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THE INNOVATIVE POTENTIAL OF AGRO-PROCESSING ENTERPRISES IN THE CONTEXT OF RESOURCE CONSERVATION AND CRISIS MANAGEMENT

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Abstract

Under conditions of fierce competition, financial instability, and limited resources, the functioning of agro-processing enterprises is accompanied by various crises, which can result in financial insolvency or bankruptcy of these entities. In this situation, the use of innovations in processing that provides a positive effect on the implementation of crisis management measures is the basis for the formation of competitive strategic prospects of agricultural enterprises. The probability of success in avoiding crises directly depends on the level of innovation activity of a particular enterprise, which defines the relevance of determining the level of product innovation potential. However, in many cases, modern economic reality requires decision-making in conditions of uncertainty that makes it impossible to correctly apply deterministic models. Therefore, in crisis management, the use of fuzzy logic gives more reliable results than those obtained using traditional methods. For this reason, the aim of the research is to evaluate innovative products on the basis of "quality-price" criteria with vague assessments of criteria relevance.

The article describes the justification of using the apparatus of fuzzy set theory in solving problems of crisis management in conditions of uncertainty based on the possibility of formalizing more flexible relationships between parameters that is more consistent with the nature of real phenomena and allows to make reasonable decisions by generalizing and analyzing qualitative values. The authors propose a method of assessing the prospects of any innovative product, based on the use of the fuzzy-multiple approach.

Using fuzzy numbers and soft calculations created the possibility of making a multi-criteria choice of an alternative product and taking into account the uncertainty factor due to incomplete relevance between a prototype and an innovative product, as well as the fact that market conditions for the prototype relate to the past.

The proposed method of assessing the innovative potential of products can be used in the practice of enterprises in the process of solving problems of crisis management, characterized by a high degree of non-static uncertainty.

Key words: *Innovation, Product, Crisis management, Uncertainty, Fuzzy-multiple approach.*

1. Introduction

Given the low thresholds of adaptive capacity of agro-processing enterprises, political, economic, institutional instability, lack, wear or limited resources and fixed assets required for innovative economic activity, the creation, testing, and commercialization by bringing innovative products to market is the basis for ensuring

the appropriate level of competitiveness of agro-processing enterprises in the implementation of crisis management measures. In this context, the efficiency and profitability of agro-processing enterprises, increasing adaptive capacity while overcoming the crisis directly depends on their innovation policy, the successful distribution, and use of innovation potential [1]. At the same time, it should be emphasized that difficult access, dispersion, distortion, and low accuracy in the process of making management decisions are the most important strategic tasks that need to be solved in the process of effective crisis management under external environment turbulence, globalization, and limited resources. It should also be borne in mind that not all information or non-economic indicators can be calculated and expressed as absolute or relative indicators in the functioning of agro-processing enterprises [2]. However, the failure of taking into account such indicators leads to limited, loss of important factors and irrational use of financial, technical, information resources needed by agro-processing enterprises for the stable performance of their activities based on innovation and resource conservation.

Many scientific studies of the development and implementation of resource-saving innovations, as well as the effective implementation of crisis management measures in agro-processing enterprises, have been conducted. For instance, to ensure the efficiency of the process of resource conservation in agro-processing enterprises, the methods of implementing a system of sustainable resource planning as one of the measures of crisis management are considered in the articles by Nofal and Yusof, [3] and Chofreh *et al.*, [4]. McAdam *et al.*, [5], studies the characteristics and prospects of horizontal innovative resource-saving networks in agro-processing enterprises in the UK. Zos-Kior *et al.*, [6], proposes a method for assessing the economic efficiency of innovative projects for resource conservation in agro-processing enterprises. Herbane, [7], proposes the ways to assess the value of sources of information needed to plan crisis management activities in agro-processing enterprises. Lalonde *et al.*, [8], and Erol *et al.*, [9], consider the theoretical aspects of the organization of crisis management and identified the main financial measures to be taken by enterprises in a crisis. In the article Hsieh and Chou [10], the models of system dynamics of indicators of small and medium agro-processing enterprises activity before and after the introduction of innovations in the field of services for the development of assessment mechanisms of expediency of them in the conditions of a crisis have been constructed. Laperche *et al.*, [11], considers the peculiarities of the formation of innovative strategies in the context of the implementation of crisis management measures in French enterprises. Studies by Luo *et al.*, [12], and Galliano *et al.*, [13], identify the benefits of implementing technological and environmental innovations in agro-processing plants in the conditions of fierce competition and limited tangible and intangible assets in China and France.

