

CLUSTER COOPERATION IN ARMENIA'S GRAIN PRODUCTION SECTOR AS A STRATEGY TO INCREASE SELF-SUFFICIENCY

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Introduction

From the point of ensuring food security, the development of wheat production in Armenia is a priority issue. Currently, the level of wheat self-sufficiency can be increased by applying innovative technologies, introducing effective forms of cluster cooperation, implementing state support programs and optimal use of existing resources (unification of lands, targeted cultivation, formation of clusters). According to expert assessments, uncultivated arable land in Armenia amounts to about 230 thousand ha. In an attempt to increase the level of food security, if 60% of uncultivated lands, about 138 thousand ha, are used for wheat cultivation through cluster cooperation, then, according to our calculations, in the future the level of wheat self-sufficiency will amount to 62.6%. As a result of implementing measures aimed at increasing yields, according to our forecasts, the maximum level of wheat yield will be 45.9 cents/hectare, and under these conditions, the degree of self-sufficiency will reach 61.9%, all other things being equal.

Methodology

The studies and analyses were conducted based on international experience in applying cluster approaches, development programs of the Ministry of Economy of the RA, data of the Statistical Committee of the RA and regional development programs. Comparative, systematic, monographic, computational, graphical and other research methods were used. Currently, increasing the level of yield and self-sufficiency in the field of wheat production can be achieved exclusively through the use of innovative technologies, the introduction of effective forms of cooperation, the implementation of state support programs and the optimal use of existing resources [Voskanyan, Hovhannisyanyan, 41-46].

Literature review

The founder of the cluster approach in economics is considered to be Michael Porter, a professor at Harvard Business School. In the 1990s, in his work "Competitive Advantages of States", he formulated the classic definition of an economic cluster, its types, areas of application, and the main characteristics of the cluster approach [Porter, 1998, 42]. According to M. Enright, a regional cluster is a territorial accumulation of firms that work in one or more related sectors of the economy. Firms concentrate, due to their spatial proximity to each other, forming a cluster due to the obvious advantages of such a geographical location [Enright, 24-25]. According to Asaul, "A cluster is a location of interconnected, cooperating organizations and institutions in one geographical location, within a sepa-

rate region.” In addition, many clusters include government agencies and other institutions, such as universities, standardization centers, trade associations, which provide specialized training, technical assistance, provide necessary information, etc. [Asaul, 2005, 110]. In the European Union countries, cluster development policies are mainly implemented by national government bodies in cooperation with regional or local governments. Grain production cluster development programs are implemented in Canada, the Russian Federation, Kazakhstan and other countries.

Scientific novelty

The scientific novelty consists in the development of a scientifically substantiated model of wheat production clustering in the context of ensuring food security in Armenia, which synthesizes local breeding potential, digital (smart) agrotechnologies and economic mechanisms of synergistic interaction of all participants in the wheat value chain (seed farms, farmers, local self-government bodies, processors and scientific centers). In the case of the introduction of the novelty, an opportunity is created for the cooperation of small and medium-sized land users, the introduction of a new tool-kit of public-private partnership and resource-saving logistics systems, which will allow increasing the competitiveness and reducing its dependence on imports.

Analysis

In Armenia, the regions of Shirak, Syunik, Gegharkunik, Lori, Aragatsotn, Tavush and Kotayk are mainly specialized in grain production. 2020-2024 Changes in the growth rate of crop yield and gross harvest in the republic are presented in Chart 1. Wheat sown areas in the Republic of Armenia decreased by 4.8% [Food Security and Poverty, 2025]. This trend is especially noticeable in the regions relatively close to the capital, where an increase in the level of urbanization has been observed. Thus, in Ararat region, sown areas decreased by 15.8%, in Armavir region - by 31.6%, in Kotayk region - by 20.3%. The highest yields were recorded in Ararat and Armavir regions, the lowest in Vayots Dzor, Kotayk, and Aragatsotn regions. As a result of the reduction in wheat sowing areas, the gross harvest volumes of Armavir, Ararat, Aragatsotn, Shirak, and Kotayk regions decreased in 2024.

