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Improving of Business Planning Using the Method of Fuzzy Numbers

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Abstract

Purpose: Summarize the experience of using modern methods in the business plan with the application of economic and mathematical modeling.

Methodology: Theoretical and methodological basis of the study is the basic principles of economic theory, agricultural economics and scientific research of leading home and foreign scholars on the theory of planning.

Originality: This further justifies business planning processes in agriculture from the standpoint of raising economic protection of farmers. The methodology for assessing farm income for planned indicators through the application of fuzzy numbers method in business planning is improved.

Keywords: business planning, triangular numbers, fuzzy sets, profit

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Introduction

Successful entrepreneurial activity is based on clear calculations. For modern methods of production optimization in the Ukraine agricultural sector, it is necessary to use modern methods of optimization of enterprises, which is impossible without the development of a business plan. Creation of appropriate conditions for the functioning and development of various agribusiness companies contributes to the diversification of the agricultural market infrastructure. Business planning is based on an assessment of the institutional environment of the company; an important task in developing a business plan is the consideration of the formal and informal state institutions.

Business plans model a program of economic entities in a clearly defined period and address the specific problems of the company. Business plans, unlike conventional organizational plans and economic development, aim to address the specific problems. Therefore, the business plans model the program of those activities according to projections, the indicative plans for economic development and agriculture development, but only within the specific problems of business development.

Business planning as emphasized by many experts is more practical and develops as a result of economic activities in the marketplace. However, the resulting business plan is an arsenal of modern methods and techniques of various disciplines of strategy and tactics for implementing demand. It also can be said that business planning is the use of program-target planning. The testing procedure provides the ability to generate ideas or seek out weaknesses in the planning project.

Modeling is widely used for decision making. The model is a representation of an object or system process in a form different from the original that retains its basic characteristics. The reasons that lead to the use of simulation in the economy are the natural organizational complexities of many situations, where it is impossible to conduct experiments in real life and still focus on the future. When deciding regardless of the model used, there are some rules of decision-making. Rule decision is a criterion on which judgment is made about the optimality of a particular result. There are two types of rules. The first does not use numerical values of possible outcomes and the second uses data values.

Obviously as an object of modeling, agriculture is a very complex system. The proper construction of the economic and mathematical model and the next correct decision must be considered as essential features of reproduction processes in agriculture, economics, technology, social and others. Agriculture as an object of modeling can effectively

apply the principle of optimality because it is characterized by a certain freedom in the choice of scenarios, limitations on resources and availability performance.

The presence of different options is predetermined by the different levels of needs and resources. The same products can be produced with various different resources or their combination, and vice versa, the same resources can be used for different types of products. The principle of optimality is applied using mathematical programming methods.

Methodology

The theoretical basis of the study is a systematic approach and the research results of Ukrainian agricultural enterprises and foreign researchers. The problems of the ways to improve business planning research reflects the dedicated work of many scientists and specialists of agriculture. Various aspects of development planning methods were studied from P. Berezovsky (2004, p. 443), J. Hubeni (2012, p. 689), P. Drucker (1994, p. 215) A. Lynenko (2007, p. 148–150), V. Sizonenko (2003, p. 379) and Vladimir Drobot (2003, p. 336).

Scientists found that the use of mathematical modeling in business planning is the objective in its development stage, due to the existence of stable economic patterns and possibilities for their mathematical description (Maryuta and Boytsun, 2002, p. 384; Klebanova and Zabrodskyy, 2001, p. 140).

Improving distribution and information technology have contributed to the deepening application of mathematical modeling in economic research. The emergence of computers weakened the role of complex analytical methods for the study of economic and mathematical models. Putting in the first statement of the problem directs the development of the model, which is then investigated by numerical methods; practical data is also checked and adjusted.

According to some scientists, agriculture recently intensified the use of economic and mathematical methods and models for enterprise-level business plans, current planning and forecasting perspective (Vovk and Syavavko, 1999, p. 26–27; Syavavko, 1999, p. 56–59).

This study used a monographic method for defined benefits and opportunities of the business plan with the help of fuzzy sets. Using the methods of analysis, synthesis, comparison and abstraction, the basic problems of development and implementation

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of methods in agricultural enterprises of Ukraine were defined. Using these studies made it possible to develop recommendations for the creation of favorable conditions for development of the business planning process in Ukraine.

