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JUSTIFICATION OF THE STRUCTURE AND SIZE OF MAJOR PRODUCTIVE RESOURCES OF AGRICULTURAL ORGANIZATIONS

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Abstract: *The article suggests a methodical approach based on using the device of transformation functions, which allows to estimate the level of technical and technological development of individual agricultural enterprises and their territorial and industry aggregate, and to justify the reasonable structure of their basic productive resources. Using the proposed methodological tool set, the reasonable size of land tenure by agricultural enterprises of the Krasnodar Region is substantiated, the level of their technological development is determined, the optimal structure and sizes of labor, energy, material, and technical and financial resources of the region are justified.*

Keywords*: technical and economic efficiency, agricultural enterprises, transformational function, boundary function of distance, reasonable size of land tenure, structure of productive resources.*

1. INTRODUCTION

Economic efficiency of production is manifested in achieving the best results (output volume) per unit of resources used. The main factors to achieve economic efficiency are:

- the advanced level of production management;
- the optimum size of production;
- reasonable allocation of production resources based on their production ability and use value (Chetroiu, & Calin, 2013; Murillo-Zamorano, 2004).

The efficiency of production management can be expressed as an indicator of technical efficiency, reflecting the ability of an economic entity to produce the maximum number of products under minimal use of resources and the existing level of technology.

The level of economic efficiency is formed not only by the ability of manufacturers to maximize the use of available resources, but also by the scale of

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production, as well as the effect of the production activities diversification. Therefore, to increase the efficiency of production, it is very important to determine the contribution of each of these factors into the formation of a common economic result.

Building the resource capacity of the agricultural production contributes to its susceptibility to the development of industry innovation and reduction of unit production costs. However, it should be noted that with the growth of the resource base, the law of diminishing returns from scale increasingly manifests itself.

With the transition of the domestic agro-industrial complex to the market methods of management and with the emergence of producers having various organizational-legal forms and forms of ownership, the relevance of studying features of their functioning, justification of reasonable sizes and structure of the resource potential increase.

Under the term "reasonable", we understand such size of agricultural enterprises, which ensures the maximum benefit from using productive resources for certain climatic conditions and the existing level of technological development.

Information about the structure of production resources for a company or industry, which ensures minimum current production costs under the achieved production volume, is extremely important for the formation of a reasonable program of technical and technological re-equipment of agricultural manufacturers.

The technical base of the agricultural organizations consists of their machine and tractor fleet, the physical and moral deterioration of which has reached a critical level for more than two past decades.

The correctness of assessing the effectiveness of investments in the creation and updating of technical base for agricultural enterprises is largely determined by the validity of the technical and technological component contribution in the formation of the total income of manufacturers. The complexity of defining this indicator stems from the fact that the remaining available net farm income generated as a result of the production activity is determined by the interdependent effect of the aggregate of resources involved into the production process, which, besides land cultivation equipment, also include labor and capital. Therefore, it is wrong to consider the formation of the enterprise income only as a result of using the active part of fixed assets.

An attempt to methodologically implement the determination of contribution of various factors into the economic result of agricultural enterprises is presented in the scientific paper by P.V. Kovel (2012). The basic assumptions of this methodical approach boil down to the fact that the author considers the process of cash proceeds formation from the sale of products exclusively in terms of cost-intensive positions, and the assessments of involving different productive resources into expenditures and the results are presented as identical.

The record of cause-and-effect relations of the industry dynamics, their quantitative expression are often presented in literature by means of production functions, which make it possible to determine the contribution of individual production factors into the formation of end-use agricultural products (Filiptsov, 2003; Kazakova, 2013; Epstein, 2012).

This paper attempts to assess the impact of various components of the productive capacity of agricultural enterprises, including the level of production management, production scale, the structure and size of the resource base, on the effectiveness of their production activities. An apparatus of transformation functions is proposed as the methodological framework of the assessment, with the help of which the reasonable sizes of agricultural organizations of the Krasnodar Region as well as the structures of their productive resources were substantiated.

2. RESEARCH METHODOLOGY

2.1. The methodology for determining the rate of productive resources participation in the economic results of the agricultural production

The ability to use a productive function to solve this problem is determined by the property of its homogeneity. According to the Euler's theorem on homogeneous functions, in order the function $f(x_1, x_2, ..., x_n)$ could become a homogeneous function with the order of homogeneity q, it is necessary and sufficient to fulfill the following relation:

$$\sum x_k f'_{x_k}(x_1, x_2, ..., x_n) = qf(x_1, x_2, ..., x_n). \tag{1}$$

If $q = 1$, the function $f(x_1, x_2, ..., x_n)$ is linearly homogeneous and, given that $MP_{xk} = f_{xk}'(x_1, x_2, ..., x_n)$, it can be shown that:

$$Q = MP_l L + MP_s S + MP_r K, \tag{2}$$

or

$$P \times Q = P \times MP_l L + P \times MP_s S + P \times MP_r K. \tag{3}$$

where P is the price for agricultural products marketing; Q is the volume of agricultural production; L, S, K are the labor, land and capital costs, respectively.

