The analytical model of the agro-industrial local complex system

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The analytical model of the agro-industrial local complex system

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Abstract. In order to effectively manage the agro-industrial complex of municipalities, it is necessary to use high-quality management models. The principle approaches of management in logistics can provide the functions of public administration at the regional level. The use of the principles of logistics systems functioning and modeling in the assessment of agro-industrial complex management in municipalities will allow to see the problematic elements of the system that characterize the state of the municipality economy and social sphere. The object of the research is the process of functioning of the agro-industrial complex system in the municipality. The model of functioning of the agro-industrial complex system in the municipality taking into account the principles of logistics is offered in the article. The main purpose of the study is to coordinate the activities of the municipality in a competitive market environment, aimed at the effective management of material, information, financial and human resources in the agro-industrial complex. The article also presents the analysis of the main indicators of the agro-industrial complex in the Rybinsky district municipality: indicators of crop production, indicators of livestock production and financial results. To assess the effectiveness of the proposed model, the integral assessment of the links of flows based on the effectiveness indicators of the agro-industrial complex in the Rybinsky district municipality was used. The proposed analytical model has an average effectiveness and is characterized by the rise in the rate of growth of the agro-industrial complex system in the Rybinsky district municipality. At the same time, the influence of the state in the form of subsidies, allows to timely supply the model of the agro-industrial complex system in the municipality with the necessary resources.

The application of the principles of logistics system modeling as a method of the agro-industrial complex effective management in municipalities allows to combine all the subsystems of socio-economic reproduction into an effectively functioning market mechanism. In logistics, abstract modeling is often the only way of modeling, it can be symbolic and mathematical according to the way of expression [1,2,3].

The object of the research is the process of functioning of the agro-industrial complex system in the municipality.

One of the main stages of the system formation process is to determine the purpose of the system. To ensure the functions of public administration at the regional level, the principles of designing a logistics system that is adaptive to the socio-economic needs of society are taken into account as the basic ones.

The typical management system consists of a specific number of elements and certain relationships. For abstract modeling of the system we use the planning methodology SADT (Structured Analysis and Design Technique) developed by D. Rossa.

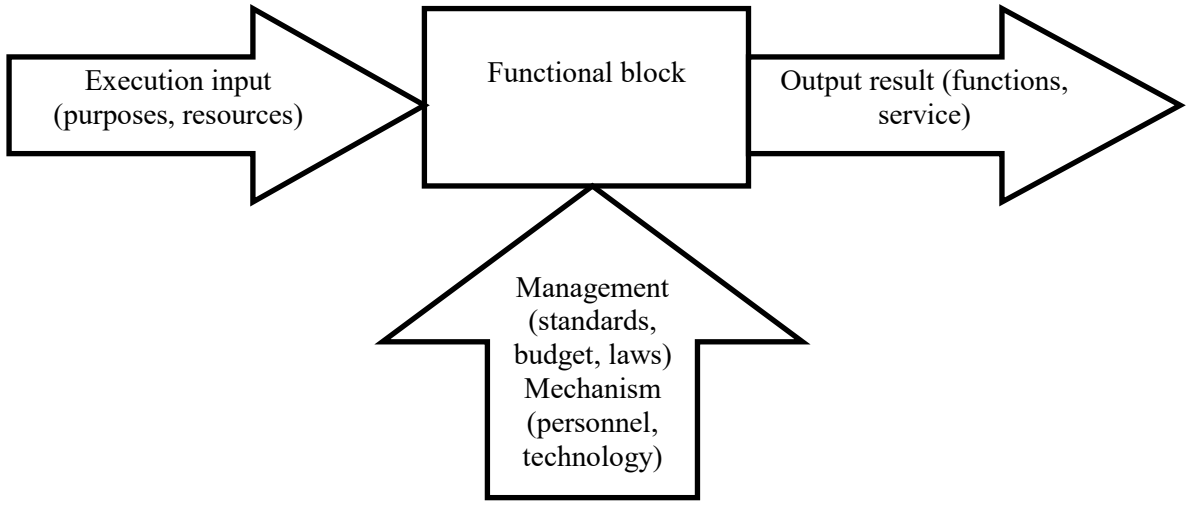

Figure 1. Planning methodology SADT.

On the basis of interstate programs, the systems involve the creation of the unified economic space, where obstacles to the movement of capital, goods, information, and labor resources are minimized. The methodology of the agro-industrial complex functioning in the municipality, taking into account the principles of logistics, will be as follows (figure 2).