Results

In the process of making market decisions, one is faced with a single common problem: the uncertainty of tomorrow that creates vague conditions for investment. Everyone is trying to make the world more predictable, which leads to the need for planning, forecasting and assessing market risk. One should develop plans for prospective developments related to changing prices, output and sales of agricultural products, changing macro parameters of economic environment (level of tax rates, short-term loans, rate of inflation) and then carry out the analysis plan. Optimistic plans improve the financial position of an enterprise and its position in the market.

One of the essential components for the enterprise is the wide use of different mathematical methods and models. They are actively used in the development of collected information, without which it is impossible to solve the problem of planning, analysis and forecasting of the company (Grebennikova and Trofimov, 2007, p. 131–144).

In the real world of modern business, the use of traditional methods and models is problematic. This is due to the complexity of constructing multi-models as well as the inability to determine the distribution of considered parameters (Altunyn, 2000, p. 352). Those skilled in the enterprise has to operate indicators, the exact value of which cannot be found. However, their impact is very significant and should be taken into account by accessing certain management decisions. Often they cannot be represented in a clear quantitative form or they do not have quantitative characteristics that describe them in a good state. Difficulties may arise in the description of internal factors, although it is theoretically controlled and operated, but not always like that in practice. This may be due to both the nature of an indicator and internal corporate governance difficulties or a not properly built system management.

The use of "traditional" clear numerical values to describe these indicators makes calculations and conclusions "dry" and deprives the results of flexibility. Analysis of international experience has shown that many studies today are focused on deterministic processes that fully prevent adequately reflecting their essence. An important step for successful solutions to these problems is to use simulation and fuzzy data. Application of fuzzy values allows formalizing a wide range of tasks. In connection

with these real life problems are development of theoretical foundations, new methods and models for analysis and assessment of objects through the use of fuzzy logic and expert knowledge in the field of rural households, allowing developing and implementing a number of formal criteria that have high rates of reliability.

Simulating the financial activities in terms of significant uncertainty, it is proposed to use formalism of fuzzy sets in financial analysis for business plans of agricultural enterprises. The theory of probability loses much to this theory. To fight with uncertainty, one must learn to simulate it.

Today one of the most promising areas of research in the field of analysis, forecasting and modeling of economic phenomena and processes is fuzzy logic. Fuzzy-multiple models, often presented in the form of software for personal computers, allow managers at various levels as well as business owners to make economically sound decisions.

Although the first mention of a new method of mathematical modeling was nearly half a century ago, this area of research is still less explored. In 1965, L. A. Zadeh, professor of computer science at UC Berkeley, introduced in science the concept of a fuzzy set, which gave the name to the eponymous theory (fuzzy logic) (Zadeh, 1978).

The merit of Zadeh's concept is that it expanded the classical notion of set, assuming that the characteristic function (function of membership for element set) can take any value in the interval (0, 1), not just value 0 or 1. These sets were called fuzzy. He also identified a number of operations on fuzzy sets. He offered to generalize the known logical methods of inference called *modus ponens* and *modus tollens*. By later adding the concept of linguistic variable and assuming that its values (terms) are fuzzy sets, Zadeh developed a device to describe the processes of intellectual activity, joining ambiguity and uncertainty of expressions (Zadeh, 1978).

The reasons that determine the level of effectiveness of an enterprise are partly beyond the pale and don't fit into total control on their part, which leads to the phenomenon of uncertainty.

The uncertainty available in the tasks of management activities of any company are characterized by the vagueness of used opinions and expert assessments, along with incomplete and unclear details about the basic parameters and conditions of the test tasks. Thus, the uncertainty that leads to a significant increase in the complexity of the enterprise management tasks is caused by a variety of factors. The combination of these factors on practices creates a large range of different types of uncertainty.

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In a monograph by A. A. Nedosekin (2003) devoted to fuzzy sets, there is a classification of uncertainty. If one redesigns this classification to the specific decisions for management of the economic strategy of a company, one can define two types of uncertainty:

1) Uncertainty that is the lack of accurate knowledge about the future state of the projected parameters of the entity economic indicators.
2) Fuzzy classification of certain parties in the current financial condition of the company.