With regard to the production functions, the q meaning provides a numeric representation of returns from scale, which is inherent to the industry technological system. In this connection, in the case of $q \neq 1$, the identical relation (3) can be modified as follows:

$$P \times Q = \frac{P \times MP_l}{q} L + \frac{P \times MP_s}{q} S + \frac{P \times MP_r}{q} K. \tag{4}$$

Subtracting the overall costs of production from both parts of the equation, we will obtain the amount of profit:

$$P \times Q - C = \frac{P \times MP_l}{q} L + \frac{P \times MP_s}{q} S + \frac{P \times MP_r}{q} K - C. \tag{5}$$

Given that $C = wL + aS + rK$, where w, a, r are the costs of labor involvement, land and capital, respectively, and substituting this expression into the right-hand part of the equation (5), it becomes possible to express the participation of all factors in the formation of profit:

$$P \times Q - C = \Pi = \left(\frac{P \times MP_l}{q} - w \right) L + \left(\frac{P \times MP_s}{q} - a \right) S + \left(\frac{P \times MP_r}{q} - r \right) K. \tag{6}$$

The production capacities of an organization, which uses ***N*** types of resources for manufacturing *M* types of products, can be represented as a transformational function of the following form:

$$T(x, y, z, t, Q) = 0, \tag{7}$$

where x is a vector of costs, $x \in \Re^n_+$; y is a vector of outputs, $y \in \Re^m_+$; z is a vector of distinguishing production factors (the size of an enterprise, the direction of specialization, etc.), $z \in \Re^p_+$; t is a vector of external variables simulating the technological development in the period under study; Q is a vector of parameters to be estimated.

Transformational function can be regarded as a special case of the distance function, which makes it possible to analyze the level of using the production potential of the industry in addition to its technological features (Coelli *et al.*, 2005; Tsionas *et al.*, 2015).

The boundary distance function can be represented as follows:

$$D_{input}(x, y, t, z) = \max \left\{ \theta : \frac{x}{\theta} \in L(y) \right\}, \tag{8}$$

where $L(y)$ is a set of costs vectors $x \in \Re^n_+$ that can produce a vector $y \in \Re^m_+$, i.e.:

The costs oriented distance function is characterized by the following properties: (1) the function is non-decreasing in costs x and non-increasing in outputs y; (2) the function is linearly homogeneous in costs x; (3) the function is concave in costs and (quasi) semi-concave in outputs; (4) if $x \in L(y)$, then $D_{input}\{x, y, t, z\} \geq 1$ and

$D_{input}\{x,y,t,z\}=1$ if an enterprise operates on the boundary of the industry production capacities.

The value of the inverse distance function $D_{input}\{x,y,t,z\}$ can be viewed as the coefficient of resources usage according to Debre, or as the level of technical efficiency, which shows the value, by which it is possible to radially reduce the costs vector under condition of maintaining the achieved volume of production and using the advanced technological experience (Coelli *et al.*, 2013; Farrell, 1957; Greene, 2007). Meanwhile, the organization that produces the maximum output at the lowest possible volume of production resources involved and at the given level of technology development in the industry is considered technically efficient.

The functional representation of the industry-related boundary production capacities that meet the requirements described above is a boundary function of distance, the formalized representation of which (Kounetas, & Tsecouras, 2007; Pauw, 2003; Ray, 2003) is as follows:

$$\begin{aligned}\ln D_{it}(x,y,t) &= \alpha_0 + \sum_{k=1}^{m}\alpha_k \ln y_{kit} + \sum_{j=1}^{n}\beta_j \ln x_{jit} + \gamma_t t + \frac{1}{2}\gamma_{tt}t^2 \\ &+ \frac{1}{2}\sum_{k=1}^{m}\sum_{l=1}^{m}\alpha_{kl}\ln y_{kit}\ln y_{lit} + \frac{1}{2}\sum_{j=1}^{n}\sum_{g=1}^{n}\beta_{jg}\ln x_{jit}\ln x_{git} + \\ &\sum_{k=1}^{m}\sum_{j=1}^{n}\delta_{jk}\ln y_{kit}\ln x_{jit} + \sum_{k=1}^{m}\varepsilon_k \ln y_{kit}t + \sum_{j=1}^{n}\theta_j \ln x_{jit}t + v_{it},\end{aligned} \tag{9}$$

where D_{it} is an unobservable random variable, which characterizes the level of inefficiency in the industry, t is an ordinal number of the year; v_{it} is the error term value expressed by a random variable distributed according to the normal law $N(0, \sigma^2)$; α, β, γ, δ, ε, θ are the coefficients to be assessed.