Paying tribute to these scientific works on solving the problems of crisis management in the agro-processing sector by increasing and accumulating the innovative potential of enterprises, it should be noted that they insufficiently considered the method of evaluating the effectiveness of innovations taking into account inaccessibility, dispersion, distortion and low accuracy of the information in the macro-environment that comes to the enterprises. In this regard, the aim of the study is to determine the connections between quality and cost of agricultural goods, as well as the need on this basis to make management decisions in conditions of limited information, high financial risk, and instability of the business environment using mathematical tools approximate calculations and symbolic fuzzy logic in conditions of difficult prediction of the speed of environmental changes.

2. Materials and Methods

Trending tendencies in the market environment due to the unpredictability of their effects on the microenvironment of agricultural enterprises make it impossible to use common in mathematics deterministic models that can be used to plan and implement anti-crisis measures due to the factors of unpredictability, randomness, chaotic property of the system that characterize the modern market economy especially in the conditions of the pandemic and the spread of COVID-19. That is why the use of approximate calculations and symbolic fuzzy logic in crisis management in agro-processing enterprises gives more authentic and true results than those obtained by describing scientific methods based on the studying of mass phenomena that allow quantification of large data processing.

The tools of approximate calculations and symbolic fuzzy logic are used in the study to assess the feasibility of creating, testing, and subsequent commercialization of any innovative products in a crisis at agro-processing enterprises, causing the need for bifurcation changes. This choice is due to the possibility of generalization, formalization, and comparative studies of a large array of data using this mathematical tool and determine the non-dogmatic relationship between the input non-numerical parameters of quality and cost of products related to innovations, as well as the need for making authenticated management decisions under inaccessibility, distortion, low level of information accuracy and lack of financial resources.

3. Results and Discussion

The primary task of crisis management of agro-processing enterprises in the context of globalization of agricultural markets is to increase the competitiveness of their products, which is possible under the conditions of total implementation at the micro-level of innovative resource-saving technologies, development, testing, implementation, and commercialization of innovative products, which are unique and do not have analogs at least on the national market [14]. There is a need at the enterprise level to apply the method of evaluation and comparison of products that are planned as unique and innovative with those that are similar in quality in the context of parity of their cost and quality for making authentic management decisions concerning the expediency of the uniquely-innovative products in economic activity of the agro-processing enterprise.

We believe that the primary task for assessing the degree of parity and feasibility of choosing between two goods managers of agricultural enterprises must determine the multiplicative value of the congruence of their implementation (E_i) in the current activity by formula (1):

$$E_i = \tilde{P}_i * \tilde{Q}_i, \quad (1)$$

Where: $\tilde{P}_i$ - the adjusted cost of goods sales (innovation or similar in a quality sample); $\tilde{Q}_i$ - adjusted indicator of goods quality (innovation or similar in a quality sample).

Based on the formula (1) there is a need to describe the definition of the adjusted cost of goods sales (innovation or similar in a quality sample). It should be noted that there are both implicit and explicit factors that affect the formation of the cost of goods of the agro-processing enterprise: implicit factors are factors that depend entirely on the effectiveness of internal management of the enterprise; explicit ones - are factors that are formed in the external environment and which cannot be influenced by the managers of the enterprise. The explicit factors are difficult to predict and are the biggest threat to the company in a crisis situation in the economy. Wherein the explicit factors influencing the prime cost are forecasted in the conditions of uncertainty or some limited information. There is a need to apply symbolic fuzzy logic in the implementation of crisis management costing, and hence the market price for an innovative product, which is reflected in the following logical algorithm.

