

Future expectations of agronomy intensification due to use of mineral fertilizers

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Abstract — We analyzed the modern state of production and use of mineral fertilizer in the Russian Federation. On the example of Volgograd region we studied the future expectations of agronomy intensification and increasing of grain production due to use of mineral fertilizers. It was explained the practicability of inland use of fertilizers comparing with their export.

Keywords — mineral fertilizer, intensification, export, grain production, payback, weather conditions, cultivation technology)

I. INTRODUCTION

Production of mineral fertilizers in the Russian Federation in 2017 amounted to 22.5 mln tons (at the 100% of the active ingredient) and increased comparing with the beginning of the 90th years of the past century in 1.8 times. Their use was fundamentally changed – in the pre-reform period the mineral fertilizers were used almost totally inland, in the period of market reforms they were sold out at external markets. This tendency began in the 90th years of the last century, when due to financial hardship of agriculture goods producers it was difficult to sell mineral fertilizers at inland markets. That is why even the production of fertilizers decreased. Then this economic sector for mineral fertilizers production was restored and developed then the three quarters of the produced mineral fertilizers are exported mostly to the far abroad countries (China, the USA and others), and one quarter – inland the country. That proportion of use the mineral fertilizers have got supporters as well as opponents.

II. MATERIALS AND METHODS (MODEL)

The supporters of the export orientation at the economic sector of mineral fertilizers production explain the selected priorities with the low effectiveness of their use inland [1]. The opponents of the export orientation in use of mineral fertilizers explain, that the problem of their effective use inland is not investigated enough and their not sufficient effectiveness is explained mostly by imperfection of technologies being used of cropping [2]. Actually, all disputes are about the fact what is more profitable for the country – to export the agricultural goods, produced with the help of fertilizers of the fertilizers themselves?

In the Russian Federation 2017 the agricultural goods producers used the mineral fertilizers in 2.5 times less

comparing with the beginning of the 90th years of the last century. In Volgograd region these reduction was in 4.7 times (table 1).

Table 1. Factors dynamics in use of mineral fertilizers in Volgograd region (in conversion to 100% of active ingredient)

years	Used		Including the crops in kg:					Ratio of the crops. Where fertilizers were used in %
	Total in thousand tons	Per 1 ha of crops, kg	grains	sunflower	Vegetable crops	potatoes	Feed crops	
1990	189,6	43	44	56	220	217	33	39
1995	9,7	3	3	2	97	83	3	5
2000	3,3	2	2	1	49	200	1	4
2005	25,3	15	16	17	129	144	2	32
2010	29,8	20	23	10	430	238	3	33
2015	26,8	17	19	11	244	163	3	36
2016	35,1	22	23	19	251	361	1	43
2017	40,2	25	27	18	248	248	3	52

Removal of mineral substances together with crop per the macrofertilizers (nitrogenous, potassium and phosphate fertilizers) in the region in 2017 was in 7.6 times greater than their use for grains and in 10 times for sunflower. In 1990 this exceedance for grains was in 3.4 times and for sunflower – 2 times.

In order to detect losses from decreasing volumes of mineral fertilizers use in Volgograd region we made the comparative analysis of average annual rate of grain production changes for 30 years (1961-1990 years) pre-reform period and 28 years period (1991- 2018), period of market reforms (table 2).

The general tendency of changes covers reduction of planted acreage for grain production. At the pre-reforms period the crops reduced for 31.3%, at the reforms period continued the further reduction on 21.6%.

Changes of average annual rate as per grain gross crop collection had different tendencies. At the pre-reform period, when use of mineral fertilizers increased, there were variations in gross crop collection, that fact in general can be analyzed as tendency of stabilization of grain production growth. In the period of reforms when the use of mineral fertilizers was dramatically reduced, there also were variations in gross crop collection, but reducing of average annual rate volumes of

grain production amounted to 29.4% comparing with previous 30 years.

Table 2. Dynamics of changes of the grain production average annual rate in the Volgograd region for the 1961-2018 years.