A partial derivative of the distance function with respect to the resources can be regarded as the marginal product of a particular type of resources under the existing volumes and structure thereof.

Using the databased reports of agricultural producers in the region or distance function zone will determine the contribution of individual factors of production in obtaining the results of production activities of an economic entity.

The coefficient of the technical and technological component γ_{TTC} contribution into the formation of the agricultural organization revenue can be determined from the following expression:

$$\gamma_{TTC} = \frac{\left(P \times \dfrac{dY_{speed}}{dx_{TTC}} - w\right) \times x_{TTC}}{\left(P \times Y_{speed} - C\right) \times q}, \tag{10}$$

where P is a weighted average price for sales of agricultural products; $Y_{speed} = g(y_1, \ldots, y_m)$ is a function, such that $g(y_1, \ldots, y_m) = h(x_1, \ldots, x_n)$ and $f(g(y_1, \ldots, y_m), x_1, \ldots, x_n) = 0$, derived from the distance function; x_{TTC} are the energy generating capacities; w is the cost of capital attraction; C are the total costs of production; q is a homogeneity degree of the production function.

For the newly formed agricultural organizations, the capital investments in the formation of their technical facilities are performed, as a rule, in one stage, and the incoming cash flow R_t (cash inflow) is distributed in time. In this case, the expression for determining the net current value of an investment project can be represented as:

$$NPV = \sum_{i=1}^{N} \frac{R_t \times \gamma_{TTC}}{(1+i)^t} - I_0, \tag{11}$$

where I_0 is the size of capital investment in the formation of the enterprise's technical base; R_t are the projected net cash proceeds from the sale of crop production in the t year; i is the discount rate; N is the duration of the revenue inflow period (the equipment operational lifetime).

2.2. The methodology for determining a reasonable size of the agricultural production

The property (3) of the distance function implies the decrease of marginal productivity in scale and, as a consequence, the existence of a certain optimum size of production that maximizes the performance of its resource potential. Determining such scale for each separate observation in the sampling suggests, by leaving the ratio of resources unchanged, the determination of a scalar ω for vector for costs x, which, under the technology currently used in the industry, $T(x, y, z, t, Q) = 0$ can produce a maximum vector of outputs χy.

Mathematically, this task can be represented as follows:

$$\max_{\omega\chi}\left[\frac{\chi y}{\omega x} : T(x, y, z, t, Q) = 0, \chi > 0, \omega > 0\right] \tag{12}$$

Given the accepted form of the transformational function, we will obtain:

$$\max_{\omega\chi} \frac{\chi}{\omega}, \text{ provided that:}$$

$$-\chi(\sum_{k=1}^{m} a_k \ln y_{kit} + \frac{1}{2}\sum_{k=1}^{m}\sum_{l=1}^{m} a_{kl} \ln y_{kit} \ln y_{lit}$$
$$+\sum_{k=1}^{m} \varepsilon_k \ln y_{kit} t) = \omega(\sum_{j=1}^{n} \beta_j \ln x_{jit} +$$
$$+\sum_{j=1}^{n}\sum_{g=1}^{n} \beta_{jq} \ln x_{jit} \ln x_{git} + \sum_{j=1}^{n} \theta_j \ln x_{jit} t) + \tag{13}$$
$$+\omega\chi\sum_{k=1}^{m}\sum_{j=1}^{n} \delta_{jk} \ln y_{kit} \ln x_{jit} + a_0 -$$
$$-\ln D_{it}(y,x,t) + \gamma_t t + \frac{1}{2}\gamma_{tt} t^2.$$

By introducing substitutions into the condition:

$$Z = \sum_{k=1}^{m} a_k \ln y_{kit} + \frac{1}{2}\sum_{k=1}^{m}\sum_{l=1}^{m} a_{kl} \ln y_{kit} \ln y_{lit} + \sum_{k=1}^{m} \varepsilon_k \ln y_{kit} t;$$

$$L = \sum_{j=1}^{n} \beta_j \ln x_{jit} + \sum_{j=1}^{n}\sum_{g=1}^{n} \beta_{jq} \ln x_{jit} \ln x_{git} + \sum_{j=1}^{n} \theta_j \ln x_{jit} t;$$

$$M = \sum_{k=1}^{m}\sum_{j=1}^{n} \delta_{jk} \ln y_{kit} \ln x_{jit};$$

$$A = a_0 - \ln D_{it}(y,x,t) + \gamma_t t + \frac{1}{2}\gamma_{tt} t^2,$$

we will obtain the following:

$$-\chi Z = \omega L + \omega\chi M + A \tag{14}$$

Expressing from (14) χ, we will obtain the following:

$$\chi = -\frac{\omega L + A}{Z + \omega M} \tag{15}$$

Substituting (15) into the objective function (13), we will obtain the following:

$$-\frac{\omega L + A}{\frac{Z}{\omega} + M} \to Max \tag{16}$$

2.3 Methodology for determining the reasonable structure of production resources

The purpose of the formed tasks can be defined as follows: given the industry-leading technological capabilities, to determine the size of such basic productive resources of an economic entity, which under the established within the industry prices for the means of production would provide the minimum production costs at a given volume of agricultural production (Stefanou, 2009).