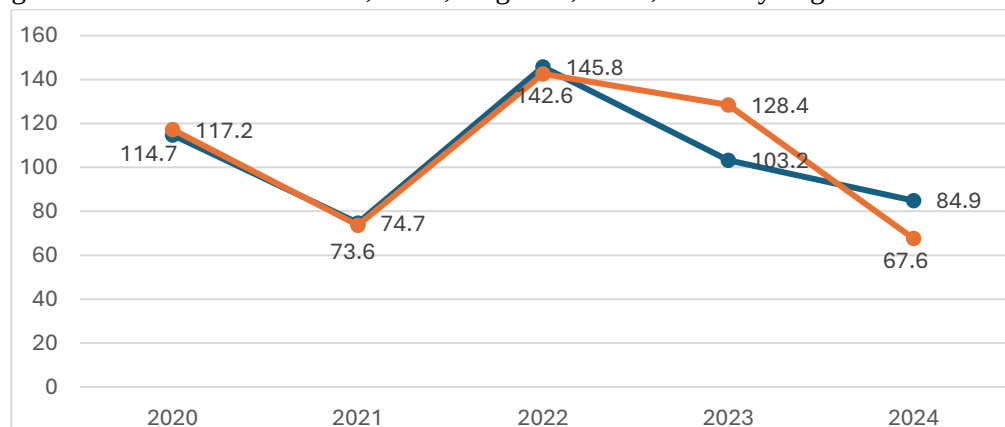


Chart 1. Change in wheat yield and gross harvest growth rate in the RA in 2020-2025 (compiled by the authors based on data from Food Security and Poverty for January-June 2025).

Blue line - Yield growth rate compared to the previous year
Red line - Gross harvest growth rate compared to the previous year

It should be noted that such low yields of wheat production are simultaneously conditioned by:

- insufficient quantity of high-quality, certified seeds corresponding to the climatic conditions of the regions,
- lack of intensive technologies /irrigation systems, selection of high-yielding varieties, soil crop rotation, integrated system of nutrition systems, fertilization, plant protection, modern sowing methods, moisture management/
- low fertility of cultivated land,
- lack of optimal crop rotation and necessary agrotechnical measures,
- ineffective cooperation between economic operators, state government bodies and other entities in the agrarian sector,
- wear and tear of agricultural machinery,
- impact of natural, elemental factors
- slow implementation of agricultural insurance mechanisms.

Due to ongoing conflicts in a number of regions, the need for self-sufficiency in wheat is becoming more important, as well as the improvement of the organizational and economic environment for production in border settlements, which will contribute to increasing employment levels and stabilizing farm incomes. The production and resource potential of wheat in the grain-growing regions of the Republic of Armenia is not used efficiently, therefore, local production does not increase over the years, and the volumes of imports that meet demand do not decrease.

Due to insufficient wheat reserves, Armenia is currently an importing country. The actual indicators of the total supply and use balance of wheat are presented in table 1.

Table 1. Wheat balance in the Republic of Armenia in 2020-2024*

Indicators	Unit of measure ment	2020	2021	2022	2023	2024	2024 compared to 2020, %
Stocks at the beginning of the year	thousand tonns	388,6	363,7	264,8	309,5	376,8	97
Production	thousand tonns	132	97,2	138,6	177,9	120,3	91,1
Imports	thousand tonns	426,4	330,4	441,7	464,9	410,7	95,9
Total supply	thousand tonns	947,0	791,3	845,1	952,5	907,8	95,8
Use for food	thousand tonns	385,6	362,5	363,4	386,2	380,6	98,7
Forage	thousand tonns	111,0	91,2	105,2	117,3	88,4	79,6
Losses	thousand tonns	45,0	39,8	35,7	45,6	37,4	83,1
Seed	thousand tonns	17,7	17,6	16,9	21,3	16,9	95,4
Exports	thousand tonns	17,2	9,6	13,0	4,4	3,9	22,7

Used for other purposes	thousand tonns	6,8	5,8	4	0,7	0,6	8,8
Stocks at the end of the year	thousand tonns	363,7	264,8	309,5	376,8	380,0	104,5
Total used	thousand tonns	947,0	791,3	845,1	952,3	907,8	95,8
Self-sufficiency rate	%	24,4	23,2	24,4	27,9	22,8	Decreased by 1,6 % points
Consumption	kg / year	139,1	129,6	135,5	138,2	133,9	96,3

****Food security and poverty in 2024. January-December.**

Food security and poverty in 2025. January-June.

