

TREND CALCULATION OF QUANTITATIVE AND QUALITATIVE FACTORS IN SUGAR BEET PRODUCTION UNTIL 2015

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ABSTRACT

Quantitative and qualitative factors applied in sugar beet production point out that all of the parameters analysed in this study (average sugar beet yield, sugar content, sugar yield, usable sugar yield and thick juice purity) show an increasing trend. Trend calculations based on linear trend method show higher yearly increase until 2015, but with lower reliabilities, compared to the moving average based trend calculations, their reliabilities are higher, but the yearly increases are lower. The calculated results show that the production value per hectare will increase in the next years, and this can be a basis for the successful and profitable beet growing in Hungary.

Keywords: sugar beet, beet production, trend calculation, sugar yield, forecast in agriculture

INTRODUCTION

Similarly to the other arable crops, the production value per hectare of the sugar beet is strongly determined by quantitative (average sugar beet yield) and qualitative (sugar content, sugar yield, usable sugar yield and thick juice purity) factors. The continuous improvement of these factors is a key question for the profitable sugar beet cultivation. This study analyses the data of the contracted farmers of Sugar Factory Kaposvár from 1995 to 2009. The main objectives of the analysis are:

- To analyze the direction and the measure of the change of quantitative and qualitative factors
- To calculate a trend for all analysed factors until 2015 to forecast the yearly increase of the factors

LITERATURE REVIEW

Nagy (2009) investigated the forecast of the quantitative and qualitative factors for different agricultural plants. He analysed country specific data between 1990 and 2006 and established that quantitative factors of most agricultural plants (wheat, maize, sunflower, potato) showed stagnation. However, some agricultural plants (sugar beet and rape seed) showed an increasing trend. Another study of Nagy (2008) pointed out that the uncertainty of forecasting in EU15 countries is lower than in the recently joined Eastern European countries. Many authors studied the correlation between the quantitative and qualitative factors of sugar beet production. These studies started from the 1950s. According to Margara and Towin (1954) there is a strong negative

correlation between the sugar beet root yield and the sugar content. In case of high sugar beet yield the sugar content is lower. In case of higher sugar content the sugar beet yield is lower. The seed variety definition system worked out by *Lüdecke* (1953) also assumes this negative correlation. The strong negative correlation is also mentioned by *Bocş* (1992) and *Potyondi* (2002).

MATERIALS AND METHODS

Data are provided by the beet accounting system of Hungarian Sugar Ltd Sugar Factory of Kaposvár. All data are cumulated yearly. Two types of the trend analysis are carried out for all factors. First a linear trend calculation is made, but in that case the determination coefficient shows moderate reliability. To increase the reliability of the trend calculation a three-year-moving average trend calculation is also implemented. The moving average calculation smoothes out the yearly differences and the trend line is more visible. In case of moving average based trend calculation the correlation coefficient is always over 0.85 with only one exception.

RESULTS AND DISCUSSION

The analysed quantitative and qualitative factor in the period of 1995-2009 are shown in *Table 1*.