The distance function monotonicity condition is violated in some cases, which is manifested, in particular, through the incorrect estimates of resource contributions into the production result (Marsh, 2003; Alene, & Zeller, 2005; Svetlov, & Hochmann, 2007). Another assumption, which is often violated during the 'free' econometric assessment, is associated with the property of the distance function concavity in costs and quasi-concavity in outputs.

One way to avoid these difficulties is to determine the unknown coefficients of the model using the linear programming models.

It is possible to calculate the value of model coefficients (9) by solving the following task of mathematical programming:

$$\min \sum_{n=1}^{I} \ln D_{it}(x,y,t) \tag{17}$$

under constraints

$$\ln D_{it}(x,y,t) \geq 0,\ i = 1,...,I,\ t = 1,....T, \tag{18}$$

$$\frac{d \ln D_{input}(x,y,t,)}{dx_{in}} \geq 0 \quad \text{i = 1... ln = 1...}N,\ t = 1...T \tag{19}$$

$$\frac{d \ln D_{input}(x,y,t,)}{dy_{im}} \leq 0 \quad \text{i = 1....N, m = 1....M, t = 1....T} \tag{20}$$

$$\frac{d \ln D_{input}(x,y,t,)}{dx_{in}^2} \leq 0 \quad n = 1....\text{N} \tag{21}$$

$$\frac{d \ln D_{input}(x,y,t,)}{dy_{im}^2} \leq 0 \quad \text{m = 1....M,} \tag{22}$$

$$\sum_{n=1}^{N}\beta_n = 1,\ n = 1,...N,\ \sum_{n=1}^{n}\beta_{nq} = 0, n = 1,...,\ N,\ \sum_{m=1}^{M}\delta_{nm} = 0,\ m = 1,...,M \qquad (23)$$

The constraint (18) takes into account the fact that the distance functioncan take on values greater than or equal to 1 if the resource vector x is an element of the set thereof forming a space of production capacities. Constraints in the form of inequalities (19-23) define the scope of possible solutions.

The constraints (19) and (20) ensure compliance with the condition of the distance function monotonicity. Following the constraints (21) and (22) forms the distance function, which is concave in costs and quasi-concave in outputs. A group of constraints on the estimated coefficients (23) is introduced for the purpose of imposing a condition of the first degree homogeneity in resources on the distance function.

The first derivative of the boundary distance function with respect to resources characterizes the relative importance of their individual types for the technological process and their production capacity in case of using advanced technological methods.

An average producer in the sampling under consideration, as a rule, does not use all possible productivity potential of the resources involved, and therefore, the relative importance of individual factors for such producer will differ from its estimates on the boundary of production capacities. In our opinion, the level of production capacities of manufacturers at the industry average level is of scientific and practical interest as well. To determine this level, the task (17-23) should be transformed into the following:

$$\min \sum_{n=1}^{I} \ln D_{it}(x, y, t)^2 \qquad (24)$$

under conditions:

$$\frac{d \ln D_{input}(x,y,t,)}{dx_{in}} \geq 0\ i = 1....\text{I}\ n = 1....N \qquad (25)$$

$$\frac{d \ln D_{input}(x,y,t,)}{dy_{im}} \leq 0\ \ i = 1....N,\ m = 1....M \qquad (26)$$

$$\sum_{n=1}^{N}\beta_n = 1,\ n = 1,...,N,\ \sum_{n=1}^{n}\beta_{nq} = 0,\ n = 1,...,N,\ \sum_{m=1}^{m}\delta_{nm} = 0,\ m = 1,...,M \qquad (27)$$

$$\sum_{n=1}^{I} \ln D_{it}(x, y, t) = 0,\ i = 1,...,I \qquad (28)$$

The task of programming (24)-(28) consists of a non-linear objective function and the system of linear constraints. This task can be solved by using mathematical programming model that implements the method of least squares. This takes into account the conditions of the distance function monotonicity and its linear homogeneity in resources (25)-(27). An additional condition (28) ensures searching for the solution that provides a zero-equal mathematical expectation of a random error, which is expressed by ln D_{it} (x, y, t).