According to table 1, wheat production volumes decreased by 8.9%, self-sufficiency level by 1.6% percentage point, consumption per capita by 3.7%. It is noteworthy that losses in the whole value chain of wheat decreased by 16.9%. Reserves increased by 16.3 thousand at the end of the year. in tons, mainly at the expense of reducing export volumes by 13.3 thousand tons and reducing losses by 7.6 thousand tons.

The main guarantee of food security is the policy conducted by the government of the given country in the field, so the RA government regularly emphasizes in its programs the increase of the efficiency of agriculture and the level of food security, the introduction of modern technologies, the increase of the profitability of small households, peasant cooperatives, processors and exporters included in the entire agricultural value chain. It should be noted that the RA Government's program [www.arlis.am] adopted by the decision N 65-A of February 8, 2019 is more targeted, the main goal of which is to promote the increase of productivity and the reduction of the cost of land, the creation of new jobs, the purposeful use and effective management of land, to contribute to the increase of the volume of investments in the field of agriculture and the increase of competitiveness through state support for land consolidation. The project was implemented in 2023-2025 and covered the entire territory of Armenia [https://mineconomy.am/page/2202.]. As a result of the implementation of the project, 11 contracts were signed for the unification of lands with a total area of 810 ha, of which 2 - 30-100 ha, 2 - 100-200 ha, and 7 - for the purpose of unification of land with an area of 5-30 ha. The program will serve as a basis for the development of the cooperative movement, the implementation of the cluster policy and close cooperation with various organizations. With the implementation of these and similar programs, the task is to create educational, scientific-research, industrial clusters and promote cooperation for the purpose of effective management of agriculture.

International experience shows that clusters are formed quite actively in the last two decades. According to expert estimates, clustering currently covers 50% of the economies of leading countries. In the US, the number of clusters reaches 380, which include more than half of the organizations and provide more than 60% of the GDP. In the countries of the European Union, 38% of the labor force is employed in clusters, and cluster support

programs are implemented within the framework of territorial, science and technology development, as well as industrial policy [<http://www.icsti.su>].

In 2018-2023, a wheat cluster development program was implemented in Canada, aimed at increasing the level of profitability of farms, increasing yields, developing new and cold-resistant varieties. The funding of the projects was 25 million dollars. The program is continuous, covering 2023-2028. Research is underway to develop new wheat varieties adapted to climate change [<https://www.wheatresearch.ca/wheat-cluster>].

The introduction of effective mechanisms of cluster policy in the field of wheat production in Armenia will enable to quickly overcome such problems as the low level of mechanization of work, the difficulties related to the acquisition of fixed and borrowed funds, the introduction of innovative technologies in production, realization and effective use of land.

According to expert assessment, uncultivated arable land in the republic amounts to about 230 thousand hectares. In order to increase the level of supply of food wheat, if 60% of uncultivated arable land - about 138 thousand hectares, as a result of cluster cooperation, is used for the purpose of wheat cultivation, then it will contribute to the increase of local production of wheat and the reduction of import volumes. Based on the data of table 1, in case of conditional average wheat yield of 23.8 tons/ha, wheat production will be 328.4 thousand tons. t. In perspective, the volumes of wheat production and import are presented in table 2.

Table 2. Wheat production and import volumes in the future*

Indicators	Unit of measurement	2028
Stocks at the beginning of the year	thousands of tons	320
Production	thousands of tons	328,4
Imports	thousands of tons	201
Total supply	thousands of tons	849,4

*Compiled by the authors.

According to calculations, the level of wheat self-sufficiency in the future will be:

$$\text{Self sufficiency} = \frac{328,4 \text{ thousand of tons}}{328,4 \text{ thousand of tons} + 201 \text{ thousand of tons} - 5 \text{ thousand of tons}} \cdot 100 \% = 62,6 \%$$

As a result of the cultivation of uncultivated lands, wheat production volumes will increase by 2.7 (328.4/120.3) times, and import volumes will decrease by half. As a result, the level of wheat self-sufficiency will increase by about 40%.

It is obvious that the level of wheat self-sufficiency is determined by the level of wheat yield. In order to analyze the interdependence of these indicators, a regression analysis was performed using the data of the Republic of Armenia for 2016-2024.