Uncertainty is a quality of the market environment, which cannot be eliminated. It is associated with exposure to many different factors in market conditions that don't have common assessments. But even if one considers market factors, uncertainty will still be preserved and cannot be eliminated, given the market reaction factors to certain actions (Nedosekin, 2003).

The flow of publications on the application of fuzzy sets in economic analysis is quickly growing. The International Association for Fuzzy-Set Management and Economy (SIGEF) regularly presents new results in clearly set economic research. The scientists publish hundreds of books on the subject, but in Ukraine, this process is just picking up.

Media U is a universal set that includes all observations within the estimated quasi stats **(**Chopra and Ziemba, 1998; Zadeh, 2014).

A fuzzy set A is the set of values of the media; herewith each value of media corresponds to the degree of membership of the value to the set A.

Operations on fuzzy sets, such as union and intersection, can be defined in various ways. Next is shown several such definitions. The choice of one depends on the meaning given in appropriate operations within the considered problem.

Association of fuzzy sets A and B with X is a fuzzy set $A \cup B$ with the membership function as follows:

$$\mu_{A \cup B}(x) = \max\{\mu_A(x), \mu_B(x)\}, \quad x \in X \tag{1}$$

The intersection of fuzzy sets A and B with X is a fuzzy set $A \cap B$ with the membership function as follows:

$$\mu_{A \cap B}(x) = \min\{\mu_A(x), \mu_B(x)\}, \quad x \in X \tag{2}$$

Supplement of fuzzy set $A \subset X$ is a fuzzy set $\overline{A}$ with the membership function as follows:

$$\mu_{\overline{A}}(x) = 1 - \mu_A(x), \quad x \in X \tag{3}$$

Obviously, $\left(\overline{\overline{A}}\right) = A$

Difference of sets A and B with X defined as a fuzzy set A/B with the membership function as follows:

$$\mu_{A \setminus B}(x) = \begin{cases} \mu_A(x) - \mu_B(x) & \text{за } \mu_A(x) \geq \mu_B(x), \\ 0 & \text{otherwise.} \end{cases} \tag{4}$$

Membership function $\mu_A(u)$ is a function, in which the area of definition is a medium U, $u \in U$, and the field of values has a single interval [0,1]. The higher $\mu_A(u)$, the higher in fuzzy set A would be assessed the degree of belonging to the element of medium u. Fuzzy number is a fuzzy subset of the universal set of real numbers, which have both normal and convex membership functions, i.e.:

- There is such a value of medium, in which membership function is one;
- For the assignment of the maximum left or right, the membership function disappears.

The scientific literature identified two types of fuzzy numbers: trapeze and triangular. Consider the quasi stats and linguistic variable Ω = "The value of parameter U", where U is the set of values of the medium of quasi statistics. One distinguishes two sets of values: T1 = "U is in the range of about a to b" with fuzzy subset M1 and ring value T2 with fuzzy subset M2, moreover U updated with M2 = M1. Then the membership function μT1(u) has trapeze look (Figure 1).

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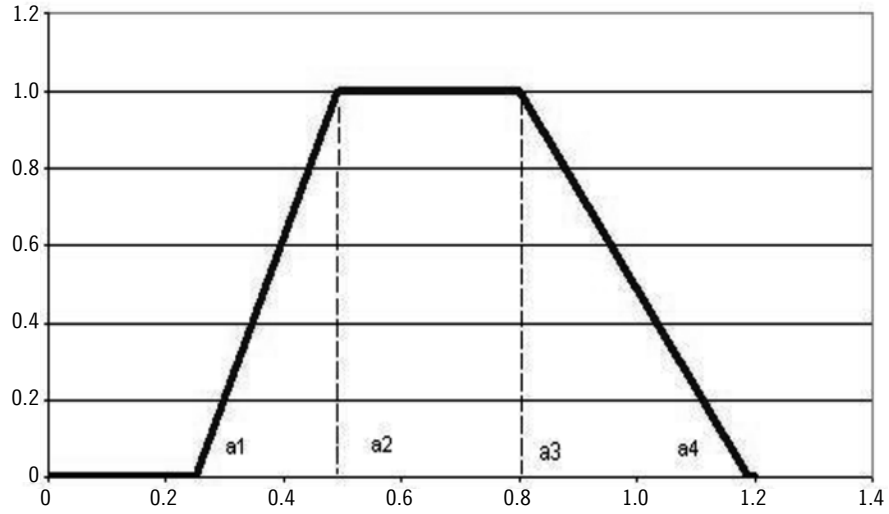
Figure 1. The membership function of trapeze value



Source: Filimonenkov (2004).