Table 1

The analysed parameters

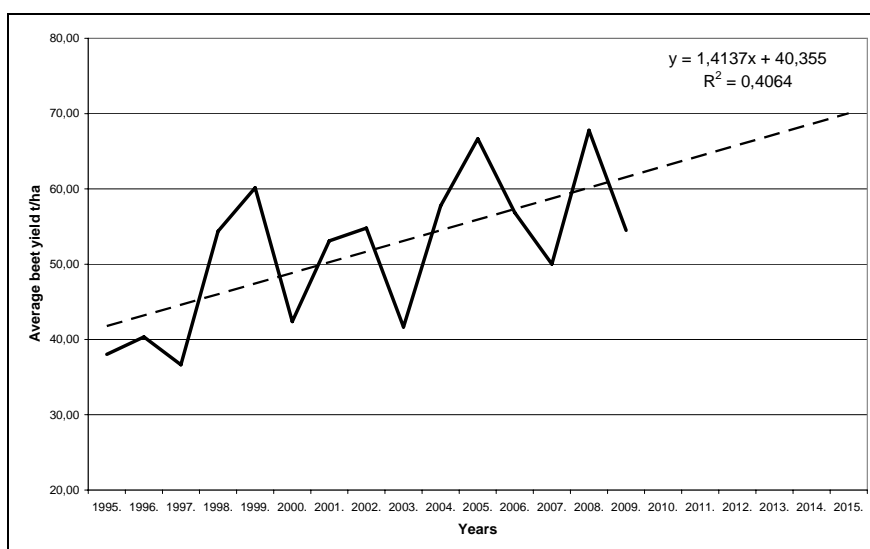
Years	Sugar-content	Average beet yield	Sugar yield	Usable sugar yield	Thick juice purity
	%	t/ha	t/ha	t/ha	%
1995	14.88	38.03	5.66	4.65	90.97
1996	15.79	40.33	6.37	5.28	91.24
1997	16.27	36.63	5.96	5.04	92.14
1998	14.34	54.35	7.79	6.53	91.90
1999	15.02	60.14	9.03	7.74	92.99
2000	14.79	42.38	6.27	5.32	92.47
2001	15.60	53.07	8.28	7.08	92.77
2002	15.60	54.80	8.55	7.24	92.29
2003	15.30	41.66	6.37	5.38	92.21
2004	15.53	57.76	8.97	7.68	92.84
2005	15.21	66.65	10.14	8.66	92.80
2006	16.28	56.86	9.26	7.98	93.11
2007	15.17	50.01	7.59	6.44	92.45
2008	17.14	67.79	11.62	10.10	93.48
2009	16.57	54.50	9.03	7.80	93.23

Average beet yield

The most important quantitative factors used in the sugar beet production is the average beet yield per hectare. The factor shows extreme fluctuations in the analysed period. There is 85% difference between the lowest (36.6 t/ha) and the highest (67.8 t/ha) value. This difference can be explained partly with the changeable weather conditions in different years, but there are some other influencing factors like plant disease, applied technology, harvesting conditions. Despite the high yearly differences, the linear trend calculation shows an increasing trend with middle reliability. The average yearly increase until 2015 is 1.4 t/ha (Figure 1). Trend calculation based on moving average shows high reliability and 3.6 t/ha increase in 3 years period, which corresponds 1.2 t/ha yearly increase. Linear trend calculation shows 70 t/ha average beet yield in 2015, with 40% reliability. Moving average trend calculation shows 63 t/ha average beet yield in 2015, with 85% reliability (Figure 2).

Figure 1

Average beet yield linear trend



Sugar content

The most important qualitative factor of sugar beet production and also of sugar production is the sugar content in the sugar beet. Similarly to the average beet yield the values show high fluctuations in the analysed period. There is 20% difference between the lowest (14.34%) and the highest (17.14%) value, but this is much lower than the 85% in case of average beet yield. Consequently, the assumption is that the sugar content can be forecast with higher reliability. However, the analysis contradicted this assumption. The reliability of linear trend calculation is only 0.26, and the yearly increase of sugar content is 0.085% (Figure 3). The moving average based trend calculation does not increase the reliability considerably (0.4), and the

forecast increase of sugar content is 0.225%, which corresponds a yearly increase of 0.075% (Figure 4). Linear trend calculation shows 16.7% sugar content in 2015. The same factor in case of moving average trend calculation is 16.5%.

