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Economics

Regression-Correlation Analysis of Self-Sufficiency Level of the Grain in the Republic of Armenia

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Abstract. Grain production is traditionally one of the important branches of Republic of Armenia (RA) agriculture, on the development of which the food security and safety of the country largely depend. It provides the food industry with raw materials for the production of food products of critical social importance for the population's consumption (flour, bread, cereals). In the context of current geopolitical developments, providing grain products is a key issue for Armenia's food security. The relevance of the article is due to the fact that grain is a primary food product, and monitoring its self-sufficiency level and keeping it at the center of attention is of strategic importance for Armenia. The main goal of the article is to carry out an econometric assessment of the grain self-sufficiency level and, based on the obtained results, give the priorities of the state policy in regards to increasing grain self-sufficiency. *© 2025 Bull. Natl. Acad. Sci. Georg.*

Keywords: food security, grain, self-sufficiency level, regression model, state policy, price intervention

Introduction

Food security has always been the basis of national security, social stability, and economic development and a major strategic issue. Grain has its own place in the food security basket (Manucharyan, 2021). This is why there are many studies and researches on assessing the efficiency of grain production. Agriculture is a sector where climate change could play a significant role. Lee et al. (Lee et al., 2018) observed that the repercussions of climate change in one region, irrespective of its nature, exert an influence on other regions through trade. This phenomenon is predicated on the premise that domestic demand for food in net-importing countries is met, thereby engendering an augmentation in farm incomes in net-exporting countries. In order to effectively address the food security concerns of net importing countries, national and international policies must also take into account how climate change affects crop yields in different geographic regions of the world (Manucharyan, 2025). As noted Delince et al. (Delince et al., 2015) a direct impact of climate change on agriculture is reflected through altering crop growth development and yields due to changes in rainfall and temperature patterns. The authors by the Agricultural Model Intercomparison and Improvement Project studied the impact of climate change on agriculture. The analysis was conducted using a combination of 11 economic models specifically for Chinese agriculture. The results show that, at the global level, climate change will reduce agricultural productivity (by 2050, ranging from 2% to 15%) and increase food prices (from 1.3% to 56%). Other authors have also studied the impact of climate change on agriculture, in particular, Wei et al. (Wei et al., 2019), noted, that climate change could affect agricultural production and possibly affect the grain self-sufficiency of some countries, threatening their food security. They concluded that autonomous adaptation measures in the agricultural sector can counteract the negative effects of climate change. By responding to market signals, grain producers can largely offset the decline in soil productivity caused by climate change. The agglomeration of the grain industry and the overall productivity of the green factor of grain in China are reviewed by Wang et al (Wang & Long, 2024). The authors noted that China, as the largest developing country, attaches great importance to grain security, constantly increasing grain production capacity, transforming the development model of grain industry and reaching the milestone of "basic grain self-sufficiency and absolute security of grain rationing". As a result of the study, the authors concluded that the government should encourage the adoption of key technologies and promote green technological innovation. In addition, it is necessary to improve the cooperation mechanism between industry, academia, research and environmental monitoring system of grain production management. Zhang et al. (Zhang et al., 2018) studied the impact of advanced methods of integrated crop management on grain yields. The authors of the study found that compared to local farmers' practices, integrated crop management not only improved grain yields, nitrogen use efficiency and irrigation water productivity, but also agronomic and physiological performance.

Niu et al. (Niu et al., 2021) presented the spatial and temporal patterns of grain self-sufficiency in China. The authors analyzed the patterns and determinants of grain production, grain demand, and grain self-sufficiency in China over a 30-year period. They noted that the grain self-sufficiency model is fundamental to food security. As a consequence, proposed to urgently develop a reasonable grain production scheme in accordance with natural resources. Another work, Shen et al. (Shen et al., 2024), is devoted to the identification of determinants affecting the environmental efficiency of grain production. Several factors have significant effects: the level of economic development, agricultural production structure, urban-rural income gap, and labor and crop area ratio all have a significant positive effect on the ecological efficiency of grain production. Conversely, the level of distress and the replanting index significantly reduce the ecological efficiency of grain production. Increasing the efficiency of agriculture, raising the incomes of entities involved in the entire agricultural value chain, and enhancing the level of food security in the country are the priorities of the policy implemented by the government in the RA agrarian sector. Moreover, the most effective policy for achieving these goals in the long term is investment in experimental developments and research in the agrarian sector, while in the short and medium term, it is the subsidization of agro-inputs (Ali & Ali, 2001). However, the current agrarian policy of the RA does not fully address the positive and negative aspects of agriculture, nor does it ensure the sector's development, food self-sufficiency, or the social development of rural areas. Following the experience of Iran, it is recommended that when developing agrarian policy, both the socio-economic and political consequences of the country's most critical issue – ensuring food security – should be taken into account (Amid, 2007).

