UDS 65.012.34: 631.115

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Modeling of decisions made by a member of the servicing cooperative in the system of modification and logistics of grain storage

Scientific problem. The activity of a modern agricultural servicing cooperatives is connected with technological (qualitative transition in subject of labor), logistical (storage, stocking transportation and so on) and other business processes.

The major part of servicing cooperatives in agribusiness are multifunctional and at the same time perform separate functions concerning logistical provision of a main type of business activity of their members. Hence these formations are cooperatives with attendant agrilogistics activity.

Besides among such cooperatives there are the agricultural servicing or manufacturing cooperative with one of the tasks is to provide separate logistical process (processes) in the activity of their members or other subjects of business activity [14].

Today specialization in activity of numerous multifunctional cooperatives is connected not only with features of providing business processes but also with types (fields) of their economic activity.

One of the most widespread formations in the world practice is a grain servicing cooperative with attendant logistical activity which is an important object of managing.

Along with that effective business activity of participants of such cooperatives requires application of appropriate ways of modeling managerial decisions.

Analysis of recent researches and publications. Problems of preparing managerial decisions with the help of methods and models of rationalistic logistics in grain field of agrarian-industrial complex are studied in works of such Ukrainian scientist as, Ya. Drobotia [1], I. Savenko [2], N. Tsymbalista [3], N. Vasylyeva [4] and others.

Study of agrarian logistics and features of using quantitative methods and models in the system of a farming and agrarian servicing cooperation is the subject of attention of such foreign researchers as H. Conte [10], B.L. Dahl [16], F. Dooley [8], J.R. Ellis [7], S. Frederico [6], A. Krueger [8], D.S. Lobo [10], I. Manikas [11], Sh.M. Schlecht [13], W.W. Wilson [16] and others.

General models of managing alternatives in the system of agrarian cooperation were studied by M. Lafleur [9].

D.S. Lobo and H. Conte considered separate methodical approaches to planning modification and strategy of logistics in storing coarse grains in cattle-breeding cooperatives [10].

W.W. Wilson and B.L. Dahl studied features of modeling risks and losses in cooperative logistics and marketing of grain in its general chain of export distribution [16]. In their studies along with Sh.M. Schlecht, they applied logistical approach MRP for modeling grain flow in material flow [13].

A. Krueger, F. Dooley, R. Berruto and D. Maier studied possibilities of imitative modeling expenses and risks in the process of after-gathering modification of grain on cooperative grain elevators [8].

However in most studies logistics of grain storing is considered only as a component of management in the supply chain (SCM) in agribusiness. At the same time the fact that it is one of the specialized types of agrilogistics of ration-

alistic or providing type and works both inside and outside the material flow is not considered. The fact the logistics is not equal to SCM concept but only has partly common basis (integrated logistics) should also be taken into account.

Along with that expenses for different technological, logistical and marketing operations in the system of agrarian cooperation are often considered as expenses for universal marketing activity. Furthermore main focus in the studies is concentrated on modeling managerial decisions of grain servicing cooperatives, not their members.

The objective of the article. The aim of the article is to study the model of preparation of decisions in a member of a servicing cooperative in the system of modification and storage of grain taking into account possible alternatives and existing limitations in separate technological and logistical business processes.

Methodological basis of studies has been a combined application of such elements of logistical modeling as a method of the decision tree and linear programming.

Statement of the main results of the study. Term "logistical model" is most appropriate to be used for mathematical, algorithmical, matrix and other informational models which are used in the process of solving separate managerial tasks in providing logistics (supplying, maintenance of production, distribution) and in other functional fields of business activity of enterprises (production, marketing, finances, management and so on) [15].

One of the most spread logistical models is graphical systematization in the process of decision making in management using the method of decision tree (alternatives, possible options, classifications and so on).

However a significant downside of the decision tree is that its practical application is based on heuristic algorithms where each optimal decision is made locally within each chain. Consequently this algorithm cannot provide optimality of the whole tree in general [12]. Besides data which include categorical changes with significant set of levels (closing), more informative weight is provided for those prescribers who have a bigger number of levels [5].

