AGRISCIENCE AND TECHNOLOGY
Armenian National Agrarian University
ԱԳՐՈԳԻՏՈՒԹՅՈՒՆ ԵՎ ՏԵԽՆՈԼՈԳԻԱ АГРОНАУКА И ТЕХНОЛОГИЯ
International Scientific Journal
ISSN 2579-2822

Journal homepage: anau.am/scientific-journal
doi: 10.52276/25792822-2021.4-349

UDC 633.11”324”:338.43

The Dynamics of Winter Wheat Production and Analysis of the Main Affecting Factors in the Regions of the RA in 1991-2020

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ARTICLE INFO

Keywords:
gross yield,
sown area,
yield per hectare,
main development tendency,
statistical index analysis

ABSTRACT

The main goal of the current research is to study development tendencies of winter wheat production in the period of 1991-2020 and to examine the effect of the changes in cropland areas and yield capacity per hectare on the gross yield of winter wheat in separate periods. In 1991-2005, the gross yield demonstrated extensive (quantitative) growth, and in 2006-2016, it was characterized by intensive (qualitative) growth. In 2017-2020, the yield capacity per hectare decreased almost in all marzes of the RA. As a result, the gross yield of winter wheat annually decreased by 13.54 thousand tons in the mentioned subperiod.

Introduction

Cereal production is one of the key directions of food security in the Republic of Armenia. In the mentioned context it is very important to develop the level of grain production infrastructures, properly implement agro-technological measures and to continuously improve the developing mechanisms of the sector. In the sector of grain/cereal crop production winter wheat has a significant role, since its share in the gross yield of total cereal crop production is rather high. In the RA, throughout 1991-2020, the self-sufficiency rate of wheat didn’t increase above 54 %. Only in 2016, the self-sufficiency rate of wheat was 53.2 %, which was mainly due to the yield increase per hectare.The low level of self-sufficiency rate is related to the gross yield of winter wheat, which, in its turn, is directly estimated upon the yield per hectare.

Due to the economic and political situation throughout the years of independence in the Republic of Armenia, almost all economic sectors were developing with constantly changing tendencies.

The aim of this research is to study the main development tendency of winter wheat production indices for the period of 1991-2020, and to disclose the impact of cropland sizes and yield capacity level on the gross yield per the studied subperiods.

Materials and methods

The development tendency of the winter wheat's gross yield has been analyzed via the trend modeling for individual periods and the significant shifts taken place in the entire period have been disclosed. The tendency has been presented by the linear trend:

$$\hat{y}_t = a + b_1 t, \quad (1)$$

where $\hat{y}_t$ is the calculated value of studied indicators by the linear trend, t is the time factor ($t=1; 2; \ldots n$), a, b_1 are the parameters, b_1 describes the absolute growth of the studied phenomena (Eliseeva, 2014). The whole studied period was divided into three analytical subperiods based on the notable variation of time series indicators of gross yield for winter wheat, such as the absolute differences, growth rate, etc. The separate periods included the following years: 1991-2005, 2006-2016, 2017-2020, and the analyses were conducted per marzes of the RA. The separation was done, since the main characteristics of formed trends for each subperiod were significantly different.

For disclosing the effect of the changes in harvest areas and yield amount per hectare on the dynamics of winter wheat's gross yield production, the analyses were done through the index analysis methods. Statistical index analysis method allows to disclose individual effects of qualitative and quantitative factors on the dynamic of studied phenomena (Gromiko, 2005).

The aggregate index and the absolute growth of gross yield are presented as follows:

$$I_{BC} = \frac{BC_1}{BC_0} = \frac{\sum \Pi_1 Y_1}{\sum \Pi_0 Y_0}, \quad (2)$$

$$\Delta_{BC} = BC_1 - BC_0 = \sum \Pi_1 Y_1 - \sum \Pi_0 Y_0.$$

The aggregate index of the yield per hectare and the absolute growth of gross yield due to change of the yield per hectare are presented as follows:

$$I_Y = \frac{\sum \Pi_1 Y_1}{\sum \Pi_1 Y_0}, \quad (3)$$

$$\Delta_Y = \sum \Pi_1 Y_1 - \sum \Pi_1 Y_0.$$

The aggregate index of the sown area and the absolute growth of gross yield due to change of the sown area are presented as follow:

$$I_\Pi = \frac{\sum \Pi_1 Y_1}{\sum \Pi_1 Y_0}, \quad (4)$$

$$\Delta_\Pi = \sum \Pi_1 Y_0 - \sum \Pi_0 Y_0.$$

BC_1 and BC_0 are the gross yields in comparable periods, Π_1 and Π_0 are the sown areas in comparable periods, Y_1 and Y_0 are the yields per hectare in comparable periods (Hakobyan, 2004). The statistical index analysis of winter wheat's gross yield allows to underline the intensive or extensive ways of its growth. The time series of gross yield, sown areas and yield per hectare in the RA are demonstrated in Figures 1, 2, 3.

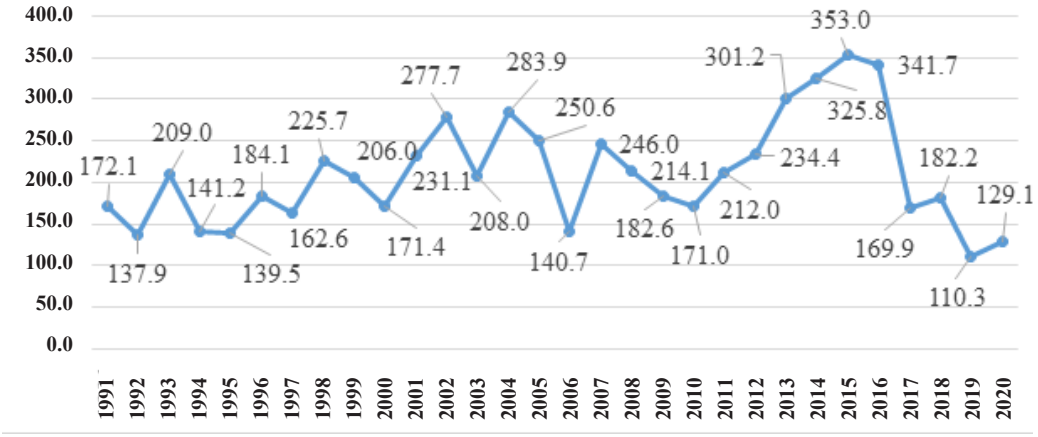

Figure 1. The gross yield of winter wheat in the RA for 1991-2020, 1000 tons *("Agriculture in the Republic of Armenia, 1991-2005" Statistical Compendium - 2001, 2006", "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSS of the RA, 2006-2018, "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSC of the RA, 2019-2021).*

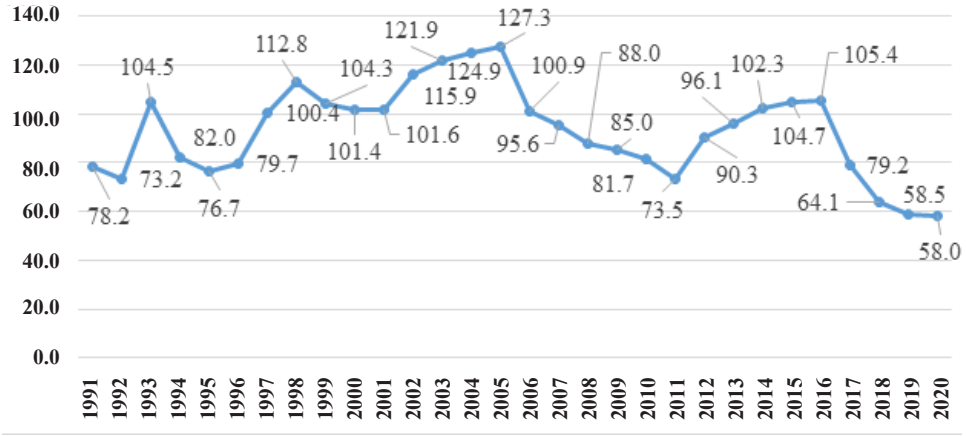

Figure 2. The sown areas of winter wheat in the RA for 1991-2020, 1000 ha *("Agriculture in the Republic of Armenia, 1991-2005" Statistical Compendium - 2001, 2006 "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSS of the RA, 2006-2018, "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSC of the RA, 2019-2021).*

