SUGAR BEET PRODUCTION IN SERBIA: ESTIMATION OF DAMAGES CAUSED BY CLIMATE FACTOR[14]

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Abstract

Sugar beet represents a basic raw material in sugar production at the European continent. In line with given natural conditions, the most parts of Serbia have favorable preconditions for organization of its production. Besides, production and processing of sugar beet is among the key production lines that influence sustainability of food security and development of agro-complex at national level. By a long time period, global agriculture has been facing the of certain climate changes. From this issue Serbia usually has a negative connotation, or more precisely, insufficient and irregular precipitation patterns followed by presence of high temperatures (drought) that threaten in great extent achieved results in crop production.

Negative impact is mostly reflected through the economic losses of agricultural producers and food and processing industry that relays on sugar beet and its products, as well as possible shortage in part of national GDP generated by agriculture. Although the sugar beet is the specific crop production that requires significant amounts of water during its vegetation, unfortunately there are negligible irrigated surfaces in Serbia.

The main paper goal is contained in the value estimation of damages caused by drought incurred in beet production at the national territory during the period 2008-2017. Estimation scenarios are based on secondary data of National Statistical Office and Annual Agro-Meteo Reports of Hydro-meteorological Service of Serbia. Gained results could be considered as the best recommendation for the further strengthening of public support related to use of appropriate measures against the climate change in sugar beet production.

Keywords: sugar beet production, Serbia, climate factors changing, damage.

Introduction

The International Panel on Climate Change (IPCC, 2007) describes climate change as a deviation in climate (whether due to natural variability or as a result of human activity) that can be identified through changes in average values and/or through variability of climate parameters over the time. Climate change is globally present, and its negative impact mostly affects the sectors of agriculture, energy and tourism (Steininger et al., 2016).

The largest part of the territory of Serbia is characterized by a moderate continental climate with somewhat expressed local specificities, conditioned by geographical position, relief and exposure of the terrain, present vegetation and river systems, distribution of air pressure, level of urbanization, etc. (Sekulić et al., 2012). An analysis of the average annual air temperature trend in Serbia over the last century points to its rise by 0.5 °C (SEEDEV, 2017). On the other hand, in the last few decades, the general deficit of precipitation, accompanied by high temperatures, and frequent and ever-longer heat waves, leads to the appearance of droughts of higher intensity (UNDP, 2015). Conducted analysis of spatial variation of precipitation for the last sixty years, have shown that the western part of the central and south - western part of Serbia have an above

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average cumulative amount of annual precipitation, while northern, north - eastern, central, eastern, southern and south - eastern parts are in relation to the national level and are characterized by the below average precipitation level (Gocić, Trajković, 2014). General expectations are that these trends will have an even more pronounced presence in the close future.

Sugar beet (*Beta vulgaris ssp. vulgaris*) is a representative plant species *Beta vulgaris L.*, within the most famous culture adapted to the needs of man and domestic animals are Swiss chard, beetroot, fodder beet and sugar beet (Smulders et al., 2010). It was cultivated at the end of the 18th century in Germany from the lines of fodder beet that accumulated a higher dose of sugar at its root. Soon, the commercialization for the extraction of sugar from the root of the sugar beet begins, thus offering an alternative to the sugar obtained from the sugar cane. Along with the development of the sugar production industry, sugar beet cultivation is expanding to all continents (Harveson, 2018).

For regions with moderate climates, sugar beet today represents a very important crop that generates almost a third of the world's annual sugar production (Dohm et al., 2014). It is most commonly cultivated at the territory of Europe, North America, the Middle East, Turkey, Kazakhstan, India, Chile, China and other (Leff et al., 2004).

Available climate and natural conditions of Serbia enable the successful cultivation of sugar beet on its wider territory, where the production of mentioned crop has a manifold importance for the development of the national agro-industry. Plant is being cultivated primarily for the technological exploitation of the root from which sucrose is extracted. Sucrose is the product widely used in human nutrition, as well as an important input in many industries. By-products of sugar beet root processing (wet beet pulp, beet tailings and molasses) are an important raw material for some industries, as well as high quality animal fodder. Harvest residues (heads and leaves) are also used as animal fodder, while saturation sludge (waste from the process of sugar production) is often used for the calcification soil. On the other hand, the demand for intensive agro-technics and good technical equipment of the farm (primarily for soil cultivation, fertilization, care and crop protection, harvesting and roots transport) has an immense importance on the development of the national agro-complex (Jeločnik et al., 2015).

1. Methodological approach and data sources

The crop production is under increasing pressure of climate variability (predominantly drought), which reflects in quantitative and qualitative oscillations of realized yields. Pressure carries a dose of complexity, as it primarily threatens global food security and health safety of products, as well as the economic status of farmers and the share of GDP generated in agriculture.

As in some previous researches (Jeločnik et al., 2017; Jeločnik, Zubović, 2018), there is a justified need of numerical explication of the impact of drought on losses in national agriculture, which would further exert pressure on popularization and wider implementation of available measures for adaptation to climate change (irrigation, use of drought-resistant hybrids, improvement of agro-technic and production technology, harmonization of agro-technical deadlines, insurance, etc.).