The proposed methodological approach allows, in particular, to determine the structure of the basic productive resource of an agricultural organization, which minimizes the total value of production costs, on a desired size of land tenure:

$$\min_{x} \Sigma_{j=2}^{n} C_j X_j + C_1 X_1 \tag{29}$$

under conditions:

$$e^{\alpha_0} \times \prod_{k=1}^{m} y_{kit}{}^{\alpha_k} \times \prod_{j=1}^{n} x_{jit}{}^{\beta_j} \times e^{\left(\gamma_t t + \frac{1}{2}\gamma_{tt} t^2\right)} \times e^{\left(\frac{1}{2}\sum_{k=1}^{m}\sum_{l=1}^{m}\alpha_{kl}\ln y_{kit}\ln y_{lit}\right)} \times e^{\left(\frac{1}{2}\sum_{j=1}^{n}\sum_{g=1}^{n}\beta_{jg}\ln x_{jit}\ln x_{git}\right)} \times \times \prod_{k=1}^{m} y_{kit}{}^{\varepsilon_k t} \times \prod_{k=1}^{m} y_j{}^{\left(\sum_{i=1}^{K}\gamma_{ij}\ln x_i\right)} \times \prod_{j=1}^{n} x_{jit}{}^{\theta_j t} - 1 = 0 \tag{30}$$

$$X_{area}^{\min} \le X_{area} \le X_{area}^{\max} \tag{31}$$

$$X > 0,\ j = 1 \ldots n \tag{32}$$

The proposed methodological approach allows us to define the size of reasonable land tenure and to substantiate the directions for modernizing technical and technological base of the agricultural organizations.

3. RESULTS AND DISCUSSION

3.1. The data used and the assessment procedures

The correctness of the proposed methodology and the accuracy of the results obtained with its help were tested using the data from 106 agricultural organizations of the Krasnodar Region located in different climatic zones of the region. The analysis included the data of resource provision and the production activities result of these organizations for the years 2006-2012.

As the analyzed variables, the transformational function (9) included the crop production volumes in grain units net of vegetable feed, dt; the cost of animal production, thousand rubles; the availability of energy generating capacities, hp; the cost of the active part of fixed assets, thousand rubles; livestock of nominal agricultural animals calculated using the coefficients of conversion according to the parity criterion of economic keeping of various kinds of animals, nominal heads; labor costs in agricultural production, thousand man hours; the cost of current assets (seeds and planting material, mineral fertilizers, plant protection products, payment for work and services performed by third parties), thousand rubles; farmlands area, ha. The cost values of variables are presented in a year comparable type by means of price deflation.

During the analyzed period in the sampling of farms under consideration, minor changes in both resource provision and the structure of the agricultural products produced thereby were observed (Table 1).

Table 1
Availability and use of productive resources in the sampling of 106 agricultural organizations of the Krasnodar Region

Indicator	*Year*			
	2006	*2010*	*2011*	*2012*
An average economic security of one enterprise				
The area of farmlands, ha	8,203	8,015	8,834	8,900
Availability of labor resources per 1 ha of farmlands, man hours	128	101	89	85
Availability of energy generating capacities by 100 hectares of farmlands, hp	301	261	245	253
Availability of nominal heads of agricultural animals per 100 hectares of farmlands	32	27	25	22
Obtained on average by one enterprise				
Crop production per 1 ha of arable land, grain units	41	38	49	40
Milk in gross weight from 1 cow, kg	4,605	5,010	4,857	5,152
Meat based on 1 nominal head of cattle, kg	252	274	274	252
Combined gross product per 1 man hour in crop production, rubles	519	647	777	1,151
The same in animal production, ruble	222	402	390	1,500
The same per 1 hp, rubles	5.1	6.5	7.6	5.8

The average area of farmlands per one enterprise in the sampling under study for the analyzed period increased from 8,200 to 8,900 hectares. At the same time, the security of energy generating capacities decreased by 16% from 301 to 253 hp per 100 hectares of farmlands. The reduction by 34% in the number of nominal heads of agricultural animals is also noted. Reducing labor costs per 1 ha of farmlands at almost constant gross output of products indicates a slight increase in labor productivity in crop and animal production. This is indirect evidence of the region's technical and technological development of the agricultural production, the rate of which can be estimated using the proposed method.

The study assessed rates of several types of models (17)-(23) and (24)-(28), differing from each other in the form of technical base representation therein as a production resource: in the form of available energy generating capacities expressed in horsepower, and in the value expression of the active part of fixed assets reduced to a comparable form by deflating the corresponding price indices. The models (17)-(23), (24)-(28) and (29)-(32) were estimated via the Risk Solver Platform software.