Table 3. Levels of wheat yield and self-sufficiency in Armenia for 2016-2024

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Yield level, cents/hectare										
32,3	33,4	32,4	21,8	28,2	19,6	22,5	16,8	24,5	25,3	21,5
Level of self-sufficiency, %										
48,7	49,5	53,2	33,2	31,5	25,9	24,4	23,2	24,4	27,9	22,8

Source: <https://armstat.am/file/doc/99563698.pdf>; <https://armstat.am/file/doc/99520943.pdf>
<https://armstat.am/file/doc/99516793.pdf>

The relationship between the level of wheat yield and the degree of self-sufficiency in Armenia in 2014-2024 was presented using a two-dimensional linear regression model:

$$\hat{y}_i = a_0 + a_1 x_i \quad (1),$$

where

$\hat{y}_i$ - is the theoretical level of the output indicator (the theoretical level of wheat self-sufficiency in the i-th year),

x_i - is the actual level of the factorial characteristic (the actual level of wheat yield in the i-th year),

$a_0; a_1$ - are the parameters of the equation, which are estimated by the least squares method,

a_1 - is the regression coefficient, which shows how much an increase in the factorial

Table 4. Results of regression analysis between wheat yield and self-sufficiency levels in the Republic of Armenia based on data for 2016-2024

Regression characteristics	results
Correlation coefficient	$r = 0.883$
Coefficient of determination	$R^2 = 0.781$
Regression model	$\hat{y}_i = -13.3 + 1.84x_i$
Significance of regression coefficient	$t_{a1} = 5.6, \quad p - value = 0.0003$
Model significance	$F = 32.1, \quad significance = 0.0003$

The analyses presented in the table show that in the years under study, a direct and strong relationship was formed between the level of wheat yield and the degree of self-sufficiency in the Republic of Armenia ($r=0.883$). The constructed regression model and the regression coefficient can be considered significant ($F=32.1$, $significance=0.0003$, $t_{a1}=5.6, p-value=0.0003$). According to the constructed regression model, an increase in the level of wheat yield by one cent/hectare in the Republic of Armenia during the years under study

contributed to an increase in the degree of wheat self-sufficiency by 1.84 percentage points, all other things being equal ($a_1=1.84$). According to the calculated coefficient of determination, about 78.1% of the variation in the degree of wheat self-sufficiency in Armenia in 2014-2024 is due to the variation in the level of wheat yield, and the remaining 21.9% is due to random and unspecified factors in the model. Since the degree of wheat self-sufficiency in Armenia will be mainly determined by the level of yield, therefore, it is important to study the trend of the development of the level of yield and build forecasts based on it.

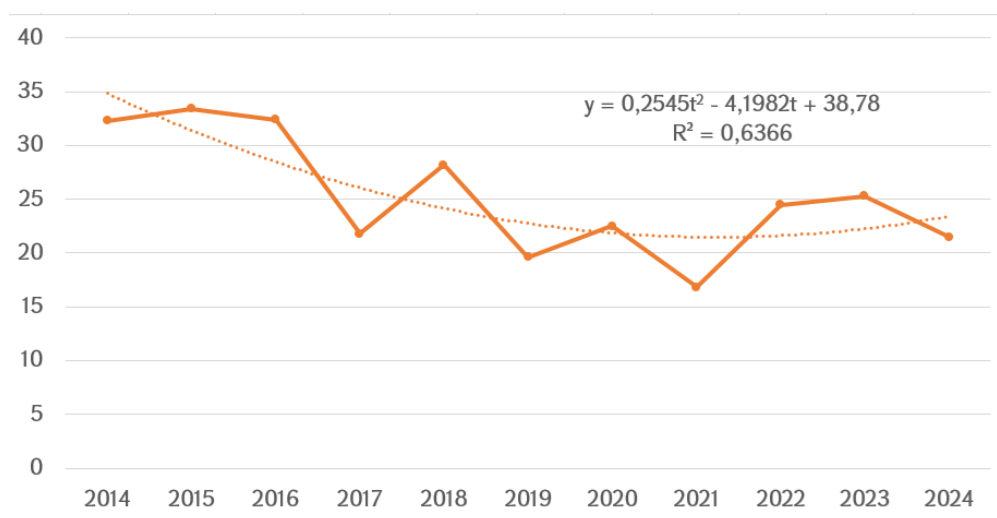


Chart 2. The dynamics of the wheat yield level in RA and the presentation of the second-order curve trend with the data of 2014-2024

The analyzes showed that the main trend of the development of wheat yield level in RA in 2014-2024 is best represented by a second-order curve or a parabolic trend (Figure 3). Based on the trend modeling, the minimum and maximum possible yield levels are calculated with 95% confidence, and wheat self-sufficiency level predictions are made using the regression model based on the predicted yield levels.