Figure 2

Average beet yield moving average trend

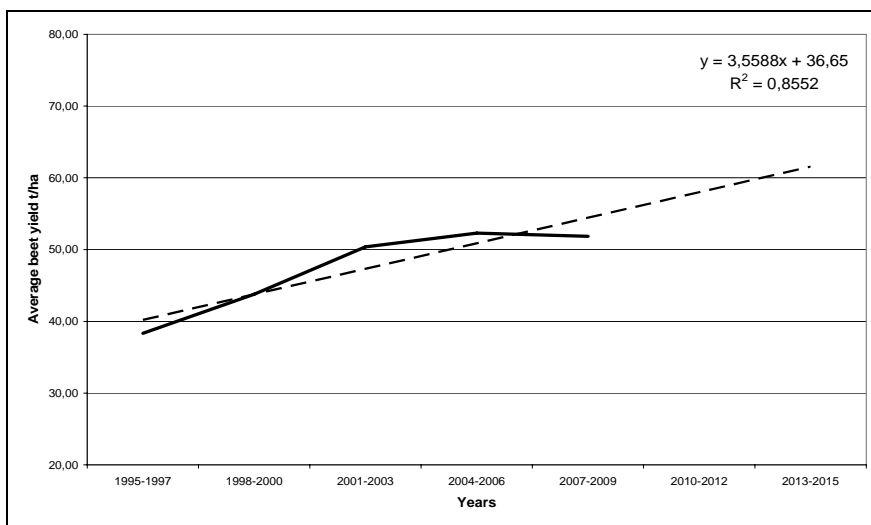


Figure 3

Sugar content linear trend

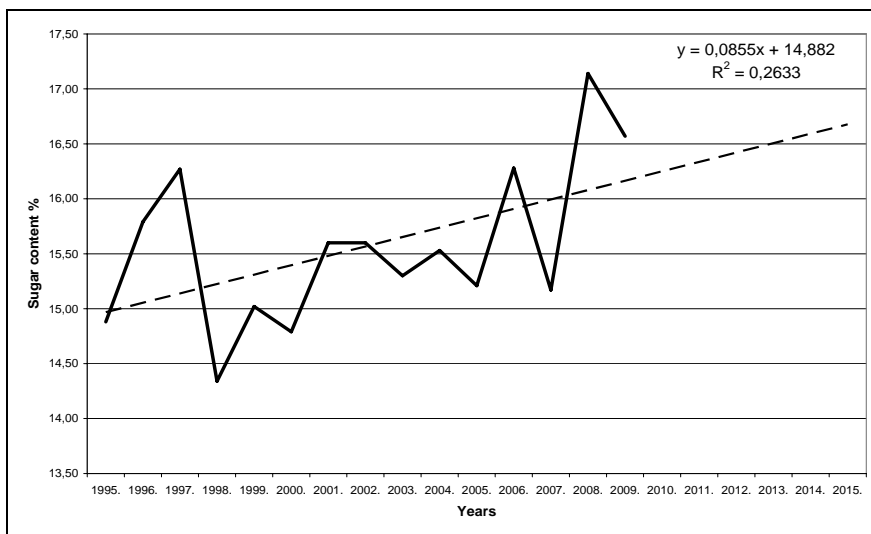
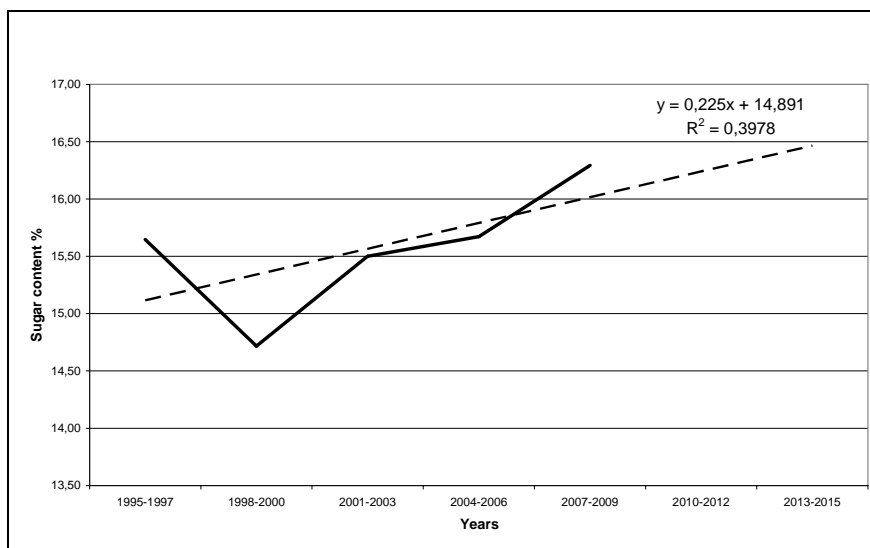