3.2 Evaluation of the resource potential level of the region's agricultural enterprises and substantiation of directions in its development

The calculated according the model (17)-(23) coefficient of technical efficiency of the analyzed agricultural organizations has an average value of 0.60 and a standard deviation equal to 0.15. This means that the average producer in the sampling spends for the production 40% more resources than the leading manufacturers that are closer to the technological industry-based boundary.

Indicators of the distance function elasticity with regard to resources and outputs characterize the relative importance of resources in the production process, the resource intensity of individual products, and the return from the production scale. Tables 2 and 3 show the estimation of elasticity of transformational functions on industry average indicators.

The performed analysis showed a relatively high resource intensity of animal production as compared to crop production. The elasticity coefficients of the boundary distance function for individual outputs of agricultural products during the analyzed period was calculated in the group of enterprises with a specific gravity value of crop production in the gross output value of 40 to 57%. Calculations showed that the 10% increase of animal production requires a 4.1% increase in all involved productive resources. A similar increase in the volumes of crop production requires the expansion of the resource base by only 2.6%.

It was also found that the crop production was characterized by more intense technological development as compared to the crop production. If in 2006 in the analyzed group of organizations, both industries were characterized by a relatively equal resource intensity, in 2012 the increase in crop production by 10% was achieved through the growth of all involved resources by 2.1%, while animal production increased by 4.6%.

The average return rate from the scale of 1.49 indicates a significant reserve of productivity growth of the resource potential of economic entities.

Table 2
Indicators of the boundary distance function elasticity according to output variables calculated using the model (17-23)

Year	*The elasticity coefficient of the boundary distance function*							
	according to outputs			*according to resources*				
	Crop production	*Animal production*	*Energy generation capacity*	*Labor costs*	*Current assets*	*Nominal heads*	*Area of farmlands*	*\e cost of the active part of fixed assets**
2006	-0.37039	-0.3270	0.212	0.093	0.102	0.132	0.460	0.178
2007	-0.341	-0.3590	0.225	0.088	0.109	0.143	0.434	0.184
2008	-0.334	-0.3570	0.230	0.080	0.116	0.153	0.421	0.189
2009	-0.314	-0.366	0.246	0.068	0.119	0.163	0.405	0.1862
2010	-0.267	-0.417	0.276	0.073	0.107	0.173	0.371	0.173
2011	-0.249	-0.430	0.275	0.068	0.128	0.184	0.338	0.183
2012	-0.209	-0.462	0.298	0.078	0.128	0.194	0.302	0.152

Table 3
Indicators of the transformational function elasticity according to output variables calculated using the model (24-28)

Year	*The coefficient of transformational function elasticity*							
	according to outputs			*according to resources*				
	Crop production	*Animal production*	*Energy generation capacity*	*Labor costs*	*Current assets*	*Nominal heads*	*Farmlands area*	*The cost of the active part of fixed assets**
2006	-0.206	-0.494	0.123	0.279	0.032	0.290	0.275	0.088
2007	-0.192	-0.500	0.126	0.256	0.038	0.293	0.286	0.094
2008	-0.211	-0.478	0.130	0.224	0.044	0.296	0.305	0.103
2009	-0.219	-0.468	0.128	0.196	0.051	0.299	0.325	0.108
2010	-0.199	-0.491	0.122	0.192	0.053	0.302	0.330	0.110
2011	-0.208	-0.490	0.132	0.161	0.063	0.305	0.347	0.115
2012	-0.198	-0.497	0.126	0.162	0.072	0.308	0.332	0.103

The production capacity of energy generating capacities in the given sampling of agricultural enterprises of the region grew during the analyzed period. Thus, according to the estimated boundary distance function, a ten percent increase in the energy generating capacity, according to the data of 2006, generated an increase in output by 2.1%, and according to 2012 – already by 3.0%. It should be noted that the technical base contribution in the creation of agricultural products according to the industry average technology was less than the progress achieved on the basis of advanced technology. Coefficient of the distance function elasticity according to the energy generating capacity in this case varies within the range of 0.12-0.13 and has no distinct trend within the time interval under study.

The elasticity coefficients calculated via the model (24-28), in which technical resource is expressed in the value of the active part of fixed assets vary within the range of 0.173-0.189 and have no pronounced tendency to change during the study period. The reason for this, in our opinion, may be an unequal interdisciplinary exchange in agriculture and related industries.

Although the industry average producer in the region continues to use labor-intensive technology, the dynamics of the elasticity coefficient of distance function according to labor has demonstrated laborsaving technological progress within the industry in recent years.

Calculations showed that a ten-percent increase in material costs is capable of providing the growth in agricultural production by 1.3%. It was also revealed that the upper technological boundary of the study sampling of agricultural organizations, the elasticity coefficient of the distance function according to nominal heads of cattle increased from 0.13 to 0.19, which indicates an increase in the productivity of animals during the analyzed period.

