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Ouestions of winegrape irrigation in Hungarian wine regions

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Abstract

This paper deals with the increase in needs for irrigation and their effects caused by global warming that is said to be unavoidable nowadays by the experts. Floods, excess surface waters and droughts occurring more and more frequently cause serious damages not only socially but also in terms of agricultural production. These losses could be avoided by increasing the efficiency of water management. Starting from the above factors this paper puts the emphasis on irrigation that may be necessary even if the precipitation is given, but its distribution is inappropriate. The research focuses on whether there is any demand for irrigation in a wine-growing region at all. It examines in details the effects of surplus precipitation on irrigated vineyards and specifically the effect of increased water quantity on the sugar content in grapes. Among the methods, in addition to reviewing the relevant scientific literature we have used descriptive statistics, correlations and analysis of variance (ANOVA) using SPSS software package.

Keywords: irrigation, wine region, yield increasing effect, quality

1. Introduction

"Natural resources, in particular (...) the reserves of water,
(...) shall form the common heritage of the nation;
it shall be the obligation of the State
and everyone to protect and maintain them,
and to preserve them for future generations."
Article P of the Fundamental Law of Hungary on 25 April 2011

Nowadays, newspapers and television programmes are full of weather disasters, such as forest and bush fires, floods and excess surface waters. The consequences of the effects of global warming are in the centre of public interest. It also pertains to the subject that the weather conditions are more and more extreme, and the temperature is

increasingly unpredictable, as it is true also for the distribution of precipitation. As the above quote shows the importance of the topic, we are facing an enormous task in the field of adaptation and managing waters.

It is generally believed that the annual rainfall need of vine is about 300-500 mm. If this is not available from the water resources given by weather (rainfall, mist), there is a need for irrigation in order to achieve the desired yield. The article intends to find answer to the question what the situation is with irrigation regarding to wine-growing regions. It aims to answer such basic questions as: What is the size of the irrigated and irrigable wine regions? Which wine regions are not irrigable at all? How did the size of the irrigated areas develop over the years? Is it really true that the yield of grapes can be increased with irrigation? Is it true that irrigation has a strong effect on the sugar content and the alcohol content of grapes?

2. Literature review

In July 2014, 182 percent of the average precipitation of many years (1971-2000), being 62.1 mm, was measured on country level; however there were settlements where the triple of the usual volume fell. This surplus precipitation should be retained that it could be used in a dry period. The daily maximum temperatures were above the average with 5.8 centigrade, while the minimum temperatures were below the average with 4.7 centigrade [Lakatos 2014]. It also has an impact on agriculture and strengthens the need for irrigation and precipitation management.

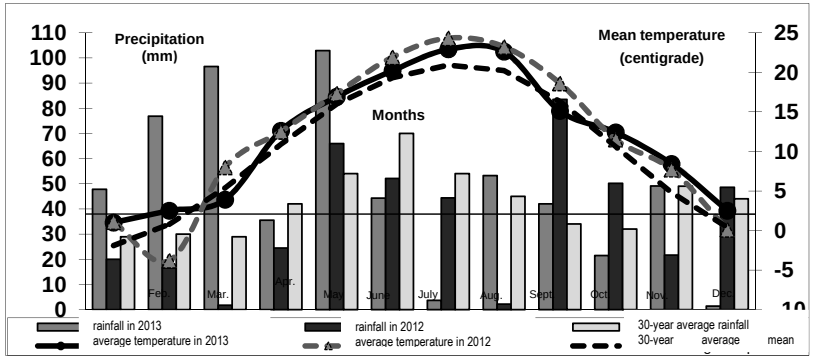

Figure 1: Precipitations and annual mean temperatures over years. Source: BCE SZBI Kecskemét-Katonatelep; Béla Nagy

Figure 1 illustrates well that the distribution of the 30-year average precipitation and average temperature was more even than the same data series measured for 2012 or 2013. In recent years, precipitation and temperature resulted more and more data, which are considered to be outliers. This also goes to show that the weather conditions are really becoming more extreme, to which we must adapt. It is especially necessary for agriculture, since it can influence the amount of harvest significantly.