Thus, as a practical example, we assume that the agro-processing enterprise *"N"*, in the process of implementing crisis management policy, revises the production strategy in the direction of an innovation-oriented one and evaluates the feasibility of replacing the traditional product I_b with innovative I_n. In particular, *"N"* produces and sells traditional samples of goods (I_{b1}, I_{b2}, I_{b3}), the cost of which is: $I_{b1} = \$145 ; I_{b2} = €110 ; I_{b3} = €152.$

In response to increased competition, the management of *"N"* in the process of implementing anti-crisis measures plans to release a new product that has all the features of innovation or know-how (I_n), the costing of which is complicated by the presence of explicit factors. We believe that the most congruently approximate value of the cost of the innovative product or know-how should be denoted by a fuzzy value. This quantity is an abstract concept of fuzzy mathematics, which is a function of the allowable values of a fuzzy interval with a convex or unimodal membership function. In this case, the product with innovative properties or know-how (I_n) will have certain quality characteristics that the basic products (similar in quality but not innovative) (I_{b1}, I_{b2}, I_{b3}) already have, but currently produced by the agro-processing enterprise. Therefore, the cost of the know-how or innovative product should be estimated using qualitative (non-numerical) characteristics of the traditional product sample I_b. There is a need to compare products I_b and I_n, so we give a reasonable sequence of such comparisons.

Firstly, to make an expert comparison of I_b and I_n it is necessary to choose a set of qualitative characteristics (R_1, R_2, R_3, R_4, R_5) of agricultural products I_b and I_n and determine the weight of each *i*-th characteristic by forming a 5-point rating. The results of this rating are shown in Table 1.

Table 1. The results of the rating evaluation of the importance of the complex of qualitative product characteristics (I_n) and (I_{b1}) of the agro-processing enterprise by experts, (points)

Determination of weight by an expert $X_{1...n}$	Weight evaluation set by an expert $X_{1...n}$ qualitative characteristics (I_n) and (I_{b1}) of an agro-processing enterprise				
	R_1	R_2	R_3	R_4	R_5
X_1	3	3	5	4	4
X_2	4	4	3	3	4
X_3	2	4	5	1	5
X_4	4	3	2	4	2
X_5	5	1	3	4	4
Overall rating	18	15	18	16	19

According to the results of the rating evaluation of the weight of the complex of qualitative characteristics of products (I_n) and (I_{b1}) of the agro-processing enterprise by the experts, we propose to calculate

the arithmetic mean of the obtained evaluation of the weight of qualitative characteristics ($\overline{R_i'}$). Based on the indicators from Table 1 we obtained the following indicators: $\overline{R_1'}$= 3.6; $\overline{R_2'}$= 3; $\overline{R_3'}$= 3.6; $\overline{R_4'}$= 3.2; $\overline{R_5'}$= 3.8.

After rating the importance of the complex of qualitative characteristics of goods (I_n) and (I_{b1}) of the agro-processing enterprise, the experts propose to compare these characteristics of goods ($\overline{R_i''}$). The results of this assessment are shown in Table 2.

Table 2. Comparative assessment of the level of quality characteristics of goods (I_n) and (I_{b1}) agro-processing enterprise, (points)

Determination of the indicator of the set of qualitative characteristics by an expert $X_{1...n}$	Goods	Qualitative characteristics of goods (I_n) and (I_{b1})				
		R_1	R_2	R_3	R_4	R_5
X_1	I_n	10	9	10	9	10
	I_{b1}	9	6	5	5	7
X_2	I_n	10	5	9	10	9
	I_{b1}	9	9	7	6	5
X_3	I_n	9	10	9	9	8
	I_{b1}	7	9	5	5	5
X_4	I_n	10	10	10	8	9
	I_{b1}	8	5	9	9	10
X_5	I_n	8	8	5	10	8
	I_{b1}	6	4	9	9	4
Overall rating	I_n	47	42	43	46	44
	I_{b1}	39	33	35	34	31