The activation of processes of the material and technical base of reproduction of agricultural organizations observed in the last 10 years and related to the improvement in the general economic situation in the country contributed to the intensification of agricultural economy of the region, which is manifested in the broad introduction of advanced equipment and technology, using the latest achievements in breeding and seed production, allowing to achieve growth of production volumes while saving productive resources. The intensification of agricultural production reduces the contribution of the land factor to the formation of a common result of the production activity of agricultural enterprises.

A comparison of the obtained elasticity coefficients of the distance function, which can be interpreted as the specific weight of the allocative-efficient resource in the minimum total costs with the actual specific weights of costs for the use of individual resources within the production process indicates the presence of a substantial allocative inefficiency of production activities of the considered sampling of the region's agricultural organizations.

3.3. Substantiation of the reasonable size of land tenure by agricultural organizations of the Krasnodar Region

In the course of study, the substantiation was carried out using the proposed methodological approach of the reasonable size of land tenure by agricultural organizations of the Krasnodar Region. The production and economic characteristics of 6 medium regional agricultural enterprises of different specializations with the sizes of land tenure of 8-9.5 thousand ha and 2 large agricultural holdings with land tenure size exceeding 50 thousand hectares were used as the initial data.

Table 4 shows the characteristics of the resource potential of these organizations as well as the calculated therefor, by means of the boundary productive function model, values of scalar of the resource vector w growth, which ensures maximum growth of the total factor productivity by x/w times. The analysis of the data presented in the table shows that the radial increase in volumes of all resources by 1.5-1.7 times (line 8) will make it possible to achieve a reasonable size of production, ensuring the growth of total factor productivity by 6-18% (line 9).

It should be therefore noted that the actually achieved level of this indicator exceeds the unit value only in the organizations with the energy supply level of more than 2.5 hp per 1 hectare (line 10).

The results allow to characterize the range of the land tenure size of 13.5-15.0 thousand hectares as a near to optimal one. The recommended land tenure size within this range for a particular producer is determined by its specialization and the level of basic productive resources availability.

The analysis of the data in Table 4 also shows a relatively lower efficiency of the large vertically integrated agricultural units' functionality as compared to the organizations, the land tenure size of which is closer to the substantiated reasonable range. The values of the indicators presented in row 10 of the Table show that each ruble invested in the expansion of the agricultural holdings production generates only 0.72-0.75 ruble of additional products, while in medium-sized organizations, the value of this parameter ranges from 0.91 to 1.54.

3.4. Substantiation of reasonable sizes of the productive resources of agricultural organizations of the Krasnodar Region

To substantiate the reasonable structure and sizes of the major productive resources of the regional agricultural organizations, an optimization task (29-32) was solved. At the same time, the specific value of each variable to be optimized was determined based on the following considerations.

Since the land is one of the main productive resources of agricultural producers, its correct assessment largely determines the adequacy and accuracy of all further substantiation (Sagaidak *et al.*, 2011).

When solving the optimization task, the calculations included the price for 1 ha of land tenure in the amount of 7 thousand rubles, which covered rents and activity costs for the conservation of soil fertility. When determining the price of

Table 4
The resource potential and boundary productive function parameters of agricultural organizations of the Krasnodar Region with different land tenure sizes and fields of specialization

No.	*Indicator*	*Medium-sized regional organizations agricultural organizations*						*The largest regional*	
		OOO AF "Pobeda"	*OOO KH "Uchastiye"*	*OAO "Kropotkinskoye"*	*OOO "Agro-Galan"*	*OAO PZ "Za Mir I Trud"*	*ZAO PZ "Niva"*	*ZAO "Agrokomplex"*	*OAO Agroobed-inenie "Kuban"*
1	The area of farmlands, ha	8,933	9,356	8,882	8,120	7,790	9,147	214,669	62,421
2	Energy generating capacity per ha of farmlands, hp	1.6	2.6	1.1	3.7	2.07	5.3	2.5	0.4
3	Labor costs per 100 ha of farmlands, thousand man hours	8.5	8.9	4.8	10.0	8.2	20.2	10.5	7.6
4	The presence of nominal animal heads per 100 ha of farmlands, units	19.5	15.2	20.9	24.2	51.1	67.7	25.3	21.6
5	The cost of current assets per 100 ha of farmlands, thousand rubles	1,348.3	1,396.2	1,771.7	519.5	250.0	2,095.9	707.3	2,126.8
6	The cost of crop gross production per 100 ha of farmlands, thousand rubles	497.6	1,586.1	1,377.5	1,041.8	1,023.4	1,466.1	1,176.5	1,660.2
7	The same for animal production per 100 ha of farmlands, thousand rubles	546.3	496.4	614.1	669.7	2,807.8	1,669.9	831.2	813.5

