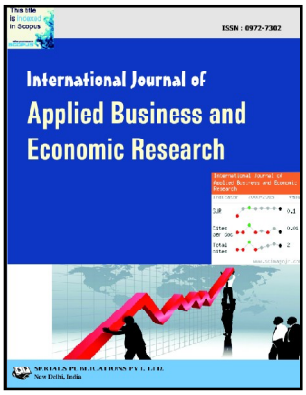

International Journal of Applied Business and Economic Research

ISSN : 0972-7302

available at http: www.serialsjournals.com

Volume 15 • Number 23 • 2017

Priority Directions of Increasing the Economic Efficiency of Crop Production

Konstantin E. Tyupakov[1*], Alexander B. Melnikov[1], Pavel V. Mikhailushkin[1], Rustem A. Shichiyakh[1] and Tatiana N. Polutina[1]

[1] Kuban State Agrarian University, Krasnodar, Russian Federation, [*] E-mail: adm@kgtu.kuban.ru

Abstract: The article describes the priority directions of increasing the economic efficiency of crop production, including technical and technological modernization of the industry, optimization of production resources, and targeted state support for the industry. To validate the optimal structure of labor, energy, material and financial resources of agricultural organizations in the Krasnodar Region with land use sizes close to optimal, the author's method was used, which provides for the solution of the optimization problem of non-linear programming that minimizes the value of the boundary production function of distance, the elements of which are optimized volumes of production resources under the implementation of a system of linear restrictions, allowing to get a numerical solution using the method of least squares (Smith & Goodwin, 1996). The performed studies allowed to develop a holistic scientific concept of formation and development of the technological base of crop production agricultural organizations, including theoretical and methodological principles of assessing the level and effectiveness of use, definition, nomenclature and quantitative composition of the basic mechanization. The study made the justification of the priorities of the updates and development of technical base of production of plant products with regard to the transfer of innovative technologies and the limited resource capacity of commodity producers, increasing the effectiveness of the system of their state support. Revealed the scientifically based recommendations for the practical implementation of the development, providing increase of efficiency and competitiveness of the production sector in the domestic and foreign markets.

Keywords: technical and technological base, technological border, agricultural production, efficiency, competitiveness, optimization, state support

JEL Classification: J43, O13, P32, Q10

INTRODUCTION

The production of crops is the basic branch of the agro-economy, the effectiveness of its functioning determines the effectiveness of the entire agricultural production, competitiveness of its products in the domestic and foreign markets, and ensures the country's food security.

The specificity of crop production manifested in the high dependence on the weather conditions, the timeliness and quality of the mechanized works within the framework of zonal agro-technologies, the degree of their adaptation to the soil and natural climatic features of the location, has special demands to the quality of the technical and technological base of the industry, the basis of which is the combine and tractor fleet of agricultural commodity producers. This determines the exceptional importance of the scientific economic justification of the processes of formation, organization of effective functioning and development of the technological base for the production of crops.

MATERIALS AND METHODS

The solution of this problem requires an increase in the efficiency of the use of all basic production resources, including the technical and technological support of crop production, which provides for the renewal and structural modernization of the existing machine and tractor fleet of agricultural organizations, the development and transition to modern environmentally safe, water- and resource-saving mechanized technologies that use elements of precision farming, etc. The realization of the listed activities is held back by the heavy financial and economic situation of the majority of domestic agricultural producers, by the critical wear and tear of a considerable part of the basic means of mechanization, by the high capital intensity of renewal of technical means, and by the low availability and high price of borrowed capital.

