Economic Efficiency of Sugar Beet Production

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Abstract: The purpose of the study is to assess the state of sugar beet production in the Republic of Bashkortostan, to identify factors that influence the effectiveness of its cultivation which determine the suitability and prospects for the development of beet growing. It is established that, the production of sugar beet in the republic is effective, the profitability on average for 2012-2016 was 25.5%. The annual increase in sugar beet yield in the republic over the last decade has been determined, on average by 6.32 centners/ha due to the intensification of the technology of its cultivation. A significant influence on the yield and efficiency of sugar beet production in the republic of hydrothermal conditions of vegetation has been revealed. The analysis of the cost structure which showed the intensification of the technology of sugar beet production in the economy of the republic at the expense of all cost items was carried out. The cost of seeds, fertilizers, fuels and lubricants and the maintenance of fixed assets have approximately the same share in the cost structure (about 13%). The share of costs for plant protection products (16.2-18.3%) is somewhat higher and expenses for crop insurance (0.8%) are insignificant.

Key words: Sugar beet, yield, sowing areas, production volume, hydrothermal conditions, efficiency, cost structure

INTRODUCTION

Sugar beet is the most important crop in many regions of the world. In large areas it is cultivated in the countries of Europe, North America and Asia. In a number of countries sugar beet is the main source of sugar and has an important economic significance (Spicka and Janotova, 2015; Baran and Gokdogan, 2016; Asgharipour et al., 2012).

Researches of scientists say that today the cultivation of sugar beet is economically and energetically more productive and efficient than the cultivation of many other crops (Trimpler et al., 2017; Toth et al., 2017).

The main product of the beet sugar complex is sugar. It is not only used in the daily diet of humans but also widely used in confectionery, bakery, canning, dairy and other industries. In general, half of the sugar produced is used for industrial processing. By products (molasses and pulp) serve as feed resources for animal husbandry (Rezbova et al., 2014).

Sugar beet has a high potential for productivity which is currently underutilized in a number of countries as the yield and sugar output depend on soil and climatic conditions (Kovacs and Tomkuljakova, 2010; Erdal et al., 2007). The basis for the economic evaluation of the cultivation of sugar beet as well as other crops is the accounting of all costs in the technological chain and their analysis (Schnepel and Hoffmann, 2016). The competitiveness of sugar beet production in different regions of the world depends on the influence of various natural, economic and political factors (Hoffmann and Kenter, 2018; Beghin and Elobeid, 2014).

According to Tupikova (2013), Zyukin et al. (2016) and Ableeva (2010) the production of sugar beet and sugar, being a highly industrial and energy-intensive production, occupies an important place in the structure of Russian agriculture. Enterprises of the industry are located in 24 regions of the country, more than 250 thousand specialists are employed in this sector of the economy. The demand of the population and the processing industry in sugar is satisfied by its own production by 55-57%.

In the research of Islamgilov and Islamgulov (2016a, b), Ismagilov et al. (2014) and Lubova (2012) the analysis of sugar beet cultivation was carried out which indicates that the Republic of Bashkortostan is the Northern region

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of industrial beet production of the Russian Federation. In 2017 sugar beet was cultivated in 24 municipal districts of the republic. In recent years, it is cultivated on the area of 51-53 thous. ha and occupies about 2% in the acreage structure of beet-growing areas.

The financial position and competitiveness of beet growing farms and in general, the plant growing of the republic depend to a large extent on the economic efficiency of sugar beet cultivation. Beet growing in the Republic is particularly sensitive to competitive tensions due to the lack of favorable natural conditions. This fact is proved by such scientists as Lubova (2011), Ismagilov and Islamgulov (2000) and Ismagulov and Bakirova (2017).

At the same time as evidenced by Islamgulov (2014, 2015) and with the introduction in recent years of the embargo in agriculture, the economic conditions for beet growing in the country including the Republic of Bashkortostan, improved.

The purpose of the study was to assess the state of sugar beet production and determine the factors that influence the efficiency of its cultivation as well as assess the suitability of cultivation in farms and the prospects for the development of sugar beet production in the country.