According to the results shown in Table 2, we propose to calculate the arithmetic mean of the level of availability of qualitative characteristics of goods (I_n) and (I_{b1}) of the agro-processing enterprise ($\overline{R_i''}$). Accordingly the indicators of table 2, we obtain the following arithmetic mean values:

For the product (I_n): $\overline{R_1''}$=9,4; $\overline{R_2''}$=8,4; $\overline{R_3''}$=8,6; $\overline{R_4''}$=9,2; $\overline{R_5''}$=8,8, and

For traditional goods (I_{b1}): $\overline{R_1''}$=7,8; $\overline{R_2''}$=6,6; $\overline{R_3''}$=7,0; $\overline{R_4''}$=6,8; $\overline{R_5''}$=6,2.

After a comparative assessment of the level of availability of qualitative characteristics of goods (I_n) and (I_{b1}) of the agro-processing enterprise, it is necessary to assess each qualitative characteristic taking into account its weight and the level of its availability for goods (I_n) and (I_{b1}). Then we propose to calculate the total amount of points for goods (I_n) and (I_{b1}). To do this, it is advisable to use the following formula (2):

$$R_i^b = \overline{R_i'} * \overline{R_i''}, \quad (2)$$

Where: R_i' is the arithmetic mean of a particular indicator from the complex of qualitative characteristics with the *i*-th weight; R_i'' is the arithmetic mean of the presence of a certain qualitative *i*-th characteristic of goods (I_n) and (I_{b1}).

The results of these calculations are given in Table 3.

Based on the use of data from Table 3 it is necessary to calculate the price for one evaluation point (P_1). To do this, the following formula can be used (3):

$$P_1 = \frac{P_{I_{b1}}}{G_{I_{b1}}}, \quad (3)$$

Where: $P_{I_{b1}}$ - the specified cost of goods I_{b1} (€103.5); $G_{I_{b1}}$ - the total amount of points received by the product I_{b1} according to the results of the evaluation of the set of qualitative characteristics taking into account their weight and the level of availability in it. Thus, P_1 will be equal to €0.84.

To determine the price for the product (P_{I_n}), which will be beneficial for the company, it is advisable to use the following mathematical expression (4):

$$P_{I_n} = P_1 * G_{I_n}, \quad (4)$$

Where: G_{I_n} - the total amount of points received by the product (P_{I_n}), based on the evaluation of the set of qualitative characteristics, taking into account their weight and the level of availability in it.

Table 3. The results of evaluating the quality goods characteristics taking into account their weight and the level of their availability in the goods (I_n) and (I_{b1}) of the agro-processing enterprise, (points)

Goods	Qualitative characteristics of the innovation-product (I_n) and the base product (I_{b1})					Overall evaluation of goods (G_{In}), (G_{Ib1})
	R_1^b	R_2^b	R_3^b	R_4^b	R_5^b	
I_n	33.84	25.20	30.96	29.44	33.44	152.88
I_{b1}	28.08	23.40	25.20	21.76	23.56	122.00

Using formula 4, we obtain the amount that equals €154 as the optimal price for a product with innovative properties.

Having estimated the optimal price (P_{I_n}), it is possible to calculate the adjusted sales price for all products according to the following formula (5):

$$\widetilde{P_i} = \frac{P_i^{-1}}{\sum P_i^{-1}}, \quad (5)$$

As a result of calculations we will get the following values of the adjusted indicators of the sales price for the innovation-product and traditional goods: $\widetilde{P_{I_n}}$ = 0.21537; $\widetilde{P_{I_{b1}}}$= 0.27030; $\widetilde{P_{I_{b2}}}$= 0.30168; $\widetilde{P_{I_{b3}}}$= 0.21773.

After estimating the adjusted sales price indicators for goods (I_n) and (I_{b1}) it is necessary to estimate the adjusted quality indicators for the compared goods. To do this, we suppose that according to the results of the rating assessment carried out by an expert $X_{1...n}$, in terms of quality our compared products received the following ranks in the rating: q_{I_n}= 1; $q_{I_{b1}}$= 2; $q_{I_{b3}}$= 3; $q_{I_{b2}}$= 4.