"By means of irrigation the yields can be increased with 20 to 30 percent, but occasionally 50 to 100 percent." - said Imre Hubai jr. Vice President of Hungarian

Chamber of Agriculture to the "Agrárszektor" portal in March 2014. It seems favourable, but if it is true, what is the reason for the fact that while 1.5 million hectares are drought vulnerable from the cultivable lands of the country, less than a fifth of it is irrigable and only 80-100 thousand hectares is irrigated practically.

In case of the EU-15 countries, irrigation covers 11 percent of the agricultural areas. In Hungary, this value is not more than 3.9 percent. If we examine the 27 member states of the Union regarding irrigation, Hungary is on the penultimate place [TDR Soil Degradation System - Ministry of Rural Development, n.d.], although there are 17 major rivers in the territory of the country. Moreover, the trend is pointing to the wrong direction if we analyse the data of the above system, since based on the maps and analyses the proportion of irrigated areas is decreasing continuously. (See Figure 2)

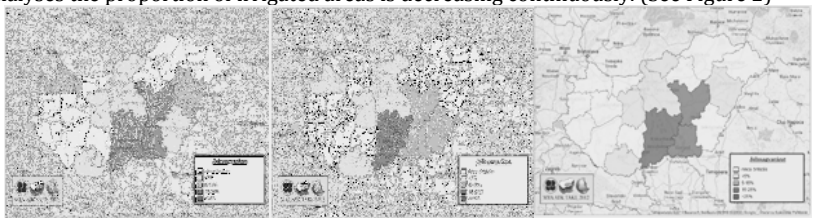

Figure 2: Proportion of irrigated areas in Hungary according to the Gazdálkodási Napló (farming diary) in 2008/2009, 2009/2010 and 2010/2011 respectively. Source: http://okir-tdr.helion.hu/?terheles=5 4 August 2014 11:44

"In Hungary, mainly in the central and southern areas of the country the rainfall decreased about 50 mm in annual average during the past 100 years, which value is very high compared to the water demands of plant." [Ministry of Rural Development TDR Soil Degradation System, n.d.]

In the period from 2008 to 2011, the proportion of irrigated areas was concentrated mainly to the Lower-Tisza region. However, during the years the irrigation disappeared in some counties, while in others, such as in Békés County, its extent was reduced. Here, there was still 5-10 percent irrigation in year 2008/2009, which was increased for the following year, but by year 2010/2011, the irrigation disappeared completely.

The fact that the years of drought occur with great frequency on the Great Hungarian Plain has been confirmed also by I. Pálfai [n.d.], who researched it for the period from 1931 to 2010.

The Hungarian Meteorological Service (OMSZ) reported: "in the past century the annual amount of rainfall showed a decreasing trend even in addition to its variability, and the decrease is almost 10 percent during 109 years". It means that we need to deal with irrigation eventually, because the variability of precipitation requires it.

Figure 3 shows that according to the data of the Hungarian Central Statistical Office (KSH) the area of irrigated vineyards ranged only from 0 to 100 hectares between 2004 and 2012. This value is insignificant compared to the total area planted with vine, since in the same period, according to the KSH the total vineyard area was between 93.2 thousand and 75 thousand hectares showing a downward trend.

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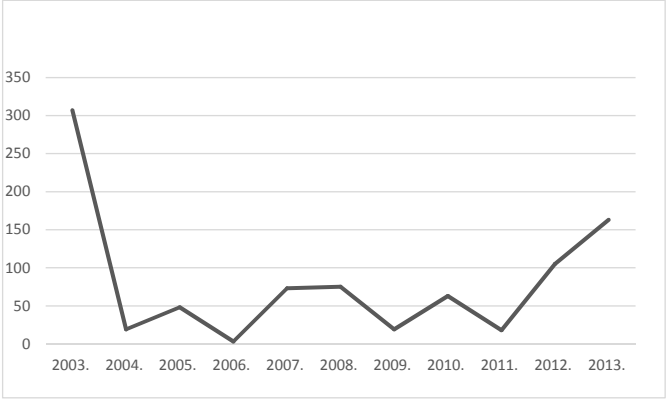

Figure 3: Total irrigated area of viniculture in Hungary (hectares). Source: KSH, edited by the author, 2015

Figure 4 illustrates the annual amount of irrigation water applied to the vineyards in Hungary, practically complementing Figure 3. Both charts clearly show that in the period between 2010 and 2011 there was a change, because then an upward trend started regarding irrigation and the applied water.