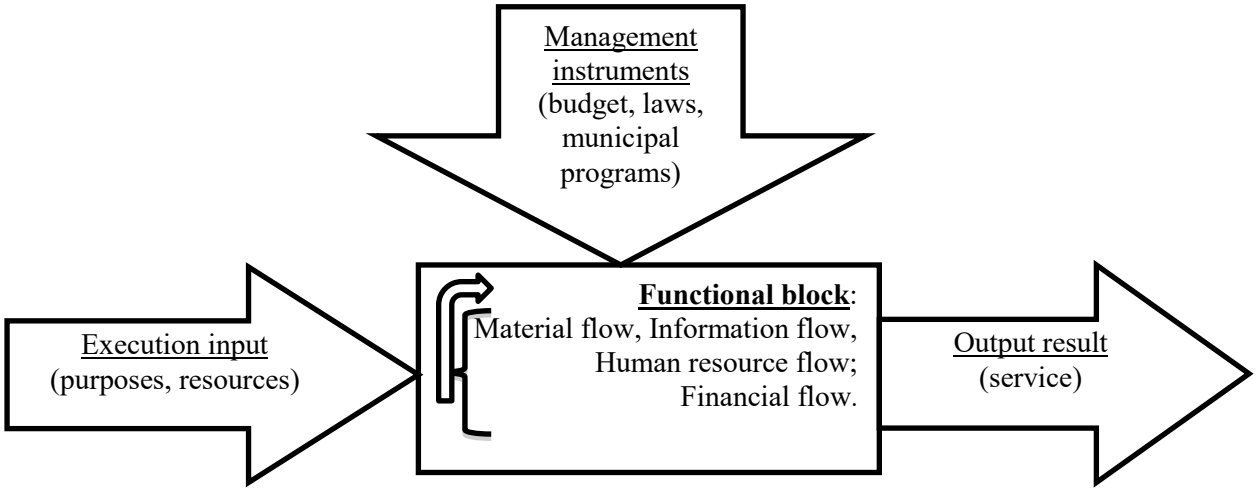

Figure 2. Methodology of functioning of the agro-industrial complex system in the municipality.

In this regard, the purpose of the research is to coordinate the activities of the municipality in the competitive market environment, aimed at the effective management of material, information, financial and human resources flow of the agro-industrial complex.

The necessity for material, economic and labor resources determines the choice of the system model. Logistics theory and current practical experience allow to reduce the variety of peculiarities in

the movement of material, monetary and other resources, as well as information in enterprises, to a certain number of standard models.

The model of the logistics system developed by Chebotaev A.A., Chebotaev A.D. (2005) serves as the basis for the formation of the analytical model of the agro-industrial complex system in the municipality. Thus, as a result of the study of these main factors, it was determined that the municipality system can be developed taking into account the principles of decomposition and can be presented as a set of L (zero level), consisting of four subsets (elements), which are called types of flows.

The model of the agro-industrial complex system in the Rybinsky district municipality will consist of the links of flows. The link of the system is a functionally separate element that is not subject to further decomposition within the framework of the task to achieve the local goal associated with the implementation of certain operations and functions.

Types of flows will determine the first level of the developed system, and consist of four subsets. The first subset L.1 will determine the group of different types of material, physical goods (commodity resources), i.e. the initial material flow itself. The second subset L.2 will determine the group of intangible intellectual factors – information and management (this is the information and management flow). The third subset L.3 will determine the group of cost factors – monetary resources (this is the financial flow). The fourth subset L.4 defines a group of factors characterizing human resources (this is the flow of human resources).

Thus, the mathematical model of the agro-industrial complex system in the municipality will look like a non-empty set, explained only by examples, as follows, where the elements: L.1, L.2, L.3, L.4 belong to the set of L and are denoted by the sign e: i.e.

L – {(L.1), (L.2), (L.3), (L.4)},
where L.1 e L;
L.2 e L;
L.3 e L.
L.4 e L.

The set of L.1 characterizes the parameters of flows and their intensity in the form of the mass of goods or commodity resources (ton, head, thousands of pieces, etc.), transferred for a certain period of time – a year. The system elements forming the flows are: L.1.1 – sown area of agricultural crops; L.1.2 – gross harvest of agricultural crops; L.1.3 – sales of crop production; L. 1.4 – livestock and poultry at the end of the year; L.1.5 – production of animal products; L.1.6 – sales of livestock products; L.1.7 – the presence of the main types of agricultural machinery; L.1.8 – the number of profitable agricultural organizations; L. 1.9 – the number of unprofitable agricultural organizations.