contd. table 4

No.	Indicator	*Medium-sized regional organizations agricultural organizations*						*The largest regional*	
		OOO AF "Pobeda"	*OOO KH "Uchastiye"*	*OAO "Kropotkinskoye"*	*OOO "Agro-Galan"*	*OAO PZ "Za Mir I Trud"*	*ZAO PZ "Niva"*	*ZAO "Agrokomplex"*	*OAO Agroobed-inenie "Kuban"*
8	The optimum Omega value	1.60	1.50	1.70	1.70	1.70	1.50	x	x
9	The maximum Xi/Omega value	1.18	1.06	1.11	1.17	1.11	1.10	x	x
10	The total productivity of the production factors**	0.64	1.32	0.94	1.54	0.91	1.04	0.72	0.75
11	The potential level of total productivity of the production factors given movement towards the optimal production size	0.75	1.39	1.05	1.79	1.01	1.15	x	x

**The indicator is calculated as the ratio of the APV total of crop and animal productions to the value of all annual costs in these sectors other types of productive resources, we used the frequency distribution analysis of their values according to the Xi-square fitting criterion.

As the price for energy generating capacity, the calculations used the average amount of costs related to fuel and lubricants, electricity, replacement parts, and power means depreciation per 1 horsepower, which makes 3.83 thousand rubles in the study region.

The price for labor resources was defined as the ratio of annual salary of workers employed in the agricultural production sector to the amount of labor costs in the crop and animal productions and the related thereto general production and indirect labor costs. The payment distribution pattern for 1 man hour in the regional farms can be best described by the normal distribution law with an average value of 91 rubles and a root-mean-square deviation of 30 rubles.

The cost of feed per 1 nominal head of farm animals has been taken as the price for keeping one head of cattle. A very high variability of this indicator among agricultural producers at the mathematical expectation of 27.0 thousand rubles should be noted.

The minimum of the agricultural production costs was used as the optimization criterion. The optimization results are presented in Table 5.

Table 5
Results of optimizing the structure of the productive resource sizes among the agricultural organizations of the Krasnodar Region

Indicator	*Value*	*Per 100 ha of farmlands*
The area of farmlands, ha	13,000	-
Energy generation capacity, hp	39,871	295.3
Nominal heads of cattle, heads	6,007	44.5
Labor costs, thousand man hours	862	6.4
The cost of current assets (seeds, chemical protective equipment, fertilizers, payment of services rendered by third parties), thousand rubles	52,611	390
General production costs, thousand rubles	568,104	4,208
The gross output value, thousand rubles	950,143	7,031
Gross income, thousand rubles	382,039	2,823
Crop production output, dt of grain units	709,616	7,096

The analysis of the optimization results shows that the most effective is the production activity of the agricultural organizations with the size of land tenure making 13,000 hectares, which has 295 hp of energy generating capacity, 44 nominal heads of cattle, and 6.4 thousand man hours of labor resources per 100 hectares of farmlands. The studies showed (Bershitsky *et al.*, 2015) that under conditions of the national currency depreciation it is economically feasible for the domestic producers to purchase agricultural machinery of domestic manufacture.

CONCLUSION

The conducted studies lead to the following series of important conclusions.

1. To assess the level of technical and economic development of the agricultural organizations of the region, it is suggested to use the boundary distance function, the coefficients of which are determined by a mathematical model of linear programming.
2. The analysis of the agricultural organizations of the Krasnodar Region performed by the proposed methodological approach showed that the average commodity producer in the region has a 40% lower level of its development as compared to the technical and economic boundary, which proves the need and the possibility to increase the efficiency of the sectoral production activities.
3. The studies revealed a relatively higher resource intensity of animal production as compared to the crop production. This proves the need to prioritize technological modernization of the animal production industry, to ensure the growth of the livestock and poultry productivity, to strengthen the federal support of dairy farming.
4. There are significant reserves for increasing the efficiency of agricultural production, which can be realized by optimizing the scale of production. It was found that a reasonable size of the land tenure by the agricultural organizations of the Krasnodar Region, which ensures the maximum return from using productive resources, is in the range of 13-15.0 thousand hectares and is determined by the field of specialization and the organizations security with other major types of production resources (energy, labor, and finances).
5. Optimization of the structure and sizes of the productive resources among the agricultural organizations of the Krasnodar Region showed that the agricultural production activities of a model agricultural enterprise with the land tenure size of 13,000 hectares, which has 295 hp of energy generating capacity, 44 nominal heads of cattle, and 6.4 thousand man hours of labor resources per 100 hectares of farmlands, can be the most efficient.

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