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# QUALITY CRITERIA IN APPLYING A STIMULATION MODEL IN LIVESTOCK AGRICULTURAL ENTERPRISE MANAGEMENT

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## *Abstract*

Modern economic development is characterized by such features as innovation, dynamics and globalization. Timely and maximally quick pro-cessing of socio-economic data, their analysis and obtaining new, non-trivial knowledge about the economic condition of the enterprise and the choice of "preferred managerial" decisions is a key task of economic development. The management of livestock agricultural enterprises constantly has to decide the following question: how decision-making should be organized to maximize remuneration? The study describes the procedure for selecting quality criteria in applying a simulation model in livestock agricultural enterprise management. The recommended procedure includes requirements that must be met by quality criteria. They should allow calculating the achievement of the goal by means of the chosen strategies, as well as taking measurements at the highest levels - scales of intervals or relations. The recommended selection procedure includes: eliminating the ambiguity of goals, agreeing on a list of goals, scaling goals, conducting ranking of quality criteria, setting single-criteria or multi-criteria decision-making tasks. Corresponding mathematical tools are given. The elimination of the uncertainty of goals is carried out by experts. The result of eliminating the uncertainty of goals is to generate a list of goals that are pursued by the decision maker (DM). Preliminary verification of goals for feasibility - economic, social, physical, etc. carried out using a semantic analysis. Relationship scales are preferred for quality criteria used in simulation models. At the end of the procedure for selecting quality criteria, mathematical formulations of single-criteria and multi-criteria decision-making problems are formulated.



**Keywords:** Agribusiness, livestock agricultural enterprise, quality criteria, simulation model, decision maker, management.

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## 1. Introduction

One of the main national goals of the Russian Federation is to develop a highly productive export-oriented sector based on modern technologies in the agro-industrial complex. Livestock agricultural enterprises form the backbone of such sectors. The livestock agricultural enterprise management constantly has to answer the following question: how decision-making should be organized to maximize income. For the case of using the criteria-based approach to decision-making (Shepel, Speshilova, & Kitaeva, 2019) it is advisable to formulate a statement of the problem, select quality criteria, determine manageable parameters, describe disciplining conditions, build a simulation model, make calculations with it and make a decision.

There are three types of problem statements: GDMT - general decision-making task, SP - selection problem and GOP - general optimization problem. There is no information on performance indicators and solution alternatives in the statement of GDMT; SP contains only solution alternatives; GOP contains both information on performance indicators and solution alternatives. Missing performance indicators (quality criteria) must be obtained in the process of decision-making. Therefore, the development of methods for selecting quality criteria in order to justify management decisions at agricultural enterprises using simulation modeling is relevant.

## 2. Problem Statement

The study and management of economic systems of great complexity (Mesjasz-Lech, 2014), which include livestock agricultural enterprises, led to the use of computer simulation (Podinovskaya & Podinovsky, 2014; Shepel, 2004) and primarily imitation. The large dimension, lack of formalizability, and often random factors make it difficult to use classical mathematical methods and, in particular, mathematical modeling methods (Zavodchikov, Speshilova, & Andrienko, 2016; Speshilova, Shevrina, & Korabeynikova, 2012). It should be noted that simulation is not widely used when using the criteria-based method for managerial decisions of agricultural enterprises.

## 3. Research Questions

The livestock agricultural enterprise carries out organized activities with specific goals, the achievement of which can best be carried out using simulation models. A quantitative assessment of the achievement of goals should be measured using optimality criteria, which are a mathematical representation of the goals pursued by the enterprise.

The study considers the following issues:

- How to draw up many goals that ensure optimal management in a livestock agricultural enterprise;
- How to relocate multiple goals into multiple criteria using expert assessment;
- Determine a principle of compromise necessary in achieving the local criteria.

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## 4. Purpose of the Study

Quality criteria are used to compare the achievement of the goal using the selected method of action. It is proposed to apply an informal procedure of five stages to select quality criteria: 1) eliminate ambiguities of goals; 2) carry out semantic analysis of the list of goals; 3) carry out scaling; 4) conduct a ranking of quality criteria; 5) formulate single-criteria and multi-criteria decision-making problems. In this regard, the purpose of the study is to obtain a procedure for selecting quality criteria in applying a simulation model in livestock agricultural enterprise management.

## 5. Research Methods

Quality criteria should have the following features (Orlov, 2011; Shepel & Akimov, 2015):

1) Calculate the achievement of the goal using selected strategies;

2) Carry out measurements at the highest levels - scales of intervals or relations;

3) Have a simple interpretation;

4) Comply with the law of large numbers.

Elimination of ambiguity of goals. There are usually three types of uncertainties in general decision-making tasks: uncertainty of goals, uncertainty of our knowledge of the environment (uncertainty of nature) and uncertainty of the actions of a real partner. The result of this procedure for selecting quality criteria is the generation of the list of goals that are pursued by the decision maker (DM).

The elimination of uncertainty of goals is carried out with the involvement of experts. The use of experts ensures the application of individual or collective experience. We have simple and complex expert evaluation. The use of collective evaluation led to various kinds of voting, description and analysis. In practice, there are some problems when it is impossible to find experts who can give a fairly reliable evaluation of them. For this case, expert evaluation must be specially organized. Examples of complex evaluation:

a) Goal tree method;

b) Decision matrices method;

c) Discussion and commentary.

Semantic analysis of the list of goals is carried out in the following sequence:

1) Verification of the independence of goals among themselves in the list of goals. The possibility of having only independent goals in the list of goals;

2) Verification of the consistency of goals at different levels;

3) Preliminary verification of goals for feasibility - economic, social, physical, etc.;

4) Goals are formulated, being previously agreed with the decision maker and all experts.