The set of L.2 is the information and management flow, which, as a rule, accompanies the material flow ahead or with a delay. Let's single out the subset L.2.1 characterizing the support of management by means of the state and municipal programs. The intensity of such information flow received by the executive staff is determined by the number of implemented programs per unit of time – per year or their percentage of implementation.

The set of L.3 is the financial flow, in which we allocate the subset, characterizing ruble flows, their intensity in the agro-industrial complex system of the municipality, calculated for a certain period of time – a year. The system elements forming the flows are: L.3.1 – production cost of crop production; L.3.2 – production cost of livestock products; L.3.3 – proceeds from the sale of products, works and services crop; L.3.4 – revenue from sales of products, works and services in livestock; L.3.5. – cost of sold products, works and services of plant growing industry; L.3.6 – cost of livestock sales, works and services; L.3.7 – profit (loss) from sales of products excluding subsidies; L.3.8 – the level of profitability of agricultural organizations taking into account subsidies; L.3.9 – the level of profitability of agricultural organizations excluding subsidies.

The set of L.4 is the flow of human resources where we allocate the subset characterizing the number of people, their intensity in the agro-industrial complex system of the municipality, calculated for a certain period of time – a year. The system elements forming the flows are: L.4.1. – the average

annual number, including those employed in agricultural production; L. 4.2 – the average monthly salary of employees in the agricultural organizations, including those engaged in agricultural production.

Let's consider the basic elements of the system in the Rybinsky district municipality taking into account the proposed classifications.

The main economy branches in the Rybinsky district municipality of the Krasnoyarsk Territory are represented by industry, agriculture, transport and communications and service sector.

The land fund of the "Rybinsky district municipality of the Krasnoyarsk Territory" as of 01.01.2016 amounted to 352650 hectares, including agricultural lands – 151682 hectares (43,0 % of the total land fund in the district).

8 companies in the district territory are involved in agriculture. They are represented by: the company specializing in the production of eggs, chicken and poultry (LLC "Nalobinskaya poultry farm"), the enterprises specializing in the production of meat, milk and cereals (LLC Experimental-Production Economy "Solyanskoye", LLC "Cross", LLC "Rodnik") and enterprises specializing in the production of cereal crops (Agricultural production cooperative "Vesna plus", LLC "Nektar", LLC Millman-agro"). Besides LLC "Iskra" is engaged in the production of cattle meat, milk and grain crops in the territory of the district. More than 90 farms and more than 6,000 smallholders are also engaged in agricultural production in the district.According to the data of 2016, the Rybinsky district municipality was among the best ten districts of the Krasnoyarsk Territory in terms of the area of agricultural crops in farms of all categories (table 1).

Table 1. The volume of agricultural crop areas.

Indicator	2015	2016	2016/ 2015,%
Sown area of agricultural crops in agricultural organizations, ha	59852	62016	103,6
Sown area of agricultural crops on peasant (farmer) farms, ha	3504	3726	106,4

Due to the effective system of regional agriculture in 2016 Rybinsk district was in the seventh place in terms of grain and leguminous crops (23,2 C/ha) among the regions of the territory, with the yield above the average level. In general, the district occupied the sixth place in the gross grain harvest (table 2). The largest volume of grain production among grain producers in the region from the enterprises of Rybinsk district was noted in LLC "Milman-agro" (51,2 thousand tons).

Table 2. Gross harvest of agricultural crops.

Indicator	2015	2016	2016/ 2015,%
Gross yield of agricultural crops in agricultural organizations, ton			
grain crops	103082,2	108713,2	105,5
vegetables	3363,0	3478,5	103,4
potatoes	52000,2	6170,5	118,7
Gross harvest of agricultural crops in peasant (farmer) farms, ton			
grain crops	6390,1	7227,1	113,1
vegetables	508	1532	166,8
potatoes	87	620	185,9
Sales of crop production, ton			
grain	67510	57424,2	82,4
potatoes	1759,7	2540,8	130,7
vegetables	2374,5	1372,8	28,0

The data analysis shows the positive trend in the gross yield of all crops in the Rybinsky district, while there is a significant decrease in the sale of grain and vegetables.

The volume of livestock production (in farms of all categories) also has a positive trend (table 3).

Table 3. Indicators of livestock production.