MATERIALS AND METHODS

The study was carried out using statistical data, the results of field experiments with sugar beet conducted by us in 1992-2017, agrometeorological indicators of Bashkir Hydrometeorological Center. The analysis of the field experiment results was carried out in the form of mathematical processing of the ordered results of the field experiment in order to obtain statistical estimates of the resulting indicators to identify the obtained empirical dependences, mathematical confirmation of the scientific hypothesis validity and to justify scientific conclusions. For the quantitative analysis, correlation and regression methods as well as methods for leveling the dynamics series were used. Statistical analysis was performed using standard computer programs.

In order to establish the existence of a connection between the variable factor and the resulting index in the field experiment, mass conjugated measurements and determinations were performed when the factor level and the resultant indicator (dependent attribute) were measured in pairs. For preliminary analysis, the experimental data are plotted on a graph. If a roughly rectilinear relationship is observed, the correlation coefficient (r) is found, if the relationship is more similar to the curvilinear the correlation ratio or correlation index (η) are found. The correlation coefficient and the index of correlation indicates the direction and degree of correlation of the compared characteristics (random variables) but can't judge how effective quantitative changes sign with the change in the factor variable which is important for practical applications. If there is a reason (according to the experimental data) to consider such a dependence to be linear, the description of the dependence is carried out with the help of regression analysis, the purpose of which is to determine the formula of rectilinear regression. The values of the correlation coefficients always lie in the range from -1 to +1. If the data contains well-defined subgroups of observations then the correlation coefficient is not calculated. The application of correlation and regression analysis methods allowed to prove the existence of a connection between the studied factors and to determine the models of the impact of one or more variable factors.

RESULTS AND DISCUSSION

Analysis of statistical indicators showed that large agricultural enterprises are major sugar beet producers in the Republic of Bashkortostan. Currently, in many countries that grow this culture, a similar trend is maintained (Spicka and Janotova, 2015; Toth *et al.*, 2017; Erdal *et al.*, 2007). Until 2000, almost all production of sugar beet in the republic was concentrated in agricultural organizations. In 2016, sugar beet was cultivated in agricultural organizations on an area of 40 thous. ha or 78.3% of the total area of this crop, about 20% of sugar beet was cultivated by farms and about 1% by individual entrepreneurs. In recent years there is an expansion of sugar beet crops in farms. If in 2005 the farms in the sugar beet production structure occupied 11.5% in 2016-21.3%.

The average yield of sugar beet does not differ, significantly in all forms of management. In 2017 the sugar beet yield in agricultural organizations was 257.9 c/ha in private farms 260.9 and for individual entrepreneurs 262.3 c/ha. The gross production of sugar beet root crops in the republic amounted to 1450 thous. tons on average for the last 5 years 2013-2017 (Table 1).

Table 1: Yield and economic efficiency of sugar beet production in the Republic of Bashkortostan

Index	Years							
	2010	2011	2012	2013	2014	2015	2016	2017
Sown area (thous. ha)	69	64	54	55	51	51	51	53
Yield of root crops, (centner/ha)	97	249	209	338	250	258	269.1	310.4
Gross harvest of root crops, (thous. tons)	377	1432	940	1786	1250	1301	1363	1593
Profitability of production (%)	-	18.0	4.6	42.1	29.8	28.4	23.0	-

This is about 3% of the gross harvest of sugar beet in the Russian Federation. Sugar beet is successfully cultivated in many agricultural organizations and farms of the republic. Thus, in LLC Bashkiragroinvest 312 centners of sugar beet root crops per hectare with sugar content 17.5% were received on an area of 12,468 ha on average for 2014-2016. The profitability of sugar beet cultivation in this agricultural organization was 32.0% on average over 3 years. Consistently, high yields are produced in farms Saturn, Irek, Divaev, Chernov, etc. In the farm Saturn on average for 2015-2016 577 centners of root crops from each of 450 ha of sowing sugar beet were harvested. The profitability of sugar beet cultivation here was 80.5%.