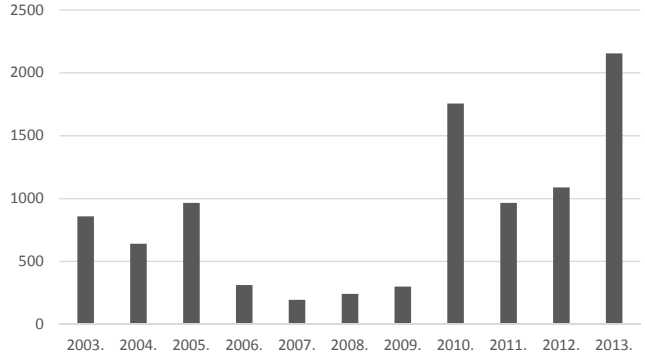

Figure 4: Amount of irrigation water per hectare in the areas of viniculture in Hungary (m3/ha)

Following the basic data of irrigation, we have investigated the opinions in the international scientific literature for the formulated hypotheses. I have faced the fact that Gawel [n.d.] identified the non-irrigated vineyard as that could produce high-quality wine. He writes that in most places and in most of the years the vintage would be unsustainable commercially or the grapes would dry up and get damaged when vine was not irrigated. He also notes that in France irrigation is not allowed in very many wine-growing regions. In Australia, they believe that the irrigation of vineyards always results that the quality of the wine lowers. Its alcohol and colour content will be smaller, and the wine will be thinner and mediocre. Owing to the warm climate in Australia, the

fact that they do not irrigate is rather an exception than a rule. In his opinion at irrigating, it is necessary to find a balance between quality and yield.

Bravado et al. in Slack-Martin [1986] write that irrigation tends to increase the yield and influences the sugar content less than the yield. Also in this book, Sotomayor-Lavin described the high water content reduces the alcohol content, extract, colour and other factors that are considered later on at the organoleptic evaluation of wine.

In our country, a part of the growers uses their vine-lands according to different purposes. Some plots provide the secure living and the volume, while the others serve raw materials for quality wines.

For example, one of the growers said that the needed rainfall had been given also in 2013, however its proper distribution had been doubtful, and a pre-harvest irrigation, for which the plants had been already starved, had resulted in a crop yield growth.

In our experiences, it does not matter what amount we mean by the yield of grapes. In Hungary, the average vintage can be put to a much lower level per hectare than for example the average of the largest European countries.

3. Materials and methods

Regarding to irrigation the KSH data are only on regional level and in the aggregate, that is why we used the series of the National Council of Wine Communities (HNT) during our research, which apply to the wine-growing regions directly. Unfortunately, the data relevant to me were available only for 2013. From these data, no meaningful conclusion could be drawn; however, in any case it can show an interesting awareness-raising direction for the future. As a professional note, it is necessary to add that regarding to the total amount of precipitation year 2013 reached 300-500 mm being sufficient to meet the water demand of vine. Consequently, in this year the distribution of rainfall was the factor, which could be affected by irrigation most of all.

We have used the SPSS software package version 20.0 to represent and prepare the descriptive statistics, analysis of variance and correlations. I have completed the primary research with the relevant sources of the secondary research.

We have formulated our hypotheses as follows:

- The average harvest is bigger on the irrigated areas than on the non-irrigated areas.
- As a result of irrigation, the sugar content of grapes lowers.

4. Results

Based on the literature review, irrigation was concentrated to the Lower-Tisza region in the country. Here we can find the Kunság wine region and the Csongrád wine region, which often really requires additional irrigation because of the sandy soil. The total area of wine-growing regions amounted to 56,013 hectares in July 2014 according to the HNT, from which the irrigated areas meant only 40.154 hectares. This value of a little bit more than 40 hectares was distributed among 12 wine-growing regions. While the further 10 wine regions from the 22 wine-growing regions of Hungary cannot be irrigated due to specific features of the territory or are just planned for irrigation. (Table 1) This latter means that they have a water rights permit, however an effective irrigation has not occurred.