Methodology

Within the framework of our research, the indicators of grain sown areas and average yield were considered significant factors affecting grain self-sufficiency. Their selection was based on the question of whether the low level of grain self-sufficiency was due to a reduction in sown areas or fluctuations in average yield, which would allow state support programs to be more targeted. The research was conducted using an econometric method, and a multivariate linear regression model was developed. The necessary data were obtained from the publications of the RA Statistical Committee for the period 2005-2024. The following variables were included in the study:

- Dependent variable Y – Level of grain self-sufficiency in the RA
- Independent variable X_1 – Area under grain cultivation in the RA
- Independent variable X_2 – Average yield of grain crops in the RA

A correlation analysis was conducted to determine whether a statistically significant relationship exists between the variables included in the study, and to identify the nature of this relationship. Subsequently, an econometric assessment was carried out using the least squares method, and a linear regression model was developed

$$Y = c + b_1 X_1 + b_2 X_2 \ . \quad (1)$$

The Data Analytics program was used for the calculations carried out in the study.

Analysis

The main indicator of a country's food security is the level of food self-sufficiency. In 2020, the Ministry of Economy calculated the Global Food Security Index for the Republic of Armenia, which resulted in a score of 59.4. This score included 64.9 for food availability, 55.4 for accessibility, 65.1 for quality and safety, and 51.2 for natural resources and resilience (Food Security System Development Strategy, RA Government Decision, 2023). According to the 2005-2024 data from the RA Statistics Committee, the level of self-sufficiency is high in potatoes, vegetable crops, fruits, grapes, sheep and goat meat, eggs, and fish. It is above average in beef and milk and dairy products. However, the level of self-sufficiency in grain, legumes, vegetable oil, and poultry meat continues to remain low (Manucharyan & Asatryan, 2023).

Table 1. The self-sufficiency levels, sown areas, and average yield of grain in RA, 2005-2024 (RA Statistical Committee, Food Security and Poverty, 2006-2024)

	Self-sufficiency level, %	Sown area, ha	Average yield, centner/ha
2005	49.53	207752	18.86
2006	34.21	180444	11.55
2007	43.7	174228	25.67
2008	48.26	170630	23.99
2009	43.98	169548	21.77
2010	40.88	157403	20.45
2011	47.57	155810	27.95
2012	44.52	170179	26.50
2013	54.01	176403	30.82
2014	57.16	183560	31.30
2015	57.46	190957	31.20
2016	61.59	196009	30.55
2017	40.61	153172	19.46
2018	39.47	128322	26.06
2019	30.93	119427	16.33
2020	31.34	119791	20.20
2021	25.35	123317	12.15
2022	28.18	112991	21.16
2023	32.1	125815	22.88
2024	32.7	114685	19.05

In the current global economic context, the main issue of food security in the Republic of Armenia (RA) is ensuring the population's access to bread and bakery products. This issue has always been pressing, since grain self-sufficiency has always been low and Armenia is highly dependent on grain imports. According to data from the RA State Statistics Committee, in 2024, 447.2 thousand tons of grain were imported into Armenia, accounting for about 48% of total demand and twice the total volume of domestic production. Of this, 315.6 thousand tons were wheat, which accounted for about 72% of total demand and was 2.6 times the total volume of production (RA Statistical Committee, Food Security and Poverty, 2006-2024). The analysis of the dynamics of grain self-sufficiency is concerning as there is a serious problem in RA regarding this most important type of food. If grain self-sufficiency reached 49.53% in the 2005s, last decade it has halved to 32.7%. Grain sown areas have also been reduced, the trend is negative and there is no tendency for an increase in sown areas. It is noteworthy that certain positive dynamics is observed regarding the average yield of grain.

Table 2. The results of the correlation analysis*

	Y	*X_1*	*X_2*
Y	1		
X_1	0.842712352	1	
X_2	0.80010691	0.428065648	1

*The Table was constructed by the authors

Now let's discuss the results of empiric assessment. The values of the correlation coefficients between the variables included in the study are presented in Table 2. According to the correlation matrix, a direct and close relationship has been formed between grain self-sufficiency and grain crop sown areas, and a direct and medium relationship has been formed between self-sufficiency and yield. The obtained results allow us to continue the research and carry out multivariate regression analysis. The results of the calculations are presented in the Table 3. According to the results of multivariate regression analysis, a statistically significant closer relationship (R = 0.973) has been formed between the studied phenomena (Table 3).