In general, the production of sugar beet root crops in the farms of the republic is effective. A general indicator of economic efficiency is the level of profitability of production on average for 2011-2016 amounted to 25.5% with fluctuations in years from 4.6% (2012) to 42.1% (2013). The economic efficiency of sugar beet cultivation in the republic is largely determined by its yield. If in 2014 when the yield was only 97 centners/ha, the production of sugar beet was unprofitable, then in the yielding 2013 (338 centners/ha) the profitability was 42.1%. As yields increase, the cost of sugar beet root crops naturally decreases. In 2010 (productivity 97 tons/ha) the cost of production amounted to 2376 rub./ton and in 2011-1139 rub./ton (productivity 249 tons/ha).

The analysis shows that, since, 1994 the sugar beet yield in the republic has regularly increased. Figure 1 shows the dynamics of the sugar beet yield over the period 1994-2017. The trend equation of the change in yield for a given period has the following form:

$$y = 6.32x + 123.54$$

Where:
y = The yield of sugar beet root crops in the republic q/ha
x = The year number (1-1994)

The coefficient of approximation is equal to 0.546. According to this trend equation, the annual increase in the yield of sugar beet in the country is 6.32 c/ha. As studies have shown such a positive trend in crop yields is due to the country's active position on the implementation of the Federal industry target program "Development of the sugar beet subcomplex of Russia for 2010-2012" the introduction of high-yield and technologically advanced F1 hybrids and the use of single-stage dressed seeds with high seeding qualities, mechanization of all technological operations of
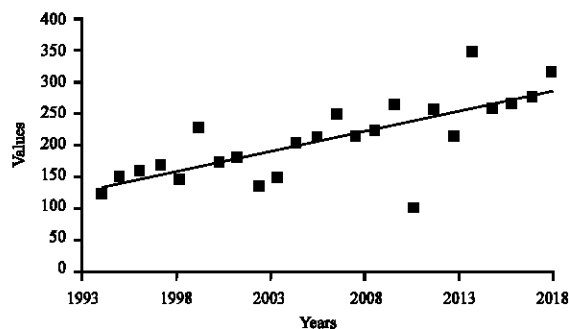

Fig. 1: Dynamics of sugar beet yield in the Republic of Bashkortostan

In recent years, 134-150 kg of mineral fertil cultivation, wide application of herbicides for the destruction of weeds and insecticides for the protection of plants from pestisizers (100% of the active substance) are applied per hectare of sugar beet sowing, 150 high-performance beet harvesters are used for harvesting root crops. At the same time as shown by the analysis of the dynamics series by years in addition to these factors other factors also have a significant effect on yields and accordingly on the economic efficiency of sugar beet production. This is confirmed by the coefficient of determination, i.e., about 45% of the yield fluctuation by years is due to other factors mentioned above. Studies have shown that mainly this is the impact of natural resources and factors. Thus, the highly arid conditions in 2010 led to a sharp decrease in the yield and loss ratio of sugar beet cultivation, the yield was only 97 c/ha or a deviation from the trend of 133 c/ha.

Our field studies have shown that, the main natural resources for the formation of the yield of sugar beet as well as other crops, for example, wheat are 'moisture', 'heat', 'photosynthetic active radiation', 'elements of mineral nutrition', 'organic food', 'duration of the growing season'. Similar research results are reported by Trimpler *et al.* (2017).

The level of natural resources varies in time (by years and throughout the year) and in space (on the territory). The technological process in crop production including the production of sugar beet roots is unequally provided with natural resources over the years and the level of some of them is not controlled by the commodity producer. This requires an assessment of the level of natural resources as an efficiency factor. In the researches by Baran and Gokdogan (2016), Kovacs and Tomkuljakova (2010) and Schnepel and Hoffmann (2016) similar information is also received.