Based on the previously mentioned, the main objective of the work has hypothesized the value assessment of the damages incurred in the production of sugar beet in the territory of Serbia caused by drought, over the last ten years (period 2008-2017).

Methodologically, the estimation was based on scenario analysis. Previously, it was given an overview of harvested areas and achieved yields of sugar beet within the observed period, and then was done their average determination. From the available national agro-meteo reports

(RHSS, 2018), the years in which the droughts had no influence on the gained yields of sugar beet were marked. In order to avoid the impact of price fluctuations on conducted estimation, all results are in line with the average purchasing price of sugar beet active in 2017 (SORS, 2018b). Assumption was that used agro-technics and seed had no influences on noticed deviations.
Economic assessment was based on following scenarios:

1) Scenario A – supposes that the drought influence is contained in all negative deviations of achieved yield in each year comparing to average yield for observed period (only if damages are not the result of excessive rainfalls, floods or storms). The individual differences in yield are multiplied by harvest area from a single year (naturally expressed damage), and then it has be done the summarization of all damages for the entire period. Afterwards, the cumulative sum of naturally expressed damages is multiplied with the average purchase price for sugar beet.

2) Scenario B – assumes that the drought impact is contained in all negative deviations of achieved yield in each year comparing to maximally achieved yield within the observed period (only if the damages are not the result of the excessive rainfalls, floods or storms), where it is considered as the reflection of the best possible weather conditions in line to sugar beet requirements. Additional calculations are identical to previous scenario.

Conducted research was based on the secondary data of the Statistical Office of Republic of Serbia and Republic Hydro-Meteorological Service. During the paper development, the actual scientific and professional literature focused on the research topic was investigated. For the better consideration and additional comparability, all results are shown by Tables in EU currency.

2. Results with discussion

Sugar beet is a plant which requires for seed germination minimal temperature in range of 7-15°C (it emerge the fastest under the air and soil temperature between 15-25°C, while the lowest air temperature range around 3-5°C). Plant growth and development, and sugar accumulation within the root are the most intensive under the overnight temperatures around 20°C, and daytime temperatures around 25°C. Temperatures over the 30°C greatly decrease concentration of sugar (Petkeviciene, 2009; Verma et al, 2014). During the vegetation period, the crop requires 550-750 mm of water, with expressed sensitivity to the lack of moisture in the initial stages of growth. The most intensive water adoption is at the final growth stages (Loboda et al., 2017). Sugar beets have a four to six month growing season that could be stretched even to 200 days. In condition of Serbia, its production showed positive correlation between root yield and solar radiation in the autumn (175-200 days after planting), (USC, 2018; Curcic et al., 2018).

The noticeable variability of quantity and distribution of rainfalls is highly correlated to the oscillations of achieved yields per production years. Previously conducted long-term experiments at the national level are shown that the crops average annual water requirements are around 590 mm, as well as that the average lack of available water during vegetation period is around 190 mm, mostly (¾ of total deficit) in July and August. Elimination of drought impact and yield stability are ensured by the implementation of agro-technical measure irrigation, as it increases average yields up to the 40% (Maksimović, Dragović, 2002).
With next table (Table 1.) are presented the main production indicators for sugar beet achieved at the territory of Serbia.

Table 1. Production of sugar beet in Serbia, during the period 2008-2017

Indicator		Harvested area (ha)	Yield of root (t/ha)	Total root production (mil. t)
Year	2008	51,261	47.9	2,454,605
	2009	65,354	45.6	2,977,781
	2010	70,968	50.0	3,551,074
	2011	59,221	50.7	3,004,237
	2012	69,069	35.9	2,482,962
	2013	66,527	47.8	3,180,008
	2014	64,112	54.7	3,507,441
	2015	42,123	51.8	2,183,194
	2016	49,237	54.5	2,683,860
	2017	53,857	46.7	2,513,495
Average		**59,172.9**	**48.6**	**2,853,865.7**

Source: SORS, 2018a.

Average yield of sugar beet root in observed period was around 48.6 t/ha, where the maximal yield was achieved in 2014, around 54.7 t/ha, while the lowest one was in 2012 (extremely drought year), around 35.9 t/ha.

In some previous researches, it was noticed that during the last few decades Serbia represents the regional leader in sugar beet production, but with achieved average yields it's far behind the certain world largest producers, such are France, Germany or USA (Jeločnik, 2017).
It should be noted that average purchase price for root of sugar beet was 4.24 RSD[15]/kg in 2017 (SORS, 2018b), respectively 0.035 EUR/kg or 35.0 EUR/t (CEKOS IN, 2018).
In the next tables (Table 2. and Table 3.) were presented the assumed damages in sugar beet production caused by the negative impact of climate factor (specifically the drought).