Scaling is to:

- Determine the unit of measure for each selected goal;
- Determine the scale for measuring goals (according to the increasing number of possible mathematical operations with quality criteria, the most common are scales; order scales; interval scales; relationship scales).

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Relationship scales are preferred for quality criteria used in simulation models. The numbers that you usually have to deal with in this case are many real numbers, characterized by the following axioms:

1. For any criteria eki, ekj ∈ R a single number is defined as:
   eki + ekj ∈ R. (1)
2. For any criteria eki, ekj ∈ R the ration is defined as:
   eki + ekj = ekj + eki . (2)
3. For any criteria eki, ekj, ekz ∈ R the ration is defined as:
   (eki + ekj) + ekz = ekj + (eki + ekz). (3)
4. For 0 ∈ R we have the following formula:
   eki, + 0 = eki is for all ek ∈ R; (4)

- Determining the obtained quality criteria

ek →(max, min, ek0); (5)

- Determining the possible measurement scale:

ek = Ωe ; (6)

where Ωe – the range of acceptable values of the quality criterion;

- quality criteria are in increasing order of importance for decision makers.

Table 01 shows possible results when selecting quality criteria.

**Table 01**. Selection of quality criteria

| **Quality Criterion (QC)** | $e_1$ | $e_2$ | … | $e_n$ |
|---|---|---|---|---|
| Rank QC | 1 | 2 | ... | $n$ |
| Weight QC | $w_1$ | $w_2$ | … | $w_n$ |

Source: authors.

It is advisable to establish standards to weight QC:

$\sum_{i=1}^{n} w_i = 1.$ (7)

Summarizing the procedure for selecting quality criteria, we formulate 7, (Nogin, 2007) mathematical statements of single-criterion (case 1) and multi-criteria (case 2) decision-making problems related to deterministic static ones.

Case 1. The management efficiency is characterized by numerical criterion - F:

F=F(X,C,ξ) (8), (8)

where X=(x1,x2,…,xn) – n –dimensional control vector,

C – an array of fixed nonrandom parameters,

ξ – an array of fixed random parameters.

The decision maker seeks to maximize the value of the quality criterion:

F=F(X,C,ξ)→max. (9)

The means of achieving this goal is the optimal choice of the control vector X from . Thus, it is required to find the value of the vector X and of the function E, satisfying the following condition:

¯E=E(¯X,C,ξ)=max¦(X∈Ωx) F(X,C,ξ). (10)

Case 2. A decision maker must determine the strategy that is best taking into account the vector of quality criteria importance and, moreover, belongs to of its acceptable values:

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$$\overline{E} = E(\overline{X}) = \underset{X \in \Omega_X}{opt} [E(X), \Lambda], \quad (11)$$

where – the optimal value of the quality criteria vector E, and opt denotes a certain optimization operator that is different for each multi-criteria operation. To simplify the study, it is convenient to accept the assumption that the strategy of the operating party is the n-dimensional vector, i.e.:

$$X = (x_1, x_2, ..., x_n) = (x_j), \ j \in \overline{1, n}. \quad (12)$$

Obviously, the elements of the control vector X (12) are associated with some restrictions caused by specific technical, physical and economic reasons. These restrictions can be represented in general terms as conditions:

$$g_i = g_i(C_i, X) \geq b_i, \ i \in \overline{1, m}, \quad (13)$$

Each particular criterion is associated with the strategy by some mapping, i.e.:

$$e_q = e_q(A_q, X), \ q \in \overline{1, k}, \quad (14)$$

where Aq – is a vector of fixed factors.

If the goal of the decision maker is to increase the possible values of all particular performance criteria, and the means to achieve the goal is the appropriate choice of strategy X from – its acceptable values, then it is obvious that the simultaneous achievement of the goal according to all local criteria by choosing a single strategy X is impossible. The solution is to resort to some compromise in achieving particular goals. Therefore, the decision-maker is forced to formulate some principle of compromise in achieving local goals and adhere to this principle when choosing the optimal strategy.

## 6. Findings

The study made it possible to determine the requirements that are desirable to meet the quality criteria: they allowed to calculate the achievement of the goal by chosen strategies; allowed measurements at higher levels - scales of intervals or relationships. The procedure for quality criteria selection in applying the simulation model in livestock agricultural enterprise management is obtained. In the beginning, the uncertainty of goals is eliminated with the involvement of experts. The use of experts ensures the application of individual or collective experience. It is useful to apply complex examinations: the goal tree method, the decision matrix method, discussions and commentary. Semantic analysis of the list of goals includes a check on the independence of goals in the list, as well as on feasibility - economic, social, physical, etc.

In the scaling process, the units of measure for each selected goal and the placement of quality criteria in ascending order of importance for the decision maker are determined. In conclusion, the procedures for quality criteria selection formulated mathematical formulations of single-criterion and multi-criteria decision-making problems.

## 7. Conclusion

When solving multicriteria decision-making problems, a number of specific problems arise that are conceptual in nature. For example, the search for acceptable solutions in the field of compromise can be

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carried out only on the basis of some compromise. The choice of a compromise corresponds to the disclosure of the meaning of the optimization operator, usually in the form:

$$\underset{x\in\Omega_x}{\text{opt}}\ E(X) = \underset{x\in\Omega_x}{\text{opt}}\ E(X) = \max \varphi[E(X)], \qquad (15)$$

where – a certain scalar function of the vector of E criteria.

When choosing a compromise scheme, one has to use various kinds of heuristic procedures in which experts play a significant role. So, the most important stage of the decision-making procedure is the selection of quality criteria. Choosing the wrong criteria means solving the wrong problem.

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