Statistical analysis of the observation results show that moisture and heat exert a significant influence on the

Table 2: Structure of costs for the production of sugar beet roots in the Republic of Bashkortostan

Cost/Items	2011		2012		2013		2014		2015		2016	
	rub./ha	Percentage	rub./ha	Percentage	rub./ha	Percentage	rub./ha	Percentage	rub./ha	Percentage	rub./ha	Percentage
Salary	3165	11.2	3654	13.3	3199	8.1	2945	12.0	3623	10.00	4327	8.1
Seeds	3748	13.2	3773	13.7	5078	12.8	3122	12.8	4028	11.10	6868	12.8
Fertilizers	3153	11.1	3892	14.1	4288	10.8	3073	12.6	3545	9.80	5800	10.8
including mineral	3101	10.9	3842	13.9	4260	10.7	2990	12.2	3457	9.60	5762	10.7
Means of plant protection	5184	18.3	5035	18.3	6439	16.2	4076	16.7	6451	17.80	8708	16.2
Electricity	73	0.3	54	0.2	61	0.2	46	0.2	98	0.30	82	0.2
Fuels and lubricants	2550	9.0	3703	13.5	3746	9.5	3502	14.3	4148	11.50	5066	9.5
Insurance	263	0.9	224	0.8	1092	2.8	910	3.7	1105	3.10	1477	2.8
Contents of fixed assets	3065	10.8	3207	11.6	8332	21.0	2890	11.8	4429	12.20	11268	21.0
Other	6371	22.5	2824	10.3	7401	18.7	3885	15.9	8731	24.10	10009	18.7
Total	28366	100.0	27528	100.0	39637	100.0	24450	100.0	36159	100.00	53606	100.0

yield and efficiency of sugar beet production from natural resources on the territory of the republic with a continental climate. The increase in the amount of precipitation during the growing season significantly increases the yield of sugar beet (correlation coefficient is 0.704). Particularly positive is the precipitation in the second half of the sugar beet growing season. If the correlation coefficient of the relationship between the yield of root crops and the amount of precipitation in June was 0.423 in August it was 0.521. High air temperature during the growing season leads to a decrease in the yield of sugar beet which is mainly due to the deterioration of the moisture supply of plants in the conditions of the continental climate on the territory of the republic with an elevated temperature regime. The correlation coefficient between the yield of root crops and the sum of active temperatures (above 10°C) is negative and is 0.507.

An important condition for increasing the economic efficiency of agricultural production including sugar beet is intensification. This is also claimed by scientists Rezbova *et al.* (2014) and Hoffmann and Kenter (2018).

In recent years, the cost of sugar beet production in the farms of the republic increased from 28,366 rub./ha (2011) to 53,606 rub./ha (2016). The investment of additiona l costs per unit area, raising revenues increased the economic efficiency of sugar beet production.

An analysis of the cost structure has shown that the intensification of the technology of sugar beet production in the republic's economy takes place practically at the expense of all cost items (Table 2). The cost of seeds, fertilizers, fuels and lubricants and the maintenance of fixed assets have approximately the same share in the cost structure (about 13%). The share of costs for plant protection products is somewhat higher (16.2-18.3%) and expenses for crop insurance are insignificant (0.8%).

In the market conditions any economic system is open to external influence. The sugar beet industry of the

Republic of Bashkortostan is also pressured by the conjuncture of the world sugar market, the rental advantages of sugar producers from regions with favorable natural and economic conditions and with developed measures of state support. This to some extent will determine the efficiency and accordingly, the state of beet growing in the republic in future. A similar situation has developed in other regions of the Russian Federation that grow sugar beet. This is evident from the studies of Tupikova (2013) and Zyukin *et al.* (2016).

In connection with the embargo on agricultural products, the competitive tension in the sugar beet subcomplex of our country including the Republic of Bashkortostan has somewhat weakened. However, due to changes in the ruble exchange rate, the cost of seeds, plant protection products and beet harvesters has increased.

CONCLUSION

Thus, in the Republic of Bashkortostan, the production of sugar beet crops is mainly concentrated in agricultural organizations (78.3%). Since, 1994, the sugar beet yield in the republic has been increasing by an average of 6.32 centners/ha annually.

The production of sugar beet in the republic is economically effective. At the same time, the profitability of sugar beet production fluctuates over the years which is mainly due to a change in yield caused by influence of hydrothermal conditions. The increased air temperature during vegetation period leads to a decrease in yield and the increase in precipitation positively affects the yield of sugar beet. There is an increase in costs in the farms of the republic for the production of sugar beet. The cost of seeds, fertilizers, petroleum products and the maintenance of fixed assets have approximately the same share in the cost structure (about 13%) the share of costs for plant protection products is somewhat higher (17.5%).

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