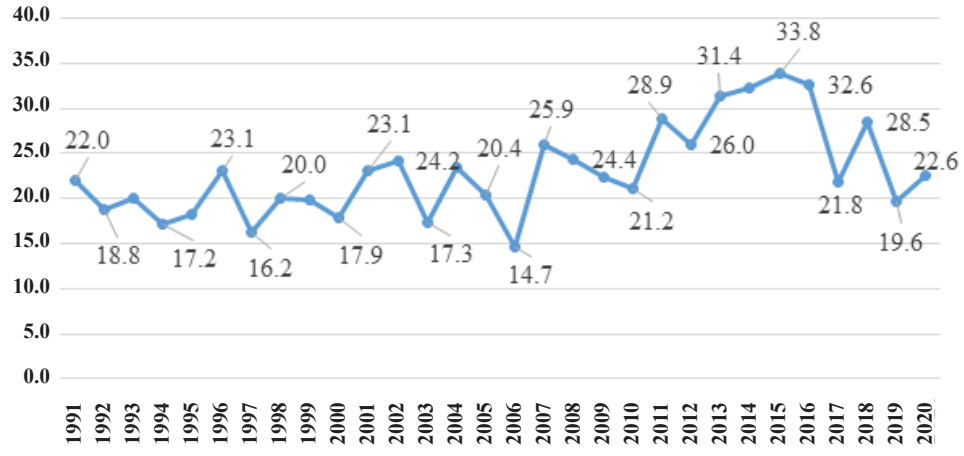

Figure 3. The yield of winter wheat per hectare in the RA, 1991-2020, centner *("Agriculture in the Republic of Armenia, 1991-2005" Statistical Compendium - 2001, 2006 "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSS of the RA, 2006-2018, "Sown areas of agricultural crops, croplands of perennial plants, gross yield and average yield capacity" Statistical Bulletin, NSC of the RA, 2019-2021).*

Results and discussions

The results of trend modeling of gross yield for winter wheat are introduced in Table 1.

Table 1. The trend modeling results of winter wheat for separate periods in the RA*

1991-2005	2006-2016	2017-2020
$\hat{y}_t = 135.5 + 8.07t$ $R^2 = 0.576, \quad F = 17.6,$ $t_{b1} = 4.2$	$\hat{y}_t = 134.7 + 18.8t$ $R^2 = 0.733, \quad F = 24.7,$ $t_{b1} = 4.9$	$\hat{y}_t = 196.4 - 19.4t$ $R^2 = 0.551, \quad F = 2.45,$ $t_{b1} = 1.5$

*Composed by the authors.

Table 2. The average sown areas, gross yield and yield per hectare for winter wheat in the marzes of the RA per separate periods within 1991-2020*

Marzes/ Regions	1991-2005			2006-2016			2017-2020		
	Sown area, 1000 ha	Gross yield, 1000 tons	Yield per hectare, centner	Sown area, 1000 ha	Gross yield, 1000 tons	Yield per hectare, centner	Sown area, 1000 ha	Gross yield, 1000 tons	Yield per hectare, centner
Aragatsotn	6.76	10.3	15.2	9.85	26.0	26.4	6.12	12.3	20.1
Ararat	9.20	31.2	33.9	4.89	19.3	39.3	2.32	9.0	38.6
Armavir	14.19	47.9	33.7	5.96	19.9	33.3	3.24	13.0	40.1
Gegharkunik	11.13	16.0	14.3	15.98	44.7	28	11.16	19.9	17.8
Lori	9.63	17.2	17.9	8.25	21.1	25.5	7.96	23.6	29.7
Kotayk	7.57	10.2	13.5	6.35	12.3	19.4	4.41	9.1	20.6
Shirak	20.19	36.3	18.0	21.93	61.1	27.8	16.95	39.2	23.2
Syunik	12.42	17.3	13.9	12.07	30.3	23.2	8.39	16.1	19.1
Vayots Dzor	2.17	2.7	12.2	1.07	2.3	21.7	0.39	0.8	20.0
Tavush	6.22	9.3	15.0	4.33	10.1	23.3	2.8	5.1	18.0
Yerevan	0.29	0.9	31.0	0.14	0.4	32.5	x	x	x
RA	100.32	199.2	19.9	93.05	247.5	26.6	64.94	148.0	22.8

*The indicators are calculated by authors based on NSC data.