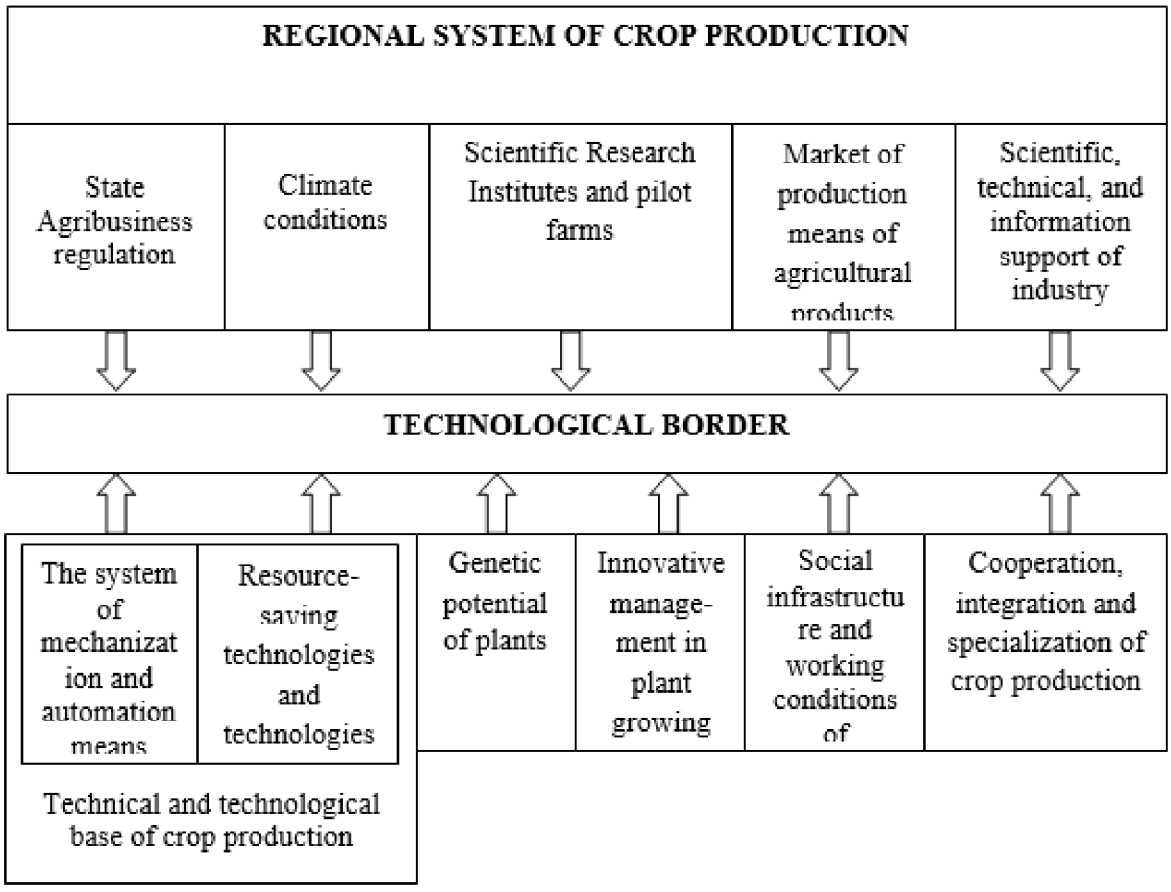

Figure 1: Scheme of the regional crop production system

Technical and technological support for the crop production is an important element of the system of a higher level - the industrial production system, the scheme of which is presented in Figure 1.

The structure of the technological and technological base of crop production includes zonal agro-technologies for the cultivation of agricultural crops and the means of mechanization and automation of production processes that provide them, the nomenclature and quantity of which must be adapted to the natural climatic and soil conditions of the distribution zone, land use and specialization of commodity producers.

This adaptation is based on the optimization of the structure and composition of the machine and tractor fleet of agricultural organizations, the result of which is the optimal nomenclature and quantity of tractors and combine harvesters, and other agricultural machinery. This ensures their rational loading over the periods of the field season and the types of tasks carried out with the minimum costs of labor, material and technical, and financial resources.

Breaks in the reproduction of fixed assets, observed in the majority of domestic agricultural organizations over the last two decades caused by a significant weakening of state support for the industry, the lack of equivalence in the interbranch exchange, high price of borrowed capital, led to considerable physical and moral wear of the basic means of mechanization in the machine and tractor fleet of commodity producers , which negatively affected the financial and economic results of their production activities.

In the current conditions, the solution of the problem of modernization of the technical and technological base of the agro-industry, which can be carried out in the forms of restoration and replacement of worn-out equipment, becomes especially important. At the same time, the the priorities of this transformation, the evaluation of efficiency and recoupment of investments in its implementation acquires exceptional importance.

