) of standard sub-blocks of the influencers for each type of risk, possible models, etc. Based on the use of standard sub-blocks

there is the possibility of a step-by-step verification of the compliance of changes with existing statistical data and adjustment in the calculations. This approach provides an opportunity to reduce the time of calculations and is a good example of the application of a method borrowed from the experience of using gert-networks: namely those networks, based on equivalent transformations [18; 19]. The advantages of using this design technique are:

1. Reducing the time of the problem solving.
2. Flexibility in both the change of input information and the construction of models.
3. The ability to track how intermediate results corresponds to the proposed model.
4. Unification of the simulation algorithm.

However, the use of this technique, in addition to the obvious advantages, has also significant drawback. Auxiliary arrays, in particular, a model library to increase the speed of intermediate operations, will have to be loaded into RAM. This circumstance will increase the cost of computer equipment.

It should be noted that the speed of simulation depends, to a large extent, on the qualification and skills of the experts, first of all, of the expert (or practicioner) in the subject area, which initially offered such a statement of the problem. Inaccuracy in the formulation of the problem can not only complicate its solution, but also lead to false conclusions.

Some practical results of the pilot test of the suggested economic-mathematical model of information processing, including incomplete data on the risk factors, for use in automatic information systems for risk analysis in the agriculture of Ukraine are given in table 1.

Table 1

Results of calculating the risks of reducing the yield of grain and leguminous crops, prices and volumes of their sales forUkrainian farms

The type of risk	Coefficient K_i	Coefficient E_i	Coefficient ω_i	Numerical value of the level of risk	The interval of the change of the calculated coefficient of risk
Reduced yields	0,19	166,9	0,07	0,02	weak risk
Reduced price	0,16	43,9	0,03	0,01	weak risk
Reduced sales volumes	0,23	2025,3	1,02	0,19	significant risk

Source: own calculations according to the data of the State Statistics Service of Ukraine http://www.ukrstat.gov.ua.

Based on pilot calculations, using generally accepted definitions of boundaries for the intervals of change in the risk factor (0.056 — weak risk, 0.057 ... 0.100 — moderate, 0.101..0.147 — acceptable, 0.148 ... 0.208 — significant risk, 0.208 — unacceptable level of risk) the risk assessment for farms growing grain and leguminous crops was carried out (see Table 1). As can be seen from the results of the analysis, the most important risk for farms growing these cultures is the reduction of sales volumes.

This risk is higher than the risks of reduced yields and reduced price of grain and leguminous plants. Thus, it has been proved that the described risk analysis can serve as a real tool in making farmers a decision to success in their business.

Conclusions. For decision-support systems in agriculture in Ukraine, an algorithm for processing incomplete information on risk parameters is suggested. The detailed stages of the algorithm formation are presented. The analysis of methods of forming an algorithm for estimating unknown parameters of influence on risk, pointed out in the course of the research, indicated a possible alternative. For the formation of the algorithm, both the analytical approach and the simulation model can be applied. The amount of complete and reliable primary statistical information may be the indicator of the expediency of choosing one or another method.

For simulation model it is suggested to use the Neumann-Ulam algorithm. The expediency of using this algorithm in the absence of information is proved in practice by solving complex and critical tasks. Unfortunately, the use of this algorithm will lead to an increase in price for computer equipment, the specified software should be implemented on which. As a survey of farmers' owners has shown, such costs are acceptable for an average farmer in Ukraine. Since the speed of obtaining

a result largely depends on the qualification and skills of the experts (in this case, the owners of the farms), the possibility of introducing a training program on the use of the suggested DSS is foreseen.

In the pilot test of the developed economic and mathematical model of information processing, including incomplete data on the factors influencing risks, for the farmers, growing grain and leguminous cultures, practical results are obtained.

The results of the risk analysis indicated that the biggest risk for farms growing these crops is a decrease in sales volumes, while the smallest risk, the impact of which has been exacerbated by practitioners before obtaining the results of the risk analysis, — is a reduction in the price for the products of the indicated farms.

Thus, the efficiency of the suggested algorithm is proved.

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