Based on the results of the rating, it is necessary to estimate fuzzy quality adjustment coefficients (Q_i) using the mathematical expression (6):

$$Q_i = 1 - (q_i - 1) * k^{-1}, \quad (6)$$

Where: k is the total number of goods produced by the enterprise *"N"*.

So, we obtain the following results calculated with the formula (6): Q_{I_n}=1; $Q_{I_{b1}}$= 0.75; $Q_{I_{b2}}$= 0.25; $Q_{I_{b3}}$= 0.5.

The estimation of fuzzy quality adjustment factors makes it possible to calculate the adjusted quality indicators for goods (I_n) and (I_{b1}) according to the following formula (7):

$$\widetilde{Q_i} = \frac{Q_i}{\sum Q_i}, \quad (7)$$

As the results of the calculations, we obtain the following values of the adjusted quality indicators for the goods (I_n) and (I_{b1}): $\widetilde{Q_{I_n}}$ = 0.4; $\widetilde{Q_{I_{b1}}}$= 0.3; $\widetilde{Q_{I_{b2}}}$= 0.1; $\widetilde{Q_{I_{b3}}}$= 0.2.

In order to estimate the value of the indicator of the need for commercialization and distribution of goods among consumers, it is necessary to substitute the obtained values of the adjusted indicators of the cost of goods and quality to the formula (1). Consequently, we obtain the following results: E_{I_n} = 0.08614; $E_{I_{b1}}$= 0.08109; $E_{I_{b2}}$= 0.03016; $E_{I_{b3}}$= 0.04354.

In the process of implementing the crisis management policy and resource conservation to determine the most optimal and effective goods for the sale, it is necessary to compare the calculated values of prospective sales among consumers using weighted aggregate power intervals of fuzzy sets (F_i). As a result, for the product (I_n) and products (I_{b1}) the indicators of optimal sales of goods among consumers will be as follows: $F_{E_{In}}$ = 0.17219; $F_{E_{Ib1}}$= 0.10411; $F_{E_{Ib2}}$= 0.03701; $F_{E_{Ib3}}$= 0.06335.

The calculations showed that the product with innovative properties or know-how (I_n) in terms of optimality among consumers significantly exceeds the calculated indicators of products (I_{b1}), which did not have innovative properties and therefore can be recommended for launching its production, as a component of the anti-crisis management policy implemented by the management of the agro-processing enterprise.

Thus, the use of tools of mathematical apparatus of approximate calculations and symbolic fuzzy logic to estimate the optimal implementation and realization of new innovative products by agro-processing enterprises allows performing a multicriteria assessment of the feasibility of creating, testing, and further commercialization of any innovative products in the context of cost, resource conservation and quality in conditions of uncertainty of the business environment.

4. Conclusions

- As a result of the study, it is proved the expediency of using approximate calculations and symbolic fuzzy logic in anti-crisis management based on the in-depth study of the relationship between quality standards and cost of innovative and traditional products, aimed at resolving crisis situations characterized by the presence of the factor of significant randomness during the periods of bifurcations of business entities.
- Thus, the usage of various logical operations of multi-criteria selection to determine the optimal launch and implementation of new innovative products by agro-processing enterprises makes it possible to assess the feasibility of creating, testing, and further commercialization of any innovative products in the context of cost, resource conservation and quality which contributes to the selection of the optimal

innovative product taking into account the variability of the external environment.

- Also it allows to solve the problem of possible discrepancy and the need for diversification between traditional and innovative goods, given that market conditions for traditional products relate to the past, and for innovative - to the future and prospective conditions. In the conditions of aggravation of competition, globalization of the market of agricultural products, carrying out of anti-crisis management the offered technique of accumulation of innovative potential of the agro-processing enterprise by means of the usage of approximate calculations and symbolic fuzzy logic to the estimation of optimum introduction and realization of innovative products will facilitate making effective management decisions in conditions of the lack of resources, chaotic system, inaccuracy of the information and crisis phenomena.

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