Table 3. The results of the regression model*

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.972892986
R Square	0.946520761
Adjusted R Square	0.940229086
Standard Error	2.567482304
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	2	1983.39296	991.696482	150.440184	1.5473E-11
Residual	17	112.063411	6.59196538		
Total	19	2095.45637			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-13.162644	3.298312	-3.990721	0.000946	-20.121473	-6.203814
X_1 Variable	0.214011	0.021687	9.868260	0.000000	0.168256	0.259766
X_2 Variable	0.954002	0.110061	8.667937	0.000000	0.721793	1.186210

**The Table was constructed by the authors.*

According to the coefficient of determination (R=0.9465), about 94.65% of the variation in sown areas is due to the variation of the factors included in the model**: grain self-sufficiency and average yield of grain crops, and the remaining 5.35% is due to the variation of random factors not included in the model. According to the adjusted coefficient of determination (R = 0.94), about 94.0% of the variation in self-sufficiency is also due to the joint variation of the factors included in the model: sown areas and yield indicators, and the remaining 6.0% is due to the variation of random factors not included in the model. Taking into account the regression results, our econometric model will have the following functional form:

$$Y = 13.1626 + 0.21401X_1 + 0.954X_2$$

**The model was constructed by the authors.

The interpretation of the regression model is as follows: the increase of grain sown areas in RA by one thousand hectares led to the increase of grain self-sufficiency by 0.214 percentage point. In other words, if we put the assumption that the target level of grain self-sufficiency needs an increase from the current level by 10 percentage points, then the grain sown areas should be expanded by 46,729 hectares.

In the case of the average yield of grain, the following result was obtained: an increase in the average yield by 1 centner/ha leads to an increase in the level of self-sufficiency by 0.954 percentage point, that is, to in crease the degree of self-sufficiency by 10 percentage points, the average yield should be increased by 10.48 centner/ha.

Conclusions

Summing up the results of the research, we conclude that the trends of decreasing grain self-sufficiency in the Republic of Armenia during the period 2005–2024 were primarily due to the reduction in sown areas. Despite the increase in grain yields, the level of self-sufficiency remains low. Although the advantages of intensive production are evident, the expansion of sown areas remains a priority in the Republic of Armenia. Grain itself is a low-value crop, and farmers earn less income per hectare compared to other agricultural crops. Therefore, in addition to expanding the sown areas of grain crops, it is essential to improve their profitability. This will directly enhance the attractiveness of grain production among farmers. Furthermore, increasing the area sown with grain crops should be coupled with addressing the issue of uncultivated and inefficiently used arable land in the Republic of Armenia (232,611 hectares according to 2024 data). Thus, the priorities of state policy aimed at increasing grain self-sufficiency in the Republic of Armenia are:

- To expand the area sown with grain crops, it is recommended to establish a tax exemption for grain growers, exempting them from paying land tax. This should particularly apply to the main grain-growing regions, where, according to 2023 data (data for 2024 is not summarized), the level of arable land use is as follows: Gegharkunik region – 41%, Shirak region – 61%, Syunik region – 44%, Lori region – 51%, and Aragatsotn region – 46%. Moreover, approximately 70-76% of the total arable land in these regions is occupied by grain crops.
- In the context of developing state support programs, it is proposed to implement goods intervention. This will allow not only the creation of a state reserve fund but also guarantee the minimum profitability of production, ensuring the stability of economic operators.
- It is recommended to apply guaranteed prices for local grain producers.

ეკონომიკა

სომხეთის რესპუბლიკაში მარცვლეულით თვითკმარობის დონის რეგრესიულ-კორელაციური ანალიზი

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[§] სომხეთის ეკონომიკის სახელმწიფო უნივერსიტეტი, ეკონომიკის ფაკულტეტი, ერევანი, სომხეთის რესპუბლიკა

(წარმოდგენილია აკადემიის წევრის მ. ჯიბუტის მიერ)