DISCUSSION

The rationale for improving the technical and technological base of crop production is based on an analysis of the results of assessment of the current level and the potential for its development. The technical and technological potential of the crop sector should, in our opinion, be considered as the maximum possible production result in the current conditions that can be realized using existing production resources in the framework of advanced technologies and advanced forms of production.

The methodological approach that allows the most adequate assessment of the technical and technological potential of agricultural organizations that we propose to use involves the construction and analysis of the parameters of the boundary production function represented by the costs and outputs of crop production in a representative sample of producers in one region or zone of location.

Such a function is a set of vectors "cost-production" of economic entities.

$$y_i = f(x_i, \beta)\exp(-u_i),\ u_i \geq 0$$

where: $\boldsymbol{y_i}$ is the production vector of i-th producer;

$\boldsymbol{x_i}$ – the vector of its costs;

f(*) – the production boundary, determined by the volumes of resources involved and technological parameters *b;*

u_i – The deviation of the actual output of the *i*-th producer from the potential value determined taking into account the technological parameters of the production boundary;

I – the set of producers in the sample.

Determining the production potential of producers of crops using the boundary function, and comparing it with their actual results, it is possible to evaluate the efficiency of using the main production resources and to identify the reserves of increasing the achieved level (Figure 2).

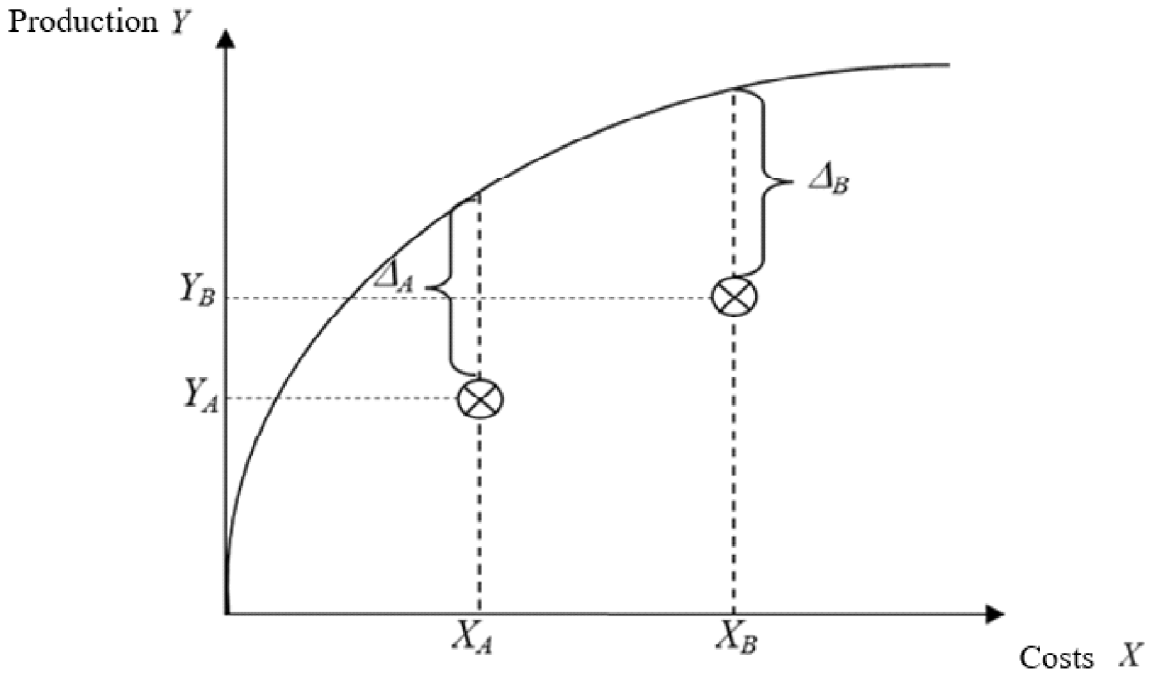

Figure 2: Level of development of technical and technological base of agricultural organizations

In Figure 2: Δ_A, Δ_B – the reserves of increasing production capacity of producers *A* and *B*.