As the boundaries of interval are defined unclearly, one needs to enter abscissas tops of trapeze as follows:

$$a = (a_1 + a_2)/2, \, в = (в_1 + в_2)/2, \tag{5}$$

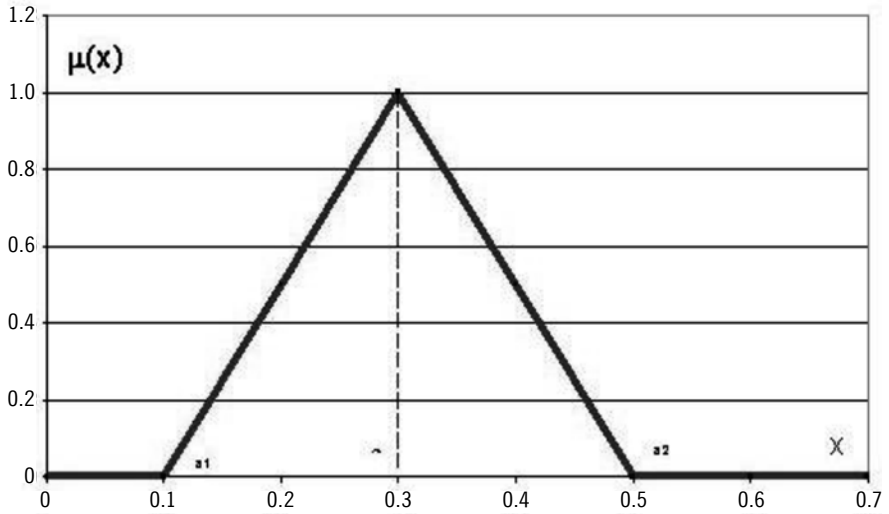
Herewith the distance of tops a_1, a_2 and $в_1$, $в_2$ accordingly from each other, depends on what demands are made.

Obviously that $a \pm \delta \approx a$, moreover with the reduction of δ to zero, the degree of certainty in assessment grow to one. This is in terms of membership function, it creates a triangular form (Figure 2); moreover, the degree of approximation determines the expert.

Triangular numbers is a type of fuzzy numbers that is often used in practice as a projected setting.

A section of fuzzy sets (fuzzy arithmetic) introduces a set of operations on crisp numbers. These operations are administered through the operation on the membership function based on the so-called principle of segment.

Figure 2. The membership function of fuzzy triangular numbers



Source: Filimonenkov (2004).

Basic operations on fuzzy numbers are reduced to operations with their credibility intervals. Transactions with intervals, in turn, expressed through operations with real numbers have the boundaries of intervals:

- operation"addition":

$$[a_1, a_2] (+) [b_1, b_2] = [a_1 + b_1, a_2 + b_2], \quad (6)$$

- operation "subtraction":

$$[a_1, a_2] (-) [b_1, b_2] = [a_1 - b_2, a_2 - b_1], \quad (7)$$

- operation "multiplication":

$$[a_1, a_2] (\cdot) [b_1, b_2] = [a_1 \cdot b_1, a_2 \cdot b_2] \quad (8)$$

Analyzing the properties of linear operations with fuzzy numbers, the researchers reached the conclusion that the shape of membership functions of fuzzy numbers is often close to triangular. This allows providing to the received result a triangular form.

It is believed that all financial figures for the number of years in the business plan should be shown in the form of triangular fuzzy sequences that characterize optimistic, pessimistic and most anticipated financial results. This is because the resulting

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performances of the business plan for several years (NPV, EVA, IRR, etc.) can be obtained as a result of the task using the method of fuzzy numbers.

Consider the process of business planning in vague terms when uncertainty allows one to create symmetrical interval estimations. Especially, this situation is typical for business plans when the original data have a maximum uncertainty. If all the parameters of the business plan are interval-symmetric, one can determine the resulting index of the business plan efficiency, net present value of the project (NPV), to interval-symmetric form by making an asymmetrically diffuse discount factor.

One can predict net sales of agricultural products. The purpose of this section is to develop models for evaluating net income of the Ternopol region farms using the theory of fuzzy sets on the condition that the upcoming sales of each product are known.