Figure 4

Sugar content moving average trend



Sugar yield

Sugar yield is a combined factor that includes the most important quantitative factor (average beet yield) and the most important qualitative factor (sugar content). Many professionals assume a strong negative correlation between these factors. This assumption can be suitable if we consider the data from the various years separately. E.g. in case of extreme weather conditions, drought causes low beet yield and high sugar content at the same time. However, if we analyse longer period and calculate the correlation factor, we can prove the opposite of this assumption. The correlation factor of sugar content and average beet yield is 0.25 in positive direction. The 105% difference between the highest (11.62 t/ha) and the lowest (5.66 t/ha) sugar yield also contradicts the initial assumption of negative correlation, because it is much higher compared to the differences of the initial two factors (85% and 20%). It shows that the differences do not compensate each other, but intensify the differences in both directions. Linear trend calculation of sugar yield shows an increasing tendency with middle reliability of 50% (Figure 5). The forecast yearly increase until 2015 is 0.27 t/ha. Trend calculation, based on moving average, shows 0.47 t/ha increase within a 3 years period, which corresponds 0.16 t/ha yearly increase. The reliability of moving average trend calculation is 88% (Figure 6). Linear trend calculation shows 11.5 t/ha sugar yield in 2015. The same factor in case of moving average trend calculation is 9.0 t/ha.

Figure 5

Sugar yield linear trend

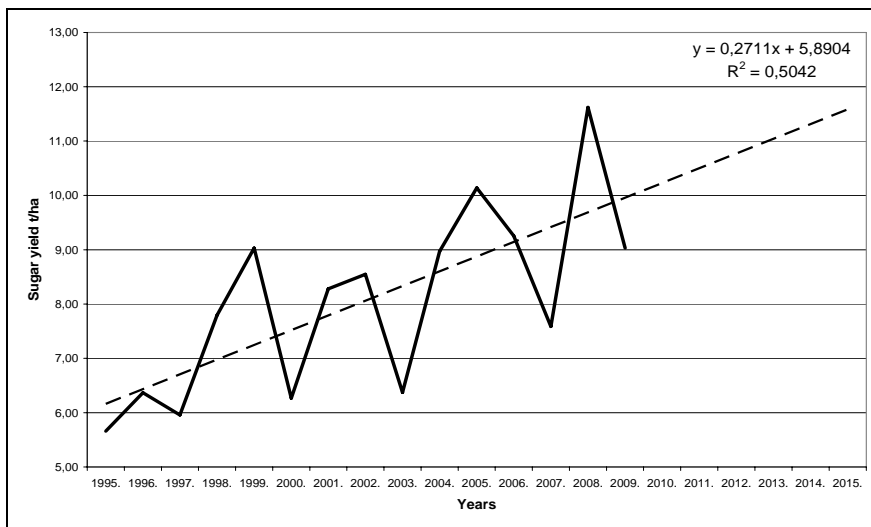
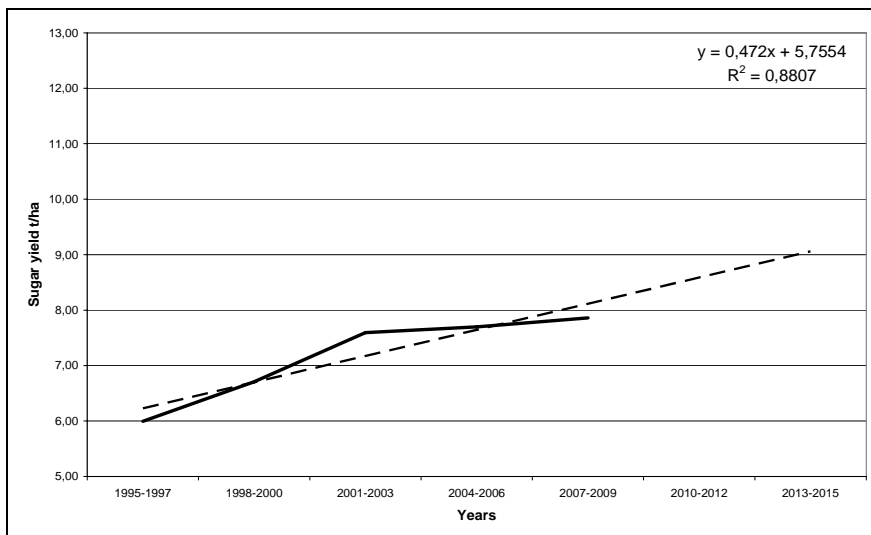