Effective formation and functioning of the technical and technological base of crop production is based on the formation of the optimal composition of the machine and tractor fleet of agricultural organizations, which is determined with the help of various mathematical optimization models that use the hard-set calendar dates and the duration of the field mechanized works as initial data (Dale & Polasky, 2007). In practice, however, these characteristics can change under the influence of natural-climatic and other factors within rather wide limits. At the same time, such changes significantly affect the number of basic means of mechanization in the structure of the machine and tractor fleet, and, consequently, its cost and the amount of operating costs for performing mechanized works.

Since the increase in the duration of the main fieldwork operations on the one hand, reduces the need for machines that perform them, and, consequently, reduces the amount of investment required for this, and, on the other hand, leads to an increase in crop losses due to violations of recommended agro-products

in the framework of zonal technologies, it becomes necessary to search for such compromise work duration that would provide a positive effect on reducing the need in the machinery taking into account the cost of product losses.

The analysis presented in Figure 3 shows that in the cost of crop production from 40 to 70% of the cost falls on the operational costs for the implementation of field mechanized work. At the same time, the greatest specific weight in the structure of operating costs is the cost of harvesting crops.

To a large extent this is due to the high prices of harvesting equipment, large volumes of harvesting of the main agricultural crops and short time within which it is carried out to minimize crop losses.

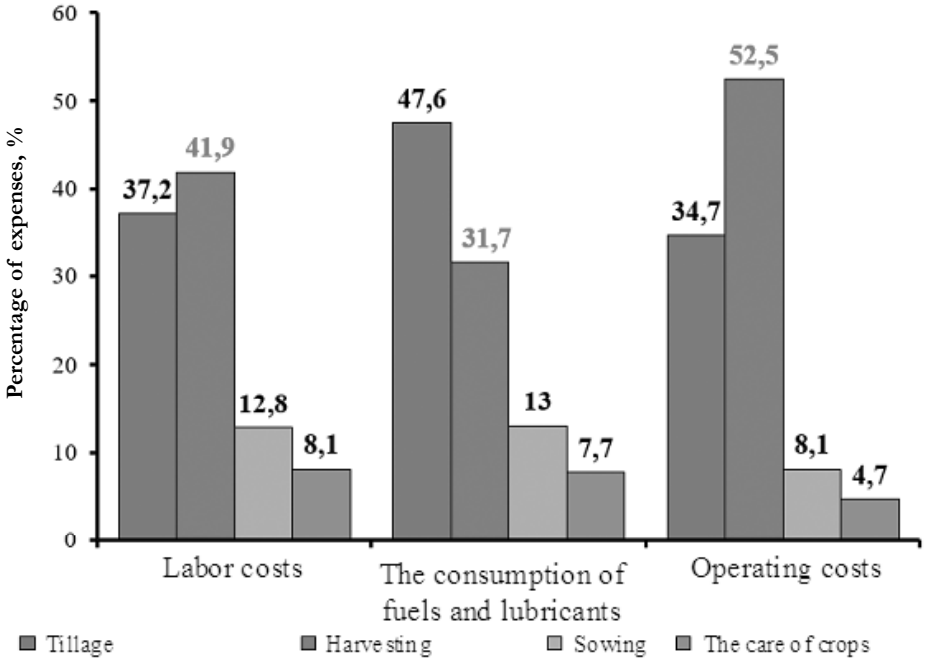

Figure 3: Percentage of costs in the production of crops

The analysis proves the exceptional importance of the economic justification for the branded and quantitative composition of the combine harvester park of agricultural organizations, which makes it possible to minimize the costs of its formation, operation and renewal.

It is especially attributable to the grain harvesting equipment, which is the main share of the combine harvester park of the enterprises of the south of Russia. It is harvesting grain that mainly determines the need for mechanization staff.

The efficiency of operation of combine harvesters is determined by their price and technical and operational characteristics, the most important of which are productivity, specific fuel consumption, grain losses, the degree of grain fragmentation and clogging (Figure 4).

Currently, the Russian market of agricultural machinery offers combine harvesters of various foreign and domestic manufacturers, differing from each other in the technical and operational characteristics, at a wide range of prices.