Years	Area, thousand hectare	Bulk yield, thousand tons	Yield per hectare in centers
1961-1965	3866	4207	10,9
1966-1970	3797	4600	12,1
1971-1975	3812	4042	10,6
1976-1980	3914	5385	13,7
1981-1985	3441	3265	9,5
1986-1990	2657	4194	15,8
Average for 1961-1990 years	3601	4282	11,9
1991-1995	2506	3324	13,3
1996-2000	1948	1775	9,1
2001-2005	1838	3075	16,7
2006-2010	2033	3222	15,8
2011-2015	1873	3004	16,0
2016-2018	1996	4618	23,1
Average for 1991-2018 years	2034	3066	15,1
1991-2018 year in % comparing with 1961-1990 years.	56,5	71,6	126,9

The average annual rate of grain crops yield showed the tendency of growth as for pre-reforms period as well as for reforms period. The more stable tendency was at the period of reforms, as the crop yield increased on 26.9% comparing with the previous 30 years. But we can't declare that grain production of the region came to the intensive pattern of development. Growth of crop yield was due to the fact of decreasing crops at the subareas of Right and Left bank of the river of the side of the third and fourth area that is at the areas of risk farming, that are the most unfavourable for cropping [3, p. 18].

III. RESULTS AND DISCUSSION

In general we can analyze the changes in organization of grain production as the assumption for transference it to the intensive way of development. First of all is the grain crops 2.0 mln hectares location within the areas with more advantageous soil and climatic conditions. Second is the ability to use more mineral fertilizers comparing with pre-reforms level considering the increased volumes of their production within the country. The economic assumptions were also formed for this purpose. Economic effectiveness of selling grains at the agricultural enterprises, where we produce three fourth of the volume produced in the region, was stabilized for the last years – the profitability level is more than 40% [4, p. 166]. This level of profitability allows successfully perform the grain production on the basis of intensive factors including the extensive use of mineral fertilizers. That doesn't exclude the practicability of developing and implementation government's restrictive measures for export of mineral fertilizers and expansionary actions for increasing of their use by the inland agricultural goods producers. There is the necessity of getting familiar with modern technologies of grains cultivation considering the

mentioned above information, and taking into account the nature and economic peculiarities of the region provide growth of crops of products of high quality.

Firstly it is necessary to consider objective features, that don't depend on people's activities. That feature of agricultural production of the region are variations of weather conditions in different years, that are at other different conditions influence on the effective index of production intensification – the crop yield. For this purpose we analyzed the indexes of grain production changes depending on weather conditions for the period between 1961 and 2018 years (table 3).

Table 3. Classification of indexed of grain production variety as the depending on weather conditions in the Volgograd region influence on crop yield for the period between 1961 and 2018 years.

Name of indexes	Number of years	Proportion in %		Average annual rate		Average yields, centers/ hectare
		At the planted acreage	At the bulk yield	Planted acreage	Bulk yield, thousand tons	
The worst years: crop yield is up to 7.0 c/hectare	9	16.5	6.9	2889	1661	5,6
Unfavorable years: crop yield up is from 7.1 to 12.0 c/hectare	13	24.6	19.2	3085	3181	10,3
Medium years: crop yield is from 12.1 to 16.0 c/hectare	17	29.4	31.1	2823	3936	13,9
Favorable years: crop yield exceeds 16.0 c/hectare	19	29.5	42.8	2530	4844	19,1
Total average	58	100.0	100.0	2812	3711	13,2

During the analyzed 9 years period we got the crop yield up to 7 centers/hectare (the worst years), during the period of 13 years - from 7.1 to 12 c/hectare (unfavorable years), during the period 17 years – from 12.1 to 16.0 c/hectare (medium years) and during 19 years – more than 16.0 c/hectare (favorable years). The worst and the unfavorable years are as a rule the dry years, specified by shortage of moistness at the root habitable layer; absence of rains during the vegetation season; high comparing with the average annual values temperature; low relative humidity of the air and other negative weather conditions. The share of the worst and unfavorable years at the planted acreage during the analyzed period amounted to 41.1%, and in bulk yield – 26.1%. At the same time the share of medium and favorable years in the planted acreage amounted to 58.9%, and in bulk yield -73.8%.