Table 5. Predictions of wheat yield level in 2025-2028

years	Wheat yield forecast level according to trend modeling, cents/ha		
	Minimum leve	Point score	Maximum level
2025	15,8	24,5	33,2
2026	17,9	26,6	35,2
2027	20,4	29,1	37,8
2028	23,5	32,2	40,9
Prediction levels of wheat self-sufficiency according to the regression model,%			
2025	15,8	31,8	47,7
2026	19,6	35,6	51,5
2027	24,3	40,3	56,2
2028	30,0	45,9	61,9

The calculations presented in the table show that in 2028 the minimum level of wheat yield in Armenia will be 23.5 centners/ha, in which case the degree of self-sufficiency will be 30.0%, and the maximum level of wheat yield will be 45.9 centners/ha, and under these conditions the degree of self-sufficiency will reach 61.9%, other things being equal.

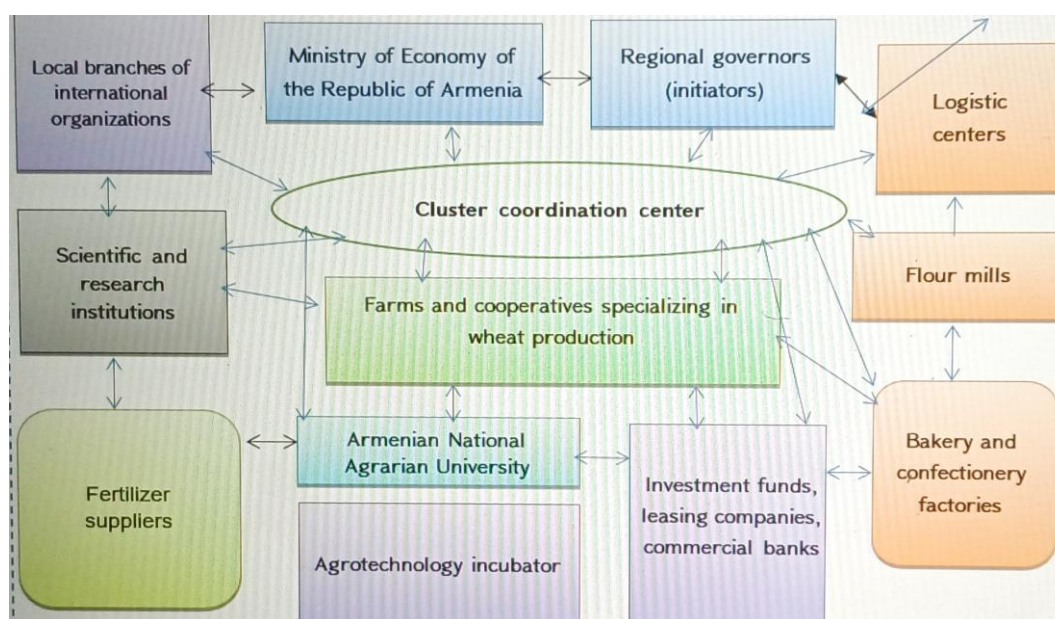


Chart 3. Structural model of the RA wheat cluster (compiled by the authors).

In order to implement cluster policy in the regions of the Republic of Armenia and develop supporting infrastructure, it would be advisable to form a cluster development department in the agriculture and environmental protection department operating within the structure of regional governorates, which would act as a mediator between interested parties and present regional programs for the development of clusters. In the Republic of Armenia, there are no relevant normative legal acts and development programs regulating the legal relations of participants for the formation and further development of clusters in the agrarian sector. We have developed a structural model of the wheat cluster shown in Chart 2.

The RA Wheat Cluster Coordination Center is the body that will coordinate the implementation of the grain cluster development project, present annual programs, strategies, coordinate and ensure cooperation between stakeholders. The model envisages cooperation between state structures, scientific and educational institutions, farms specializing in wheat production, flour mills, bread factories, regional administrations, the Center for Agribusiness and Rural Development (CARD), leasing companies (ACBA Leasing, Agrocredit), the local branch of the Food and Agriculture Organization (FAO) and other stakeholders.