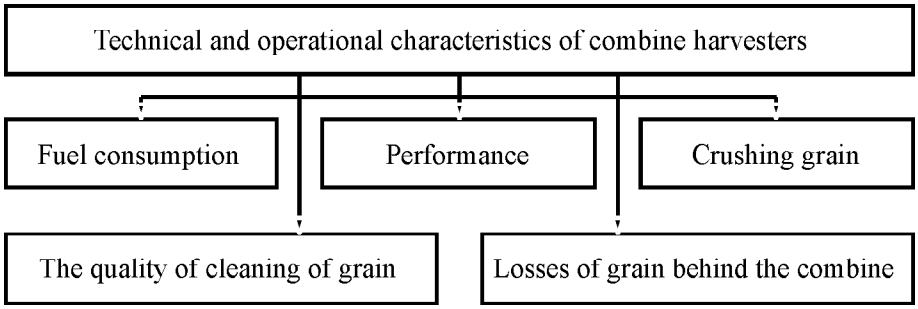

Figure 4: Technical and operational characteristics of grain harvesting equipment

Therefore, the choice of the preferred harvester brand from the presented variety is a difficult economic task. For its solution, it is proposed to use the criterion of minimum total unit costs, including the operational costs of harvesting operations and the cost of crop losses due to the design features of different brands of combines.

$$З_{\Sigma i} = З_{зi} + У_{б} \times \left[Ц_{р} \times \left(Р_{к} + К_{w} \right) + \Delta Ц_{р} \times d_{к} \right] \rightarrow \min$$

where:

Σ_{Si} – total specific (per 1 ha of harvested area) costs of harvesting performed by the *i*-th combine;

$У_{б}$ – biological yield of the crop at the beginning of harvesting;

$Ц_{р}$ – average market price of the harvested crop;

$Р_{к}$ – the share of grain losses behind the combine;

$К_{w}$ – coefficient of increase or decrease in the price of grain, depending on the degree of its dockage;

$\Delta Ц_{р}$ – the difference in the prices of sales of conditioned and crushed grain;

$d_{к}$ – the share of crushed grain in the total volume.

The efficiency of production in agriculture depends to a large extent on the emerging price situation in the markets of means of production and manufactured products. At the same time, it is necessary to take into account the low price elasticity of demand for agricultural products, due to its special need for consumers (Fafchamps, 1992). Solving the problem of ensuring the affordability of agricultural products while ensuring the profitability of its production requires the organization of adequate targeted state support for the industry. It is important to justify the size, direction, targeting of such support correctly, as well as assess the effectiveness of its practical implementation.

The effectiveness of government subsidies for the production of a specific type of agricultural products is proposed to be defined as the ratio of the increase in the profit of producers to the amount of the state support received.

$$E_{n} = \frac{\sum_{i \in I} \frac{dy_{i}}{dp} dp \times p_{i} - \sum_{j \in J} \frac{dx_{j}}{dp} dp \times p_{j}}{y \times (1 + \varepsilon_{yp}) \times dp} + 1,$$

where: I, J – types of products and resources;

x_j, y_i – volumes of use of the *j*-th resource and production of *i*-th products;

p_j, p_i – prices of resources and products;

dp – amount of support per unit of output;

e_{yp} – coefficient of price elasticity of subsidized products.

The value obtained is criteria. If the value is greater than one, it testifies to the effectiveness of the type of state support for agricultural commodity producers in question.

Despite the relatively favorable situation observed in recent years in the plant growing of the country and the Krasnodar Region, the quantitative composition of machinery in agricultural organizations in the region continues to decline (Table 1).

Table 1
Dynamics of changes in the composition of the machine and tractor fleet of agricultural organizations of the Krasnodar Territory, thousand units

Indicator	*1990*	*2000*	*2010*	*2014*	*2015*	*2015 in % to*	
						1990	*2010*
Tractors of all makes	60,4	40,8	20,9	17,9	17,4	28,0	83,2
Plows	25,5	13,1	6,0	5,3	4,9	19,2	81,6
Cultivators	28,8	16,1	9,1	8,3	8,1	28,1	87,9
Seeders	24,6	13,9	6,6	5,5	5,4	21,9	81,8
Harrows	127,5	36,1	15,2	10,5	9,2	7,2	60,5
Harvesters total	19,7	10,6	4,2	3,9	3,7	18,7	88,0
grain-harvesting	14,0	6,8	3,2	3,1	3,0	21,4	93,7
forage harvesters	4,1	2,8	0,8	0,5	0,5	12,1	62,5
Machines for applying fertilizers	8,6	3,5	2,1	2,0	0,7	8,1	33,3

Such a drastic reduction in the number of machines is partially compensated by the transition to modern agrotechnologies using high-performance combined multi-operation equipment. At the same time, the shortage of tractors and combines (Kassam, Friedrich, Shaxson & Pretty, 2009), the high degree of physical and moral wear and tear of equipment that continues to be used, are the cause of the violation of term of harvesting agro-products, increasing the costs of maintaining machinery in working condition. A direct consequence of the reduction in the number of basic means of mechanization of plant growing in the region is an increase in the load on the remaining machines in the fleet (Table 2).