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Table 1: Classification by irrigation and areas of wine-growing regions outside irrigation. Source: Based on NHT data, edited by the author

Non-irrigated wine-growing regions	Areas of non-irrigated wine regions (hectare)	Wine regions planned for irrigation, where there has been no irrigation	Irrigable areas of the wine regions planned for irrigation (hectare)
Bükk	891.660	Etyek-Buda	0.513
Mór	500.534	Hajós-Baja	0.151
Neszmély	918.792	Nagy-Somló	0.128
Pannonhalma	579.822	Pécs	0.154
Villány	2,300.519	Sopron	8.379
Total (hectare)	5191.327	**Total (hectare)**	9.325

The professional reason for the missing data in the following calculations is that for the irrigated area of the Eger wine region, which was about 4.22 hectares, there was no data for harvest. It is probably due to the rigours of weather. We have left this data from the analysis out, because it would have distorted the results very much as its proportion is high compared to the size of the total irrigated area (vine-growing area).

Taking into account the proportions, it could be said that we do not irrigate either a thousandth of our vine-growing areas, even if it could be.

we have tried to find answer also for that why the irrigated areas have such a small proportion in our country. According to Zengő, [2015] in principle the rainfall could be sufficient for the undisturbed development of vine stocks and grapes, however its distribution is not satisfactory. Then he added that in vineyards the micro spray irrigation and the drip irrigation represented the irrigation technology resulting in the largest efficiency, which were the most expensive among the irrigation systems.

By Mikóczy [2005], vine is a drought resistant plant basically, and with its irrigation, several research projects have dealt in Germany. In the opinion of prof. Hans Reiner Schultz and prof. Bernd Gruber creating "terrior" character and improving production actually speaks against irrigation. [cited by Mikóczky, 2005]

As one of the growers, Sándor Kispál [2014] said vine growing generally does not require any particular irrigation in our country. Because the vine is a climbing plant, therefore by means of its deep roots it can easily absorb the subsoil water. It adapts to drought quickly and obtains generally sufficient rainfall, but the effects of extremes show themselves increasingly also in this field. For example, in sandy areas the vine absorbs the water quickly from the soil, and due to the high average temperature the dehydration may take place in less time, which may led to a loss in the yield. In 2012, the drought resulted in 30 percent crop failure in the Szekszárd wine region. In addition, where and when the necessary precipitation is given, it is not sure that its distribution meets the needs of the plant's vegetative and generative development. By means of irrigation, yield and quality fluctuations can be moderated, thus, the cultivation of plants, including also viticulture can be made more plannable. In the present economic circumstances, planning plays an important role in the optimization of production and the realization of a profitable management. [Storcz and Illés, 2014]

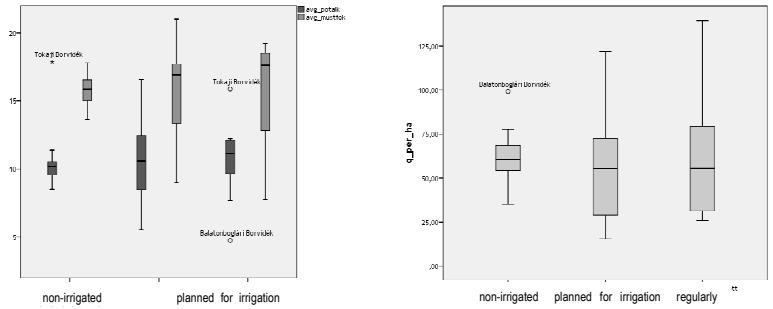

Figure 5: Standard deviation and extent of alcohol content and density of must as well as values of average vintage owing to irrigation. Source: Based on NHT data, edited by the author, 2015

On the left part of Figure 5, we illustrated the alcohol content (blue) and the density of must (green) being characteristic of the wine-growing regions in three groups according to irrigation. The chart shows well the data of descriptive statistics, where the horizontal lines at the bottom and the top of the box represent the minimum and the maximum values respectively. The box itself contains more than a half of the sample, and the line in it represents the median. Based on that it can be said that in case of alcohol content the standard deviation and extent of data is much less in the non-irrigated group than for the other two groups. At the density of must we can see a large extent in case of the area planned for irrigation. On the right part of the chart the Tokaj vine region has an outlier, while on its left part it shows an extreme value. Apart from this, the Balatonboglár wine region is the one, which differs from the other values greatly.