The key indexes, classifying the favorable or unfavorable weather conditions of the year in the region are presence of water during the vegetation period of the plants at the root habitable layer. At the certain favorable years during the vegetation period even can be too much moisture, causing untimely performing of works for the crop tending, as well as presence and spread of plants diseases and other negative events. If to classify the climatic conditions of the region in general, the dry climate, that requires the necessity to develop and implement of moisture saving technologies of cropping.

Dry climate is from one side the restricting factor for increasing of grain crop yield, and from the other it contributes to getting the more qualitative products – the high quality grain, that is expensive at the inland and international markets. But in order to get the high-yielding grain crop we need to have scientific based norm of using the macrofertilizers nitrogenous, potassium and phosphate fertilizers combined with microfertilizers. For that purpose we need to increase production of complex fertilizers in which the macrofertilizers should be combined with necessary amount of microfertilizers.

Effectiveness of use the moisture saving technologies, specialized to region's conditions – flat or so called zero soil processing, in combination with chemical substances for protection of plants practically, requires use of such amounts that not only balance removal of elements of mineral nutrition together with crops, but also float the soil. It is necessary to achieve high payback of their use. Today the average global practice of mineral fertilizers payback amounts to 10 kg of grain per 1 kg of mineral fertilizers at 100% of the active ingredient [2, p. 20]. But in order to achieve that payback at agriculture of our country as well for respective scientific research and for investments we need time.

Due to the fact that at the initial stages of agricultural industry intensification in order to define the effectiveness of the mineral fertilizers we can proceed from payback, recognized by inland agricultural economics and practice amounting to 3-5 kg grain per 1 kg 100% of the active ingredient [2, p. 21]. That is especially actual for such regions, as the Volgograd region, where it is difficult to achieve that payback at the worst and unfavorable as for weather conditions years. But the low payback of use the mineral fertilizers at certain years can't be considered as the winning factor in favor of their export comparing with the use inland, for example at the grain production. This is proved by the calculations, made with the use of table 4 data.

Table 4. Average export prices for wheat and mineral fertilizers in the Russian Federation in US dollars per 1 ton [5, p. 508]

Name of indexes	Years				
	2013	2014	2015	2016	2017
Wheat	252	245	186	166	176
Mineral fertilizers:					
Nitrogenous fertilizers at gross weight calculated per 100% of active ingredient	284 747	267 702	230 604	170 438	185 464
Potassium fertilizers at gross weight calculated per 100% of active ingredient	346 563	258 425	264 436	196 322	193 318
Mixed fertilizers at gross weight	390	367	364	282	262

So income per 1 ton 100% of active ingredient according to the global market of nitrogenous fertilizers prices in 2017 amounted 464 US dollars per 1 ton, potassium fertilizers -318 US dollars per 1 ton, mixed at gross weight – 262 US dollars, that at active ingredient is approximately 545 US dollars per 1 ton. The income per 1 ton of wheat as per global market prices in 2017 amounted to 176 US dollars per 1 ton. At the payback equal to 3 kg per 1 kg of fertilizers the estimated income for the sold wheat amounted to 528 US dollars, at the payback equal to 4 kg per 1 kg of fertilizers - 704 US dollars, at the payback equal to 5 kg per 1 kg of fertilizers – 880 US dollars.

IV. CONCLUSION

Thus at the minimal payback equal to 3 kg per 1 kg of fertilizers their use at grain production doesn't bring extra currency gain and when considering the extra expenses, for use it is not effective. At the higher payback their use inland is more profitable comparing with export. If to predict use of mineral fertilizers considering the influence of weather conditions on the results of grain, that we can say the following. During the worst and unfavorable years the low payback is possible. During medium and especially favorable years we produce almost three quarter of grain, considering the fact that their use is specified not only by action, but also by residual action, the payback can be close to average annual index, and thus compensate the losses due to low payback at the worst and unfavorable according to the weather conditions years. All this information proves the practicability of inland use of fertilizers comparing with their export.

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