Table 2. Estimated loss in sugar beet production caused by drought according to Scenario A

Element/ year	Harvested area (ha)	Average – achieved yield (t/ha)	Natural loss (t)	Price (EUR/t)	Total Value of the Loss (EUR)
2008	51,261	0.7	35,882.7	35.0	1,255,894.5
2009	65,354	3.0	196,062.0	35.0	6,862,170.0
2010	70,968	*	*	35.0	*
2011	59,221	*	*	35.0	*
2012	69,069	12.7	877,176.3	35.0	30,701,170.5
2013	66,527	0.8	53,221.6	35.0	1,862,756.0
2014	64,112	*	*	35.0	*
2015	42,123	*	*	35.0	*
2016	49,237	*	*	35.0	*
2017	53,857	1.9	102,328.3	35.0	3,581,490.5
Total					**44,263,481.5**

Source: According to authors' calculation.

[15] Serbian dinar – Official currency of Serbia.

In line to prepared analysis, it could be seen that the estimated damages in sugar beet production caused by the drought in observed decade according to Scenario A was over the 44 million EUR, or almost 1.3 million tons of sugar beet root, or around 45% of average annual production.

Table 3. Estimated loss in sugar beet production caused by drought according to Scenario B

Element/ year	Harvested area (ha)	Maximal – achieved yield (t/ha)	Natural Loss (t)	Price (EUR/t)	Total Value of the Loss (EUR)
2008	51,261	6.8	348,574.8	35.0	12,200,118.0
2009	65,354	9.1	594,721.4	35.0	20,815,249.0
2010	70,968	4.7	333,549.6	35.0	11,674,236.0
2011	59,221	4.0	236,884.0	35.0	8,290,940.0
2012	69,069	18.8	1,298,497.2	35.0	45,447,402.0
2013	66,527	6.9	459,036.3	35.0	16,066,270.5
2014	64,112	*	*	35.0	*
2015	42,123	2.9	122,156.7	35.0	4,275,484.5
2016	49,237	0.2	9,847.4	35.0	344,659.0
2017	53,857	8.0	430,856.0	35.0	15,079,960.0
Total					**134,194,319.0**

Source: according to authors' calculation.

More rigid scenario assumes much higher value of estimated damages, over the 134 million EUR (Table 3.). Naturally expressed loss considers over the 3.8 million tons of root, or for more than 10% higher quantity of root compared to complete production achieved in the best year.
The mutual relation between the damages presented by the supposed scenarios was 1:3.03, while the cumulative losses in sugar beet production per average production unit are around 750 EUR/ha in first, i.e. around 2,270 EUR/ha in the Second Scenario.

Due to the fact that sugar beet has explicit requirements for water, obtained results are also supported by the census data, where the sugar beet is irrigated at only 9,200 ha (slightly above 9% of totally irrigated areas, or over the 15% of the average area under sugar beet). Irrigation is implemented at around 7% of total number of farms involved in sugar beet production (SORS, 2016).

The presented results are a strong recommendation for producers and other stakeholders present within the sugar beet and even the sugar supply chain (processors, the competent Ministry, confectioneries and others) in order to preserve the sustainability of their business, strengthen competitiveness and ensure food security, to promote and initiate a stronger presence of available financial instruments and agro-technical measures, all in order to prevent the escalation of drought-related losses.

From the aspect of ensuring sufficient quantities of water in crop production, one should bear in mind that the implementation of irrigation in Serbia is accompanied by several limitations, such are: the instability of the capacity of local water intakes (primarily transit and domicile watercourses), frequent lack of infrastructure elements (primarily within the energy sector), low economic power of the average household (low accumulation and limited access to investments), credit policy mismatched to the needs of agriculture, producer's inclination towards risk and other. All of this leads to a significantly smaller presence of irrigation than actually possible or really necessary, resulting in the fact that currently less than 3 percent of the used agricultural land is irrigated (Subić et al., 2017).

On the other hand, the production of sugar beets finds itself facing another challenge of purely market character. Last year, the European sugar market was liberalized (abolition of production quotas, free price determination and the elimination of many foreign trade barriers), which initiated the growth of sugar beet production in Europe by 20%, so sugar refineries within the EU are in position to produce 30% more sugar than the community needs. This led to a decrease in the market price of sugar by half in a very short time, depreciating the export activities of national sugar sector. Regardless of the new situation being favorable for domestic consumers in short term, in long term it will certainly lead to significant reduction of the area under the sugar beet (Lakić, 2018).

Conclusion

Sugar beet being one of the basic (industrial) crops has great importance for human and animal nutrition, and for the sustainability of food and other industries. Serbia has satisfactory climate conditions and natural resources, long tradition and necessary agro-technical and technological prerequisites for organizing its production. Unfortunately, for the past two decades, every other year was characterized by an expressed precipitation deficit during the growth period, with available quantities of water far below the crop needs. On the other hand, irrigated areas under the sugar beet can be considered unsatisfactory.

Estimates have shown that cumulative losses in sugar beet production being caused by drought over the last ten years are in the range of 44 up to 134 million EUR. Determined values and sincere expectations of even greater losses, in line with the fact that each following decade in the northern hemisphere is warmer than the previous one, are rather great recommendation for strengthening of public support for wider application of adequate measures of adaptation to climate change in crop production, regardless of them being economic, technological or technical in nature.

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