Since the values of average harvest are more graphic on other scale, we have illustrated them on a separate chart on the right side of Figure 5. It shows well that the median of non-irrigated areas and the median of regularly irrigated wine regions are on an almost similar level. In case of the regularly irrigated areas, the upper quarter of the sample covers a wide interval. For average harvest, the Balatonboglár wine region has an outlier.

After this, we run the data series with the programme to summarize the further descriptive statistics. The results show that the average of the alcohol content is around 10 degrees; the average of the sugar content is around 15 degrees, while the average harvest (hundred kilos per hectare) is 61.2142 for the non-irrigated areas and 61.7210 for the regularly irrigated areas, which does not differ much from those specified above.

After the characteristics of descriptive statistics, we used variance analysis to examine what kind impacts the irrigation has on alcohol content, sugar content and average harvest. In order to be able to manage the database we coded the specified categories. For variance analysis, it is important to examine in every case how the variances correspond to each other. Thus, we made a homogeneity test. If the difference, i.e., the significance is less than 0.05, there is a difference between the specific categories. We could not found any significant difference statistically. After this, we completed the analysis of variance.

The fact that we examine non-irrigated area or regularly irrigated area does not influence significantly the alcohol content and the density of must, but either the average harvest. Our first hypothesis i.e. the irrigation influences the average harvest positively has not been verified in this case, either that is has a negative impact on the sugar

content. Thus, our second hypothesis has not been confirmed, consequently when vine is irrigated, it is able to produce the same sugar content if it was not irrigated.

Table 2: Correlations between examined data. Source: Edited by the authors, 2015

Correlations

		avg_potalk	avg_mustfok	q_per_ha
avg_potalk	Pearson's correlation	**1**	**,520****	**-,022**
	Sig. (2-tailed)		**,000**	**,878**
	N	**50**	**50**	**50**
avg_mustfok	Pearson's correlation	**,520****	**1**	**-,079**
	Sig. (2-tailed)	**,000**		**,583**
	N	**50**	**50**	**50**
q_per_ha	Pearson's correlation	**-,022**	**-,079**	**1**
	Sig. (2-tailed)	**,878**	**,583**	
	N	**50**	**50**	**50**

This correlation can be observed at the level of 0.01.

After this, we examined the correlation for the above properties whether there is any relation between them. Based on that, the quantity does not have any impact either on alcohol content or on sugar content. Of course, a relation can be observed also statistically between the density of must and the alcohol content, which is a moderately strong positive correlation on a significance level of 0.01. It means that if the density of must increases, the alcohol content does the same.

5. Conclusions and recommendations

The answer for the question raised at the beginning of our research is that the proportion of irrigated areas within the wine-growing regions of Hungary is minimal at least according to the data of 2013. Little more than 40 hectares were irrigated at that time, while the distribution of rainfall was not favourable then. An area of about 5,200 hectares from the wine-growing regions cannot be irrigated at all. The area, which is planned for irrigation, but not irrigated, is less than 10 hectares. The Bükk wine region, the Neszmély wine region, the Mór wine region, the Pannonhalma wine region and the Villány wine region cannot be irrigated at all.

Our hypotheses, which were formulated at the beginning of the research, have not been confirmed based on the irrigation data of 2013. It means that based on the analyses there is no statistically significant difference between the harvest results of the irrigated and the non-irrigated areas. The analysis of variance has shown that there is not only any difference in yields between the irrigated and the non-irrigated areas but the artificially applied water quantity did not even have any significant impact on the sugar content and alcohol content. Now it would be possible to analyse the year of 2014, but it was so rainy that we cannot talk about any irrigation due to drought. To sum it up we can say that irrigation is necessary in the wine-growing regions in fact only in that case if there is a very droughty year as it was for example in 2003 or in 2009.

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