The load of arable land for 1 tractor in agricultural organizations of the Krasnodar Êóïøùò increased from 72 hectares in 1990 to 165 hectares in 2014, or 2.3 times. The load on one combine during the same period increased from 128 to 333 hectares of crops, or 2.6 times. Analysis showed that the availability of basic means of mechanization significantly affects the efficiency of production of the industry. Table 3 shows the performance indicators for crop production in agricultural organizations in the Central Zone of the Krasnodar Region with different loads of arable land and grain crops for 1 tractor and 1 combine harvester.

Table 2
Profitability of crop production in agricultural organizations in the central zone of the Krasnodar Region, 2014

Indicator	*Groups of organizations with load of arable land for 1 tractor, ha:*					*Total and average*
	< 61	*61-101*	*101-141*	*141-181*	*> 181*	
Number of objects in a group	25	53	61	19	12	170
Load of arable land for 1 tractor, ha	37,4	83,8	120,1	159,0	207,4	114,3
Expenses for 1 hectare of arable land in plant growing, thousand rub.	41,1	26,5	22,7	22,9	27,5	24,9
Expenses for the production of 1 centner of cereals, rubles.	697	600	535	586	727	539
The profit from the sale of crop per 1 hectare of arable land, thousand rubles.	9,3	9,7	11,3	6,4	6,2	9,2
Profitability of crop production,%	21,6	41,8	56,6	35,6	18,7	41,5

Table 3
Profitability of cereals production in agricultural organizations of the central zone of the Krasnodar Region, 2014

Indicator	*Groups of enterprises with grain harvesters (per 1000 hectares of sowing), units:*				*Total and average*
Group interval	to 2,5	2,5-5,0	5,0-7,3	7,3-9,6	%
Number of farms in the group	59	57	32	22	170
Number of combines for 1000 hectares of crops, units.	1,7	3,8	6,0	7,8	3,5
Yield of grain crops centner / ha	54,2	56,1	58,2	57,3	56,8
Cost of grain, rubles / centner	663	533	501,2	520,0	538,7
Profit from 1 hectare of grain crops, thousand rub.	5,3	12,8	15,1	13,8	12,6
Profitability of cereals,%	14,7	42,7	51,7	46,2	41,3

From the data presented, it is clear that the optimum load of arable land per tractor, which provides the maximum profitability of the industry in the area under consideration, is a load of 101-141 hectares. The greatest profitability of grain production is provided with 5-7 grain harvesters per 1,000 ha of crops.

In the course of the analysis, it was established that there is an effect of interchangeability and complementarity of individual production resources, which demonstrates the advantages of multi-sectoral agricultural organizations over highly specialized ones (Gerbens-Leenes & Nonhebel, 2002). Studies have shown that the average level of technical efficiency of agricultural organizations in the Krasnodar Region is 67.5%, which indicates the need for substantial growth. It is also established that to increase the efficiency of crop production in the region, its scale should be increased by 11.4%.

It has been found that with an increase in the level of technical development of agricultural organizations in the region, the economic efficiency of their production activities increases (Table 4).