Table 3. The results of index analysis of winter wheat gross yield in the marzes of RA for the period of 1991-2005*

Marzes/Regions	The surplus (reduction) of gross yield		Due to changes in			
	1000 tons	%	sown area		yield per hectare	
			1000 tons	%	1000 tons	%
Aragatsotn	0.381	102.2	-0.027	99.8	0.409	102.4
Ararat	2.204	109.2	2.333	109.9	-0.309	99.8
Armavir	2.269	107.3	4.272	110.8	-2.003	96.9
Gegharkunik	0.709	102.7	-0.027	99.9	0.736	102.8
Lori	0.366	102.1	1.004	104.7	-0.638	97.5
Kotayk	0.393	102.7	1.128	106.1	-0.735	96.8
Shirak	-0.667	98.2	1.422	102.9	-2.089	95.4
Syunik	0.272	101.2	0.572	102.4	-0.299	98.9
VayotsDzor	-0.027	99.1	-0.076	97.1	0.049	102.0
Tavush	-0.129	98.8	0.143	101.1	-0.272	97.7
Yerevan	0.026	105.6	0.024	105.4	0.001	100.2
RA	6.261	102.9	7.715	103.5	-1.455	99.5

*Composed by the authors.

According to the main characteristics of trend modeling, the development tendency of winter wheat's gross yield significantly varied between the individual periods. In 1991-2005, the gross yield of winter wheat annually increased by 8.07 thousand tons, in 2006-2016 it annually increased by 18.8 thousand tons. In 2006-2016, the increasing tendency of winter wheat gross yield was much higher than that of observed for the period of 1991-2005; it was mainly due to the growth of yield amount per hectare (index analysis is introduced in Tables 3, 4).

In 2017-2020, the gross yield of winter wheat annually decreased by 19.4 thousand tons due to the decrease of yield per hectare and sown areas (Table 5).

Table 4. The results of index analysis of winter wheat gross yield in the marzes of the RA for the period of 2006-2016*

Marzes/Regions	The surplus (reduction) of gross yield		Due to changes of			
			Sown area		Yield per hectare	
	1000 tons	%	1000 tons	%	1000 tons	%
Aragatsotn	3.033	113.1	0.609	104.1	2.424	108.7
Ararat	-0.077	99.7	-0.892	96.0	0.816	103.9
Armavir	-1.477	94.0	-1.984	90.8	0.507	103.5
Gegharkunik	2.363	109.9	0.276	101.7	2.087	108.1
Lori	2.549	113.2	0.204	101.8	2.346	111.9
Kotayk	1.329	113.6	-0.059	98.8	1.388	114.9
Shirak	6.949	114.1	0.749	102.6	6.200	111.2
Syunik	3.797	117.7	0.24	102.3	3.557	114.9
Vayots Dzor	0.366	120.3	0.018	102.3	0.348	117.6
Tavush	1.265	117.6	0.139	103.8	1.125	113.3
Yerevan	-0.009	98.1	-0.025	93.5	0.016	104.9
RA	20.053	109.3	1.309	100.9	18.743	108.9

Table 5. The results of index analysis of winter wheat gross yield in the marzes of the RA for the period of 2017-2020*

Marzes/Regions	The surplus (reduction) of gross yield		Due to changes of			
			Sown area		Yield per hectare	
	1000 tons	%	1000 tons	%	1000 tons	%
Aragatsotn	-2.416	85.3	-3.439	77.1	1.023	110.6
Ararat	-2.066	80.7	-2.142	79.8	0.076	101.1
Armavir	-0.533	96.3	-0.821	94.3	0.287	1.022
Gegharkunik	-0.761	96.2	-1.424	92.7	0.663	1.038
Lori	0.253	101.2	0.305	101.4	-0.052	99.8
Kotayk	-1.097	88.4	-0.836	91.5	-0.261	96.7
Shirak	-3.747	90.4	-4.237	88.9	0.49	101.6
Syunik	-1.479	91.3	-0.997	94.3	-0.482	96.8
VayotsDzor	-0.282	66.5	-0.241	73.5	-0.041	90.5
Tavush	-1.541	71.0	-0.696	89.2	-0.845	79.6
RA	-13.473	91.3	-14.998	90.2	1.524	101.2

*Composed by the authors.