The result of the research is the processing author's approach to the solution of the problem of optimization in canals of a member of a servicing cooperative in the system of modification and logistics of grain storing through combination of elements in logistical modeling: method of decision tree and linear programming

The presented author's model is focused on a legal person – farm enterprise which is one of the members of such a cooperative formation.

In this case enterprise owns some facilities for modification and storing of grain which are insufficient for preparation and temporary storing of complete amount of the received produce before selling it at the market. Hence for covering the lack in own logistical provision an enterprise partly uses external services of grain servicing cooperatives and commercial grain elevators.

Along with that a part of services was previously ordered in the servicing cooperative. In the event of its incomplete use due to higher effectiveness of use of other logistical canals the agricultural enterprise has to pay the cooperative a fine.

Taking into account these conditions enables to form a spectrum of possible decisions for a member of a servicing cooperative in the field of modification and logistical and marketing provision of grain production (Fig.).

For preparation of the optimal decision concerning amounts of use in alternative canals of an agricultural enterprise in modification and storing of grain it has been suggested to apply the author's model of economical-mathematical task as well as a model of linear programing for finding its solution.

The task is solved for a certain defined period of time when after collecting all the unsold grain of a member of a servicing cooperative will be stored at different (or all possible) logistical canals and at that period will not be sold at the market.

While solving the task for a member of grain servicing cooperative concerning modification and logistical provision of own manufacturing activity in the system of storing grain the following could be taken as variables:

x_1 – amount of grain modification, which was not ordered for a grain servicing cooperative, on own facilities, tons;

x_2 – amount of grain modification, which was ordered for a grain servicing cooperative, on own facilities, tons;

x_3 – amount of grain modification in the grain servicing cooperative, tons;

x_4 – amount of grain modification, which was not ordered for a grain servicing cooperative, on the commercial grain elevator, tons;

x_5 – amount of grain modification, which was ordered by a grain servicing cooperative, on the commercial grain elevator, tons;