Table 4
Profitability of production activities of agricultural organizations in the Krasnodar Region with different levels of technical and technological development, 2014

Indicator	*Groups of farms in terms of the level of technical development*				*Total and average*
	<0,4	*0,41-0,6*	*0,61-0,8*	*>0,81*	
Number of farms in the group, units.	22	37	35	12	106
Average level of technical efficiency	0,3	0,5	0,7	0,9	0,7
Area of agricultural land in the farm, ha	7 960	8 195	5 842	3 874	6 880
For 100 hectares of agricultural land:					
power capacity, hp	226	262	335	440	266
cost of active part of fixed assets, thousand rubles.	1 619	2 068	2 774	4 851	2 336
number of livestock.	10,4	19,0	32,2	22,4	20,8
labor input, people/hour	6 626	7 087	6 202	5 731	7 763
The share of crop production in the gross output,%	81	68	52	54	63
Received for 1 ha of arable land					
grain crop production units	31	36	34	34	34
cost of gross crop production, thousand rubles.	23,3	27,3	28,4	28,1	26,7
Received per head of cattle					
milk per 1 cow, kg	3 719	5 242	5 983	7 342	5 525
growth of live weight on the conventional head of livestock on growing and fattening, kg	298	324	458	456	390
value of gross livestock production per 1 conventional head of livestock, thousand rubles.	74,4	97,1	120,6	169,8	109,4
Estimated income per 1 hectare of agricultural land, rubles.	-4 052	5 243	8 032	8 138	3 978
Profitability of production,%	-12,8	16,2	18,3	20,8	11,1

Organizations with a level of technical development close to the technological border have similar shares in the value of gross output of crop production and animal farming. They are characterized by the best use of labor and energy resources; the profitability of their production activity is more than twice that of the average for the group in question.

An important direction in increasing the economic efficiency of crop production is state support for the regional agro-industrial complex, which is carried out in the direction of reimbursing part of the costs of agricultural producers to pay insurance premiums, repay part of the interest rate on short-term and investment loans, supporting separate areas for the development of the crop and livestock sector, unrelated support of producers of crops, etc.

In 2015, the largest amount of state support was directed to unrelated support (per 1 ha of arable land) for the development of crop production in the region. The volume of livestock support during this

Table 5
The volume of state support for agricultural producers in the Krasnodar Region, 2015

Directions of state support	*Volume, million rubles.*	
	Total	*Incl. from regional budget*
Reimbursement of a part of expenses for payment of insurance premium in plant growing	497,3	24,9
Reimbursement of a part of the interest rate on investment loans for the development of crop production	650,8	89,7
The same for the development of livestock	534,7	51,9
Reimbursement of a part of the interest rate on short-term loans for livestock development	80,5	18,6
State support for the development of crop production	863,3	183,9
State support for livestock development	1 039,9	221,5
Unrelated support of crop production	2 123,7	457,1
State support of small farms	149,8	32,0

period was almost twice as low. The analysis showed that the size of government support for agricultural producers significantly affects the efficiency of their production and economic activities. At the same time, the limited possibilities for allocating state budget funds at different levels for these purposes require a deep economic justification for the targeting and priority of such support.

The efficiency of crop production is largely determined by the size of the land use of the agricultural organization and the rationality of the structure of other important production resources, including material, technical, labor and financial resources. The optimal size of land use for agricultural organizations in the Krasnodar Region was determined based on the results of constructing and analyzing the parameters of the transformational boundary production function using the initial characteristics of 8 typical production facilities in the region (LLC "Pobeda" Otradnensky district; LLC "Participation" Novokubansky district; JSC "Kropotkinskoye" Tbilisi district; "Agro-Galan" LLC, Kurganinsk district; "For Peace and Work" JSC, Pavlovsky district; "Niva" CJSC, Kanevsky district; "Agrocomplex" Viselkovsky district; Agroobedineniye Kuban, Ust-Labinsky District, with different land use sizes and specialization areas. The indicators for the analysis were the area of agricultural land, energy capacity, labor costs, the availability of animals, the cost of circulating assets, the cost of gross crop production, the cost of gross output of cattle rearing.

The analysis shows that a radical (1,5-1,7 times) increase in the volume of all resources allows to achieve a rational production size that provides an increase in aggregate factor productivity by 6-18%. It should be noted that the actually achieved level of this indicator exceeds one only in organizations with a level of energy capacity exceeding 250 hp. per 100 hectares of arable land.

The obtained results allow to characterize range of one of the main production resources - the size of land use as almost optimal, which, according to our calculations, is 13.5-15.0 thousand hectares. The specific value of the recommended size of land use within this range is determined by the direction of specialization of the enterprise, as well as by the level of its provision with labor and financial resources.

The analysis also shows a relatively lower efficiency of large vertically integrated agricultural units in comparison with organizations whose production scale is closer to optimal.