Figure 6

Sugar yield moving average trend



Usable sugar yield

Usable sugar yield is a factor calculated from the sugar yield and the different sugar losses during the sugar manufacturing process (molasses sugar. sugar remaining in

beet pulp, technical sugar losses). It is a very important factor both for the sugar beet producers and the sugar manufacturers. It shows the producible sugar quantity from 1 hectare sugar beet area. The result of the trend calculations is reliable, while producers' usable sugar yield shows similarity to the results calculated for the sugar yield. The reliability of linear trend calculation is 0.52 and the yearly increase of usable sugar yield is 0.25 t/ha (Figure 7). Moving average based trend calculation increases the reliability significantly to 0.89. The forecast increase is 0.44 t/ha within 3 years, which corresponds 0.15 t/ha yearly increase (Figure 8). Linear trend calculation shows 10.0 t/ha usable sugar yield in 2015. The same factor in case of moving average trend calculation is 7.9 t/ha.

Thick juice purity

Thick juice purity is an important factor for sugar manufacturing process. It shows the calculated proportion of non-sugar ingredients. The higher the factor is, the lower is the proportion of non sugar ingredients. The calculation of the factor is based on the potassium, sodium and alpha-amino nitrogen content in the sugar beet. The reliability of the trend calculations of thick juice purity is the highest from the five analysed factors. The coefficient in case of linear trend calculation is 0.64, in case of moving average based trend calculation is 0.95. The yearly increase of thick juice purity is 0.13% according to linear trend calculation (Figure 9). Moving average based trend shows 0.33% rise in 3 years period, which corresponds 0.11% yearly increase (Figure 10). Linear trend calculation shows 94% thick juice purity in 2015. The same factor in case of moving average trend calculation is 93.5%.