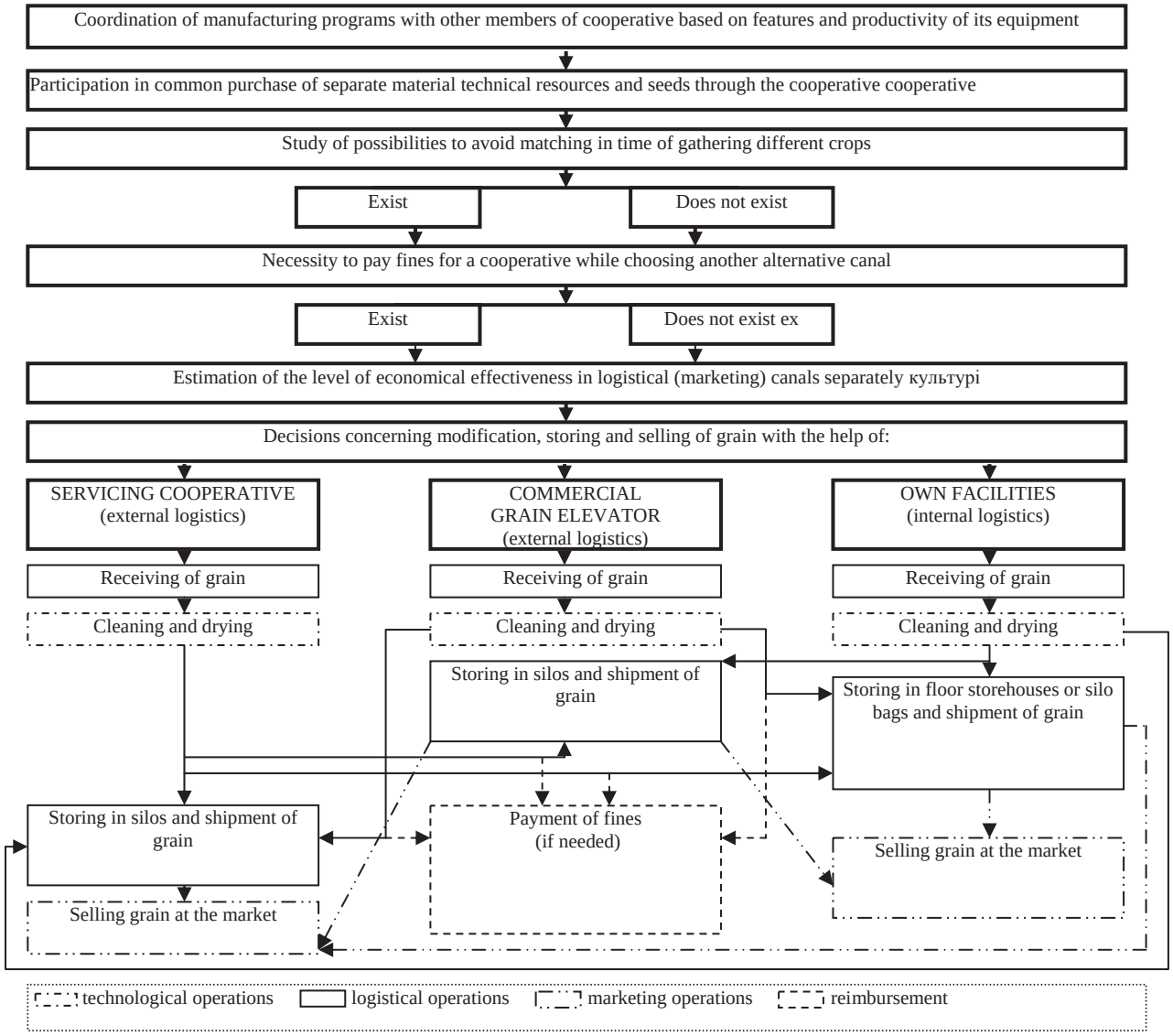
x_6 – amount of grain storing which was not ordered for a grain servicing cooperative, in own silo bags, tons;

x_7 – amount of grain storing which was ordered for a grain servicing cooperative, in own silo bags, tons;

x_8 – amount of floor grain storing, which was not ordered for a grain servicing cooperative, on own facilities in short-term periods, tons;

x_9 – amount of floor grain storing, which was ordered for a grain servicing cooperative, on own facilities in short-term periods, tons;

x_{10} – amount of floor grain storing, which was not ordered for a grain servicing cooperative, on own facilities in long-term periods, tons;



Decision tree (alternative) of a member of a servicing cooperative concerning modification, logistics of storing and selling of grain

Source: Author's development.

x_{11} – amount of floor grain storing, which was ordered for a grain servicing cooperative, on own facilities in long-term periods, tons;

x_{12} – amount of grain storing in grain servicing cooperative, tons;

x_{13} – amount of grain storing which was not ordered for a grain servicing cooperative, on a commercial grain elevator, tons;

x_{14} – amount of grain storing which was ordered for a grain servicing cooperative, on a commercial grain elevator, tons.

At that the task could have a set of restriction concerning:

- ratio in amounts of modification and amounts of placing grain for storing:

$$\sum_{i \in J} x_i \le \sum_{i \in I} x_i ; \quad (1)$$

- general amount of simultaneous grain storing by a member of a servicing cooperative:

$$\sum_{j \in J} x_j \le M ; \quad (2)$$

- facilities of own equipment for grain modification during the necessary period:

$$\sum_{i \in L_1} x_i \le V ; \quad (3)$$

For example in case of the previously defined conditions we will get:

$$x_1 + x_2 \le V ; \quad (4)$$

- own facilities of an enterprise for grain storing during the necessary period using different ways:

$$\sum_{j \in L_2^i} x_j \le F_i , \ (i = \overline{1, n}) ; \quad (5)$$

For example, facilities for storing grain in own silo bags:

$$x_6 + x_7 \le F_1 ; \quad (6)$$

For example facilities for floor storing of grain in own granaries during the short-term period:

$$x_8 + x_9 \le F_2 ; \quad (7)$$

For example, facilities for floor storing of grain in own granaries during the long-term period:

$$x_{10} + x_{11} \le F_4 ; \quad (8)$$

- facilities for storing of grain in grain servicing cooperative:

$$X_3 \le R_1 ; \quad (9)$$

- technological possibilities of gathering and modification in grain servicing cooperative during optimal agritechnical terms:

$$X_{12} \le R_2 ; \quad (10)$$

- minimal volumes of loading facilities for modification of a grain servicing cooperative by its member without the need to pay fines:

$$x_3 \ge W ; \quad (11)$$

- realization of the potential of the enterprise in loading facilities for storing a grain servicing cooperative without the need to pay fines:

$$x_{12} \ge \alpha \sum_{j \in J} x_j \quad (12)$$

- amounts of paying fines for incomplete order concerning grain modification:

$$\sum_{i \in K_1} \gamma_1 x_i \le T_1 ; \quad (13)$$

- amounts of paying fines for incomplete order concerning grain storing:

$$\sum_{i \in K_2} \gamma_2 x_i \le T_2 ; \quad (14)$$

- non-negativity of the calculated variables:

$$x_i \ge 0 \ (i \in I \cup J). \quad (15)$$

Hence the criterion of optimality in the present economical-mathematical task is a minimum of expenses for modification and logistics in grain storing using different canals, objective function implies total value of all own and external services and it equals:

$$F = \sum_{i \in I} c_i x_i + \sum_{j \in J} d_j x_j \to \min \quad (16)$$

In objective function tasks of calculating prognostic average expenses by a member of a cooperative per unit of modification and grain storing must meet a set of main requirements.

Besides in case of using own facilities:

- considering while calculating all direct and indirect constant and temporary expenses;

- calculation of the level of constant expenses on the basis of the average possible prognostic scenario in amounts of loading facilities;

- consideration of then necessary level of paying fines for orders for not used service of a grain servicing cooperative and so on.

In case of using services of a grain servicing cooperative:

- orientation on plan value of cooperative services in accordance with the carried out calculation and advance amounts of orders of its members (with reimbursement of the not performed obligations using fines);

- obligatory inclusion in calculation of extra expenses for external transportation of grain of a member of a cooperative;

- increase of calculated amount of logistical expenses on the level of the expected expenses over produce from gathering crops in not optimal agritechnical conditions (with the purpose of avoiding time matching for gathering different cultures after a long period of time for resetting a separator and complete cleaning of the separator and the drying machine of a cooperative) and others.

In case of using services of a commercial elevator:

- orientation on the announced price conditions concerning the price of the corresponding services;

- obligatory inclusion of extra expenses for external transportation of grain into calculation;

- considering the increase in price of grain delivery in case of a line at the grain elevator (due to payment for idleness of the rented vehicles);

- considering the necessary level for payment of fines for ordered but not used services of a grain servicing cooperative;

- increase of the calculated amount of logistical expenses for average and multi-year level of the expected expenses due to increased indices of contamination and humidity of grain during its modification at grain elevators and so on.

Conclusions. The system of modification and storing of grain is a technological logistical system of agribusiness which is an important part of management. Its provision for members of a servicing cooperative is connected with three key alternatives: own facilities (internal logistics), a servicing cooperative (external logistics) and a commercial grain elevator (external logistics).

Downside of the algorithm concerning provision of general optimality of the decision tree in the system of management of a member of a grain servicing cooperative can be decreased through the combined application of elements of this approach with methods of linear programming.

Criterion of optimality in the economical mathematical task should be minimal expenses for modification and logistical storing of grain using different canals. Moreover parameters of objective function in each canal should consider both factual (direct and indirect) expenses and extra potential expenses (transformation expenses) of a member of a serving cooperative.

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The article has been received 31.01.2014

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