მარცვლეულის წარმოება ტრადიციულად სომხეთის რესპუბლიკის (სრ) სოფლის მეურნეობის მნიშვნელოვანი სექტორია და მისი განვითარება დიდწილად დამოკიდებულია ქვეყნის სურსათის ჰიგიენასა და პროდუქციის უსაფრთხოებაზე. ის სურსათის მრეწველობას აწვდის ნედლეულს ისეთი საკვები პროდუქტების (ფქვილი, პური, ბურღულეული) წარმოებისთვის, რომლებიც კრიტიკულად მნიშვნელოვანია საყოველთაო მოხმარებისთვის. მიმდინარე გეოპოლიტიკური მოვლენების კონტექსტში, მარცვლეული პროდუქტების მიწოდება სურსათის უვნებლობის უზრუნველყოფის საკითხის მთავარი საკითხია რეგიონში. სტატია აქტუალურია, რადგან მარცვლეული საკვები პროდუქტების ძირითადი სახეობაა, ხოლო თვითკმარობის დონის მონიტორინგი და მასზე მუდმივი ყურადღების გამახვილება სტრატეგიული მნიშვნელობისაა სომხეთისთვის. სტატიის მთავარი მიზანია მარცვლეულის თვითკმარობის დონის ეკონომეტრიული შეფასების ჩატარება და მიღებული შედეგების საფუძველზე მარცვლეულის თვითკმარობის გაზრდის მიმართულებით სახელმწიფო პოლიტიკის პრიორიტეტების განსაზღვრა.

REFERENCES

Ali, A., Ali, M. (2001). Wheat Self-sufficiency in different policy scenarios and their likely impacts on producers, consumers, and the public exchequer. *The Pakistan Development Review, 40*(3), 203-223. http://www.jstor.org/stable/41260392.

Amid, J. (2007). The dilemma of cheap food and self-sufficiency: The case of wheat in Iran. *Food Policy, 32*(4), 537–552. https://sci-hub.se/10.1016/j.foodpol.2006.11.001.

Delincé, J., Ciaian, P., Witzke, H-P. (2015). Economic impacts of climate change on agriculture: the AgMIP approach. *Journal of Applied Remote Sensing, 9,* 1, 097099, https://doi.org/10.1117/1.JRS.9.097099.

Lee, H.-L., Lin, Y.-P., Petway, J. R. (2018). Global agricultural trade pattern in a warming world: regional realities. *Sustainability*, *10*, 2763. https://doi.org/10.3390/su10082763.

Manucharyan, M. (2021). *Food security issues in the economic security system of the Republic of Armenia*, BIO Web of Conferences, Volume 36, 08004, International Scientific and Practical Conference "Fundamental Scientific Research and Their Applied Aspects in Biotechnology and Agriculture", https://doi.org/10.1051/bioconf/20213608004.

Manucharyan, M., Asatryan, H. (2023). *The assessment of the import substitution potential of food products with low self-sufficiency in RA*, The contemporary issues of socio-economic development in the Republic of Armenia, *Scientific Journal of Articles,* (1), 142-153, https://arar.sci.am/Content/361338/167.pdf.

Manucharyan, M. (2025). *Climate* change impacts on sustainable agriculture: evidence from Armenia, *Unconventional Resources, 6,* 100159, https://doi.org/10.1016/j.uncres.2025.100159.

Niu, Y., Xie, G., Xiao, Y., Liu, J., Wang, Y., Luo, Q., Zou, H., Gan, S., Qin, K., Huang, M. (2021). Spatiotemporal Patterns and Determinants of Grain Self Sufficiency in China. *Foods,* 10, 747. https://www.mdpi.com/2304-8158/10/4/747.

Shen, L., Sun, R., Wenchao, L. *(*2024*). Examining the drivers of grain production efficiency for achieving energy transition in China*, Environmental Impact Assessment Review, Volume 105, https://doi.org/10.1016/j.eiar.2024.107431.

Wang, J., Long, F. (2024). Grain industrial agglomeration and grain green total factor productivity in China: A dynamic spatial durbin econometric analysis, *Heliyon, 10,* 5, https://doi.org/10.1016/j.heliyon.2024.e26761.

Wei, T., Zhang, T., Cui, X., Glomsrød, S., Liu, Y. (2019). Potential influenceof climate change on grainself-sufficiency at the country levelconsidering adaptation measures. *Earth's Future,* 7, 1152-1166. https://doi.org/10.1029/2019EF001213.

Zhang, H., Yu, C., Kong, X., Hou, D., Gu, J., Liu, L., Wang, Z., Yang, J. *(*2018*).* Progressive integrative crop managements increase grain yield, nitrogen use efficiency and irrigation water productivity in rice. *Field Crops Research, 215,* 1-11, https://doi.org/10.1016/j.fcr.2017.09.034.

Food Security System Development Strategy. (2023). RA Government Decision No. 1083-L of June 29, Appendix No. 1, page 3, https://www.arlis.am/Annexes/7/2023_N1083hav.1.pdf.

RA Statistical Committee. (2006-2024). *Food Security and Poverty*, January-September 2006 (pages 65-68), January-September 2008 (pages 40, 69-72), January-September 2011(pages 38, 67-70), January-September 2014 (pages 39, 68, 71, 74), January-June 2023 (pages 34, 63, 66, 69). January-September 2024 (page 74).

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