Figure 7

Usable sugar yield linear trend

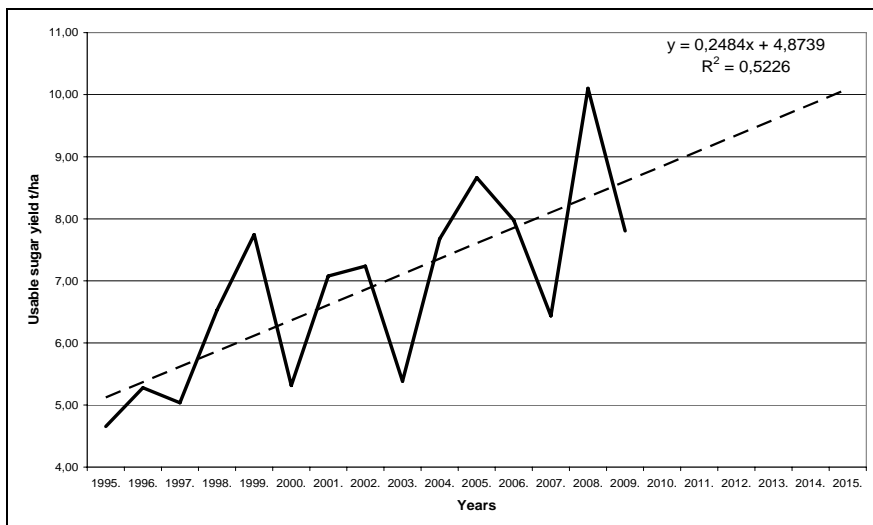


Figure 8

Usable sugar yield moving average trend

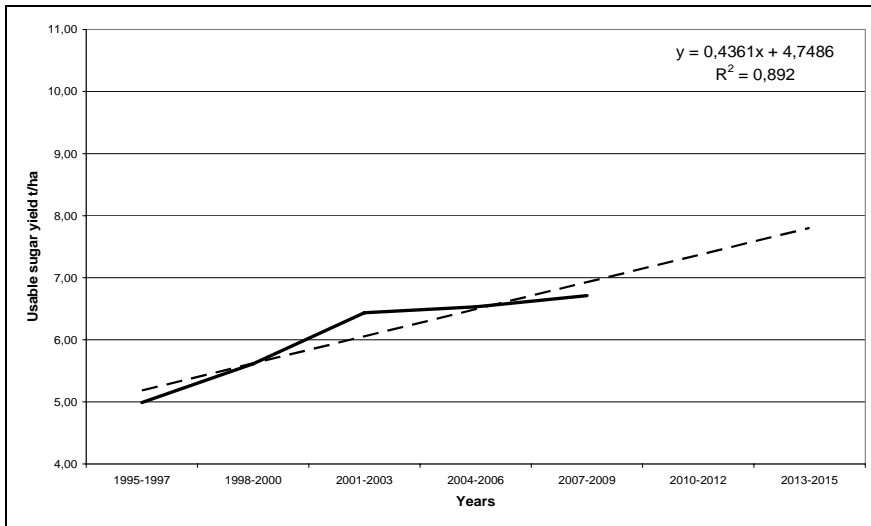


Figure 9

Thick juice purity linear trend

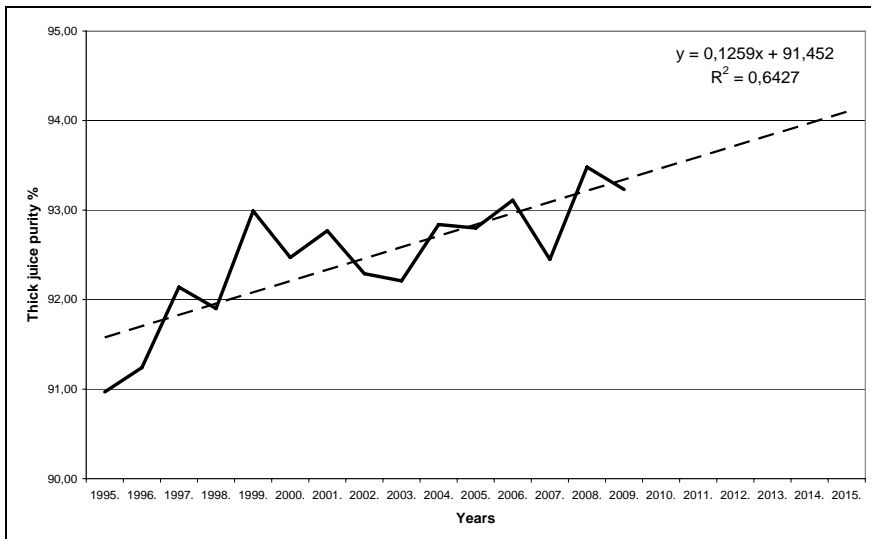
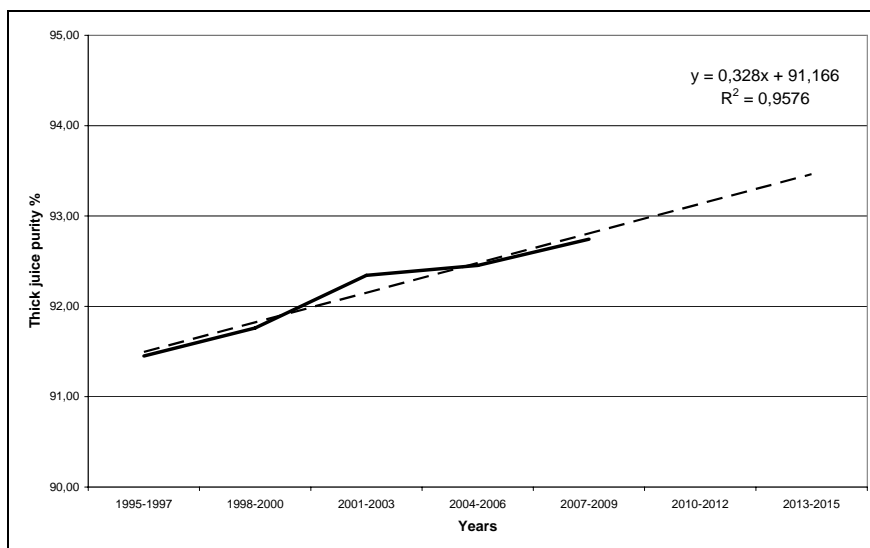


Figure 10

Thick juice purity moving average trend



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