Conclusion

The formation of a wheat cluster in the Republic is a complex process that requires a scientific approach, state support and active cooperation of farmers. The introduction of new technologies, optimal use of resources and the development of knowledge-based management systems can ensure both sustainable crop growth and an increase in the overall competitiveness of agriculture. For the formation of clusters in Armenia, it is necessary to create a favorable environment and infrastructure, as well as develop an effective budgetary, tax, credit and customs policy.

Clusters are a tool for the development of strategically important sectors and play an important role in ensuring the economic development of the region, therefore it is necessary for Armenia to

For the implementation of cluster policy in Armenia, at the first stage it is necessary to have appropriate regulatory legal acts, in particular, to develop and adopt the RA Law on "Agro-technological Clusters".

At the same time, cluster cooperation makes it possible to implement various projects.

1. Digitalization and application of new technologies to monitor and predict sustainable crop growth, introduction of agromonitoring systems, use of satellite data and smart sensors.
2. Localization of new, elite, high-yielding wheat seeds: in the case of a long and hot summer, mild winter, if irrigation is possible, the best varieties are: "Grom", "Yuka", "Alekseich", which, due to their short stature, do not lie down in the event of irrigation and high fertilization, which allows to obtain a record yield of 70-90 centners per hectare. In the foothill and arid zones at an altitude of 1200-1700 m (average rainfall, summer dryness, risk of drought), the best varieties are "Bezostaya 100" and "Tanya", whose powerful root system and high plasticity and precocity manage to ripen before the onset of summer heat and dry southern winds, the onset of frosts. In conditions of long, severe, snowless winters, high risk of frosts and short vegetation, the best varieties are: "Bezostaya 100" and local selection "Armyanka 60" and "Nairi", and for spring sowing – "Darya".
3. Application of data-based management methods for planning and cost optimization.
4. Effective management of water resources: introduction of modern irrigation systems, implementation of soil moisture conservation measures.
5. Training, consulting, awareness-raising of farmers on modern technologies, market requirements.
6. Reduction of production costs through improvement of the supply chain.
7. Creation of prerequisites for intensive cultivation of uncultivated arable lands.

According to studies, the level of wheat self-sufficiency can be increased both through extensive (increasing the sown areas at the expense of uncultivated arable land) and intensive factors (implementing measures aimed at increasing yields). True, according to experts, the sown areas in Armenia are not enough to develop wheat production, but the necessary minimum volume can be provided to minimize the deficit in emergency situations. The solution should be considered not as another program or business project, but as an important component of national security. And, in general, from the perspective of solving the problems faced by the sector and increasing competitiveness, the joint activities of economic operators in agriculture are important, especially the formation of clusters.

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Nelli GRIGORYAN, Marianna HOVHANNISYAN, Gevorg KESHISHYAN
Cluster cooperation in Armenia's grain production sector as a strategy to increase self-sufficiency

Key words: cluster, cooperation, food security, grain, self-sufficiency level

Grain crops play a crucial role in ensuring the country's food security. In the current stage of development, increasing the level of grain self-sufficiency can be achieved only through the adoption of innovative technologies, the introduction of effective forms of cluster cooperation, the implementation of state support programs, and the optimal use of available resources, including the unification and targeted utilization of land. The Armenian grain cluster model envisions cooperation among state structures, scientific and educational institutions, grain farms, flour mills, bread factories, regional administrations, the Center for Agribusiness and Rural Development, leasing companies (ACBA Leasing, Agrocredit), the local branch of the Food and Agriculture Organization (FAO), and other stakeholders. From the point of ensuring food security, the development of wheat production in Armenia is a priority issue. According to expert assessments, uncultivated arable land in Armenia amounts to about 230 thousand ha. In an attempt to increase the level of food security, if 60% of uncultivated lands, about 138 thousand ha, are used for wheat cultivation through cluster cooperation, then, according to our calculations, in the future the level of wheat self-sufficiency will amount to 62.6%. As a result of implementing measures aimed at increasing yields, according to our forecasts, the maximum level of wheat yield will be 45.9 cents/hectare, and under these conditions, the degree of self-sufficiency will reach 61.9%, all other things being equal.