To validate the optimal structure of labor, energy, material and financial resources of agricultural organizations in the Krasnodar Region with land use sizes close to optimal, the author's method was used, which provides for the solution of the optimization problem of non-linear programming that minimizes the value of the boundary production function of distance, the elements of which are optimized volumes of production resources under the implementation of a system of linear restrictions, allowing to get a numerical solution using the method of least squares.

When solving the problem of optimization, the price of using 1 hectare of arable land was set as equal to 7 thousand rubles, which included lease payments and expenses for preserving soil fertility. The average cost of fuel and lubricants, electricity, spare parts and depreciation of energy resources per 1 horsepower was used as the price of energy capacity, which was 3.8 thousand rubles in the region under consideration at the time of calculation. The price of manpower was assumed equal to 91 rubles per person per hour.

The results of the solution to the optimization problem showed that, given the current price environment for the means of production and crop production, the achieved level of technology and technology in the industry, the natural-climatic and soil potential of the allocation zone, the agricultural enterprises that are able to maximize their efficiency have 13.5-15 thousand hectares land in use, 307 hp. of energy capacity per 100 hectares of farmland, 7 thousand people per hour of labor, 1 020 thousand rubles in fixed assets and 405 thousand rubles in working capital.

Table 6
Results of optimizing the volume of the main production resources of agricultural organizations in the Krasnodar Region

Indicator	*Value*	
	Total	*Per 100 ha of arable land*
Area of agricultural land, ha	13 000-15 000	-
Power capacity, hp	39 870	307
Labor resources, thousand of man-hour	860	7
Cost of fixed assets, thousand rubles.	132 600	1 020
Cost of circulating assets, thousand rubles.	52 600	407
Conditional heads of cattle	6 010	46
Crop production, centners	709 620	5 460

CONCLUSION

Thus, the undertaken study made it possible to develop an integral scientific concept for the formation and development of the technical and technological base for the production of crops, including theoretical and methodological provisions for assessing the level and effectiveness of its use, determining the nomenclature and quantitative composition of the basic means of mechanization, justifying priority areas for renewal and development of technical base for the production of crops, taking into account the transition to

innovative agro-technologies and the limited resource potential of producers, increasing the effectiveness of their state support system, as well as scientifically based recommendations for the increased efficiency and competitiveness of the agro-industry's output in the domestic and foreign markets.

REFERENCES

Tyupakov, K.E. (2012). Forms and sources of funding for the reproduction of the material and technical base of domestic agricultural producers. *Bulletin of the Adyg State University. The Economy, 2,* 142-150.

Dale, V. H., & Polasky, S. (2007). Measures of the effects of agricultural practices on ecosystem services. *Ecological Economics, 64*(2), 286-296. doi:10.1016/j.ecolecon.2007.05.009

Tyupakov, K.E. (2014). Methodical and practical aspects of evaluating the effectiveness of agricultural production. *Problems of achieving economic efficiency and social balance: Imperatives, legal and economic mechanisms. Materials of the International Scientific and Practical Conference, Dedicated to the 95th anniversary of the Financial University*, 170-176.

Fafchamps, M. (1992). Cash crop production, food price volatility, and rural market integration in the third world. *American Journal of Agricultural Economics, 74*(1), 90-99. doi:10.2307/1242993

Tyupakov, K.E. (2015). *Managerial Economics: Textbook*. Krasnodar: KubGAU.

Gerbens-Leenes, P. W., & Nonhebel, S. (2002). Consumption patterns and their effects on land required for food. *Ecological Economics, 42*(1-2), 185-199. doi:10.1016/S0921-8009(02)00049-6

Kassam, A., Friedrich, T., Shaxson, F., & Pretty, J. (2009). The spread of conservation agriculture: Justification, sustainability and uptake. *International Journal of Agricultural Sustainability, 7*(4), 292-320. doi:10.3763/ijas.2009.0477

Tyupakov, K.E. (2016). *Features of effective formation and reproduction of technical and technological base of plant growing: Monograph*. Krasnodar: KubGAU.

Smith, V. H., & Goodwin, B. K. (1996). Crop insurance, moral hazard, and agricultural chemical use. *American Journal of Agricultural Economics, 78*(2), 428-438.