The formula for determining net income is as follows:

$$P = \sum_{i=1}^{N} x_i p_i \,, \tag{9}$$

де P – Meaning of net income;
N – Number of types of sales;
x_i – Planned sales volume of i-type;
p_i – Price sales of i-type.

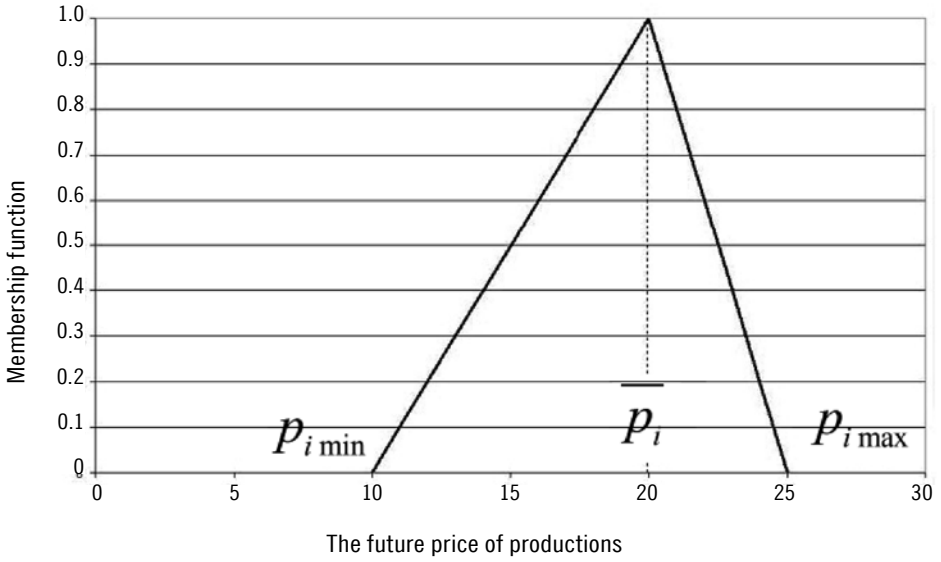
Settings of selling price of each product are not known at the time of income assessment; they are characterized by "blurring", are unclear, and their exact planned values are unknown. It is therefore advisable as input data for the model to use the triangular fuzzy numbers with membership function. These numbers simulating a saying: "Parameter A is approximately equal to $\bar{a}$ and clearly is in the range: $A \in [a_{\min}, a_{\max}]$".

After analyzing the market, a financial analyst or a person who decides concludes that the sales price of p_i i-type product next year can vary in the following ranges:

- Minimal price $p_i = p_{i\min}$;
- Medium expected price $p_i = \overline{p_i}$;
- The maximum price $p_i = p_{i\max}$.

A description allows one to consider the future price of realization *i*-type products as a triangular number $\underline{p_i} = (p_{i\min}, \overline{p_i}, p_{i\max})$. In this case, one can portray this price as a triangular fuzzy number (Fig. 3). Further one would call the parameters $(p_{i\min}, \overline{p_i}, p_{i\max})$ as significant points.

Figure 3. The future price sales of *i*-type



Source: The forecasting of resulting price.

As pointed out earlier, the basic arithmetic operations on triangular numbers is performed by executing the corresponding arithmetic operations with their significant points. Moreover, the product of triangular number on the usual "clear" is a triangular number, and the sum of triangular numbers is also a triangular number. Therefore, the assessment of net sales is a triangular number. One denotes it as: $\underline{P} = \left(P_{\min}, \overline{P}, P_{\max}\right)$. Then, of course, the assessment of net income is calculated as:

$$\underline{P} = \sum_{i=1}^{N} x_i \underline{p_i}$$

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Taking into account the above observations,

$$\begin{aligned} P_{\min} &= \sum_{i=1}^{N} x_i p_{i\min} \\ \overline{P} &= \sum_{i=1}^{N} x_i \overline{p_i} \\ P_{\max} &= \sum_{i=1}^{N} x_i p_{i\max} \end{aligned} \tag{10}$$

Then,

$$\underline{P} = \left(\sum_{i=1}^{N} x_i p_{i\min}, \sum_{i=1}^{N} x_i \overline{p_i}, \sum_{i=1}^{N} x_i p_{i\max} \right) \tag{11}$$

The model was used to estimate revenue from the sale of agricultural products by enterprises of the Zborov district. Planned sales of each product in 2011 (according to the developed consolidated plan of agriculture), and predicted maximum, minimum and average price for selling are given in Table 1.