Indicator	2015	2016	2016/ 2015,%
Total number of livestock and poultry at the end of the year in agricultural organizations, heads			
cattle	4988	5187	104,0
pigs	228	-	0
all types of poultry	182	155	85,3
horses	132	119	90,2
Total number of livestock and poultry at the end of the year on peasant (farmer) farms, heads			
cattle	383	408	106,5
pigs	547	434	79,3
Production of animal products in agricultural organizations, ton			
milk	19325,3	19787,4	102,4
meat of all kinds – produced for slaughter	1602,1	1807,5	112,8
eggs of all poultry kinds, thousands of pieces	28543	32032	112,2
Livestock production in peasant (farmer) farms, ton			
milk	291	293	100,7
cattle and poultry for slaughter (live weight)	88	82	93,2
Sales of livestock products in agricultural organizations, tons			
milk	17826,2	18415,1	103,3
cattle and poultry total	1602,1	1807,5	112,8
eggs of all poultry kinds, thousands of pieces	26477	30256	114,3

Indicators of financial results of the agro-industrial complex in the Rybinsky district municipality are presented in table 4.

Table 4. Financial results of agro-industrial complex.

Indicator	2015	2016	2016/ 2015,%
Production prime cost of crop production in agricultural organizations, rubles/ton			
grain	7316	6975	95,3
potatoes	4020	3844	95,6
vegetables	6614	5174	78,2
Production prime cost of livestock products in agricultural organizations, rubles/ton			
milk	17042	18408	108,0
cattle live weight	151807	168512	111,0
pig live weight	124159	156516	126,1
1000 pieces of eggs of all poultry kinds	3220	3462	107,5
Revenue from sales of products, works and services of crop production, thousand rubles.	786200	706114	89,8
Revenue from sales of products, works and services of livestock production, thousand rubles.	786090	818126	104,1
Prime cost of sales, works and services of crop production, thousand rubles.	524952	541234	103,1
Prime cost of sales, works and services of livestock production, thousand rubles.	694800	7747620	107,6

In general, the profitability indicators of agricultural organizations in the Rybinsk district have a positive trend, while it should be noted that the growth rate of revenue from the sale of products, works and services in crop production is lower than in animal husbandry. Profit from the sales of products, excluding subsidies in 2016 is reduced, which is due to an increase in the growth rate of sale cost of products, works and services (103,7 % – plant growing, 107,6 – animal husbandry). The average annual number of employees of the agro-industrial complex of the Rybinsk district municipality engaged in agricultural production increased by 10,3 %. At the same time, the average monthly salary of employees in agricultural organizations decreased by 1,8 %.

One of the elements of any system is the feedback. For the presented model of the agro-industrial complex system in the municipality, the feedback will determine the effectiveness (natural and cost criteria) of the municipality system functioning. Let us evaluate the effectiveness of the proposed model using an integrated assessment of links (subsets) of flows based on the performance indicators of the agro-industrial complex in the municipality. For an integrated assessment of the model effectiveness we use the growth rate indicators of the selected indices. Positive dynamics of the growth rate is assigned the rank of significance – 1, for negative dynamics of the growth rate it is 0, for a stable growth rate indicator the rank is 0,5. The dynamics was evaluated taking into account the qualitative characteristics of the indicators. The effectiveness of the model of the agro-industrial complex system in the municipality (EMAICSM)

$$EMAICSM = (EMF + EIMF + EFF + EHRF)/4 \quad (1)$$

where,

EMF – effectiveness of material flow

EIMF – effectiveness of information and management flow

EFF – effectiveness of financial flow

EHRF – effectiveness of human resources flow

For the complete assessment, it is necessary to offer the scale:

If EMAICSM is from 0,01 to 0,49 – we have low efficiency, characterized by a decline in the growth rate of the system;

If EMAICSM is from 0,50 to 0,95 – we have average efficiency, characterized by a rise in the growth rate of the system;

If EMAICSM is 1,00 – we have high efficiency, characterized by a steady growth rate of the system.

On the example of the Rybinsky district municipality we'll calculate the efficiency of the agro-industrial complex system in the municipality on the proposed model.

Effectiveness of material flow (EMF)	0,71
Effectiveness of information and management flow (EIMF)	1,00
Effectiveness of financial flow (EFF)	0,47
Effectiveness of human resources flow (EHRF)	0,50
Effectiveness of the model of the agro-industrial complex system in the municipality (EMAICSM)	0,67

The proposed analytical model has an average effectiveness and is characterized by the rise in the rate of growth of the agro-industrial complex system in the Rybinsky district municipality. The effective influence of the state makes it possible to timely provide the model of the agro-industrial complex system in the municipality with the necessary resources.

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