As shown in Table 2, in 1991-2005 the maximum gross yield was recorded in Armavir region, which amounted to 478.53 thousand tons, and in the following period the maximum gross yield of winter wheat was observed in Shirak region, i.e., in 2006-2016 it reached 610.59 thousand tons, while in 2017-2020 it fell down to 392.42 thousand tons.

As the results of analysis indicate, in the period of 1991-2005, in the marzes of Ararat, Armavir, Lori, Kotayk and Syunik, the gross yield surplus of winter wheat was only due to the expansion of sown areas, which was associated with the decrease of yield capacity per hectare. The gross yield of winter wheat decreased in the Shirak (by 0.667 thousand tons), Vayots Dzor (by 0.027 thousand tons) and Tavush (by 0.129 thousand tons) regions, which is fully related to the decrease of yield capacity per hectare.

In the mentioned period the sown areas of winter wheat decreased, but the gross yield increased in the Aragatsotn and Ghegharkunik regions. In the Aragatsotn region, the gross yield increased by 0.381 thousand tons due to per hectare yield increase by 0.409 thousand tons, and in the Ghegharkunik region the gross yield increased by 0.709 thousand tons due to per hectare yield increase by 0.736 thousand tons (Table 3).

In 2006-2016 the gross yield of winter wheat decreased in the Ararat, Armavir regions and in Yerevan city mainly due to the decrease of sown areas (Table 4). The gross yield reduction of winter wheat is a positive shift for the agricultural sector in these marzes. During this period, in the abovementioned regions intensive agricultural branches, such as horticulture, viticulture and vegetable growing, were developed. In the other regions the gross yield of winter wheat is characterized by intensive growth. The gross yield surplus of winter wheat in Aragatsotn, Gegharkunik, Lori, Kotayk, Shirak, Syunik and Vayots Dzor regions was due to the increase of yield capacity per hectare. These mentioned regions are specialized in cereal crops, particularly in wheat production, where wheat production indices have been rather improved. It is no coincidence, that in this period the self-sufficiency rate of wheat reached the maximum level against the other studied years (in 2016 the self-sufficiency rate of wheat was 53.2 %) (Statistical Bulletin, SC of the RA, 2021).

In 2017-2020, almost in all marzes of the RA, the gross yield of winter wheat decreased, again due to the decrease of yield capacity per hectare (Table 5). Due to the reduction of sown area the gross yield of winter wheat decreased in the Aragatsotn, Ararat, Armavir, Gegharkunik and Shirak marzes. In the marzes of Syunik, Vayots Dzor and Tavush the gross yield decreased due to the reduction of both the sown areas and per hectare yield capacity.

Conclusion

The aim of the research is to disclose the development tendency of winter wheat production, as well as the effect of cropland areas and yield capacity dynamics on the production indices within the entire period of 1991-2020 years. Related to the significant discrepancies in the main indicators of the gross yield dynamics, the studied period was divided into three subperiods: 1991-2005, 2006-2016 and 2017-2020.

In 1991-2005, the difficult socioeconomic situation of the country made the farmers expand the croplands of winter wheat to ensure food security, as a result of which the annual gross yield surplus of winter wheat made 6.26 thousand tons.This period can be considered as the period of qualitative decline of wheat production.

In the next period of 2006-2016, the gross yield of winter wheat significantly increased, especially in such specialized marzes as Shirak, Gegharkunik, Kotayk, Lori and Syunik. The growth of gross yield was related to the yield increase per hectare by more than 1.5 times. In this period the main indicators of winter wheat production were qualitatively improved.

In 2017-2020, the gross yield of winter wheat annually decreased by 19.42 thousand tons mainly due to the decrease of sown areas and, in individual regions, to the decline of the yield capacity per hectare. These adverse changes resulted in the decrease of wheat self-sufficiency ratio by 54.4 %.

Despite the fact that RA is a grain importing country, the promotion of yield capacity increase should be viewed as one of the key objectives of the agricultural strategic plan. The continuous increase of the yield capacity in the specialized regions of the republic will enable to ensure the development of cereal crop infrastructures and improvement of the relevant mechanisms.

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The research was carried out with the financial support of the Russian Foundation for Basic Research and the Science Committee of the RA within the framework of the scientific project No. 20-510-05020 \ 20 (No. 20RF-054).

Accepted on 10.06.2021
Reviewed on 23.06.2021