Table 1. Value of expected prices of agricultural products in Zborov district in 2013, UAH/t

Type of product	Sales of products, t	Price per 1 ton, UAH		
		Minimum	Average	Maximum
Grain	41661,00	1249,26	1409,90	1581,05
Soy	296,00	317,28	358,08	401,55
Seeds of winter rape	12187,00	2636,29	2975,29	3336,47
Seeds of spring rape	2967,00	501,77	566,29	635,04
Sugar beets	44400,00	470,46	530,96	595,41
Cattle and poultry in live weight	1200,00	9506,72	10729,18	12031,64
Honey	0,48	14780,78	16681,44	18706,46
Unskimmed milk	835,00	2706,07	3054,04	3424,78

Source: calculated by fuzzy numbers method.

Through forecasting the prices of products, data was used on the sales price of each species in 2010 and inflation indexes for the past 10 years. On the basis of the minimum, maximum and average values for the period of annual inflation indexes, forecasts were made for minimum, maximum and average prices for certain products for the following year. Note that the financial analyst for forecasting the prices of sales for the next year may use various statistical, econometric methods and approaches or methods of mathematical modeling and forecasting. The result is the set of triples values of expected prices.

The model gives an estimate of income in the form of fuzzy numbers. According to the developed project in the consolidated plan for agriculture, the expected revenue from sales is approximately 136 million UAH and is in the range [120; 152]. It was established that this method allows predicting the future income of the planned targets.

The obtained result for management decisions can be used in planning production in Zborov district and on farms in particular. The proposed model can also be used to determine:

- List of ways to optimize crops on farms, including what crops should be grown to preserve and increase profitability;
- Optimal sales of agricultural products according to predictable prices;
- Viewing range of assortment in agricultural enterprises.

Similarly, the method of fuzzy sets can be used for assessment of other variables for business planning of agricultural enterprises, like costs for example.

It is considered that the above example shows that fuzzy sets are the optimal tool for modeling the behavior of financial systems under uncertainty. When subjective probabilities are used in management rather than inertia, they are increasingly more limited in terms of information and they are insufficient and unreliable. Probability models have increasing difficulties in describing the realities of the 21st century. The scientific paradigm of financial management is changing rapidly and old methods are likely behind.

Consequently, the use of fuzzy sets has several advantages because it allows one to satisfy qualitative changes to analysis, quickly model complex dynamic systems and equate them to the desired accuracy to overcome the disadvantages and limitations of existing methods of risk. The disadvantages of fuzzy models are subjectivity in the choice of membership functions and forming the base, lack of information about the method,

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paying little attention for using methods of professional financial institutions and the large lack of special software and the availability of specialists who could work on this.

Despite its shortcomings and limitations, the method of fuzzy sets is considered promising and one that allows certain results for major international companies. For Ukrainian markets, this method is especially promising: it does not preclude the use of statistical methods but becomes a tool when other approaches to risk assessment are not suitable.

Conclusions

Scientific and methodological approaches in the development of business plans are thereby improved, which allows analyzing business activities in accordance to the requirements of a certain type of plan. The method of income assessment by using the method of fuzzy numbers in the example of Zborov district farms has essential meaning for market researchers and for practice management in conditions of valid information uncertainty. The proposed method also helps to estimate the efficiency of the plan.

The author proposes using mathematical modeling by using the fuzzy numbers method for the evaluation of future income for planned (in the developed financial section of the business plan) output. This method allows determining the minimum, average and maximum values for income in developed business plans. Assessing may be done for both agricultural development in the preparation of consolidated development plans of the agro industrial complex, and for separate companies for developing business plans. The author believes that the fuzzy sets are the optimal tool for modeling behavior of financial systems under uncertainty.

To improve this situation, the author proposes to:

- Lead seminars for district leadership about the prospects for farm use planning methods at the Department of Agricultural Development;
- Provide them with literature about business plans (brochures, guidelines, etc.).

Proper planning of activities will enable increasing the profitability of the companies as well as raising the national economy.

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