THE AGE OF CANE AT CUTTING AND AGROINDUSTRIAL RECOVERY OF SUGAR

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Abstract

The age of cane at harvest is one of the factors that most influences agroindustrial recovery of sugar (ARS). Regression models of ARS as a function of age were conducted, separating data by factory, year and cut as an approximation to site-specific management. An economic methodology was applied to quantify the monetary effect of harvest at unsuitable ages. ARS varied, not only as a result of age at cutting, but also by mill and year of harvesting. Cutting at an inappropriate age can have significant economic effects.

Introduction

ARS is the percentage (in weight) of sugar recovered per tonne of cane milled in the factory. Factors that influence ARS include the age of cane at the time of cutting, climatic conditions during growth and at the time of harvest, time left in the field after cutting, and extraneous matter. The effects of cutting age have been quantified in the evaluation of cane varieties and, based on experimental results, recommendations have been made on the optimal cutting age for varieties to obtain maximum ARS (Ranjel, 1992). Nevertheless, the overall management of the crop and the pressures from industry to meet their financial commitments have had an adverse impact on obtaining higher cane and ARS per harvest at non-recommended ages.

The purpose of this study is to develop decision-making models using regression analyses of ARS as a function of cutting age and to use these models to quantify the financial consequences of harvesting at unsuitable ages.

Materials and methods

The data used were cutting age, number of cuts and ARS for 14 665 cane lots planted to the variety, MZC74-275, harvested at the Central Castilla, Mayagüez and Providencia factories from January 1990 to December 1998. The yield trends obtained from the analysis reflect the performance of the entire agroindustrial process (field, harvest and factory). The data incorporate a large number of confounded effects: crop management (weed control, fertilisation, hydration of the cane, soil compaction); soil type (pH, fertility, salinity, texture, limitations because of the groundwater level, compaction and profundity); the climate (radiation, temperature, rainfall); the harvesting conditions (extraneous matter, deterioration over time in the field); and the factory process (recovery and loss of sucrose at the factory).

To quantify the economic consequences of harvesting at an unsuitable age, the concept of foregone production was used for decision-making. Despite the restrictions in the data used, the regression models were adjusted on the basis of averages corresponding to each of the ages.

The analysis of the results began with the analysis of variance of the general linear model (Craybill, 1976) incorporating main effects and interactions and continued with an analysis of regression between yield and age at harvest, taking into account the significance of the factors and their interactions.

Results and discussion

The mill x year interaction for ARS was significant, which showed that the differences among the cane factories with respect to ARS varied depending on the year. Similarly, the year x age interaction was significant for ARS, showing that ARS depended, not only on age at harvest, but also on the year of harvest; moreover, the differences among the age groups varied from one factory to another. Differences among the cutting groups were not maintained across cane factories and years as shown by significant interactions. In line with these results, regression models between age at harvest and ARS were constructed.

The quadratic models and their parameters are presented for the three cane factories analysed (Table 1). Given the significant result of the age x mill interaction, the differences can be readily observed. This indicates that the response of varieties to changes in cutting age is different among the factories. Harvesting at early ages had a highly negative effect on the ARS at the Mayagüez factory, where maximum recovery (12.3%) was reached at 13.5 months. At the Providencia factory, the maximum ARS (11.9%) was not in the contemplated range (10 to 15 months), occurring at 15.1 months. The Central Castilla factory had the best average ARS in the 12 to 13 month range, with a maximum of 12.1% at 12.7 months (Figure 1).

Based on the data from this study, some hypotheses can be generated:

Table 1—Regression models for the three sugarcane factories.

<table>
<thead>
<tr>
<th>Factory</th>
<th>Equation</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Castilla</td>
<td>ARS = 12.04 – 0.076 (12.60 – age)²</td>
<td>0.84</td>
</tr>
<tr>
<td>Mayagüez</td>
<td>ARS = 12.25 – 0.177 (13.47 – age)²</td>
<td>0.94</td>
</tr>
<tr>
<td>Providencia</td>
<td>ARS = 11.94 – 0.031 (15.12 – age)²</td>
<td>0.89</td>
</tr>
</tbody>
</table>
Hypothesis 1. The climate

To see this effect directly would require having the information on the sucrose % cane in the plant prior to the harvest—information that is not gathered routinely by the factories. The data suggest that there was a differential maturation rate among years: the maximum ARS occurred at 13 months in 1991, at 12.7 months in 1996 and at 12 months in 1997.

Hypothesis 2. Cane quality (due to harvest management)

The climate can aid or limit harvesting efficiency, depending on the presence or absence of rain. Harvesting modifications have been made to reduce extraneous matter delivered to the mills. The time the cane remains in the field between burning and/or cutting and milling has decreased. As a result, cane quality has been improved, and the ARS at the factory has increased.

Hypothesis 3. Improvements in the factory process

The factory has improved its performance and reduced its losses. It is probable that the improvements stipulated in the three hypotheses have occurred simultaneously with greater or lesser degrees of influence on ARS.

To analyse the economic implications of the decisions of harvesting cane at determined ages, the concept of foregone production was used. This concept is useful for identifying what production is sacrificed when cane is cut at one age rather than at another. In this analysis, the production at which there will be a reduction results from the difference with respect to the age at which the maximum recovery occurs. For example, a factory that mills 7000 tons of cane of var. MZC74-275 per day (TCD) would produce 847 tons of sugar per day (TSD) when cutting at the age of maximum recovery (13 months) compared to a reduction of 14.7 TSD if the cutting age was lowered to 12 months. If the cutting age were lowered to 10 months, potential production would be lowered by 90.3 TSD.

Factories are generally forced to begin milling cane at earlier ages to alleviate pressures to generate a cash flow. Obviously this is a powerful reason, especially in economies that have had high interest rates. However, it is worthwhile to take into account the magnitude of the value of the production that is lost.

Conclusions

The effect of the cutting age on ARS depends on the number of cuts, the factory (site) and the year of harvesting. The age to cutting is fundamental for obtaining good ARS; thus, it should be managed as a decision variable (controlled) and not an outcome variable. There have been considerable improvements in the ARS, which can be attributed to climatic factors and management technologies (field and factory). The economic implications for a factory cutting cane at ages other than that of maximum recovery can be considerable.

REFERENCES

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Resumen

La edad de la caña al momento de la cosecha es uno de los factores que más influyen en la recuperación agroindustrial de azúcar (ARS).

Se presentan modelos de regresión del ARS en función de la edad, pero separando por ingenio, por año y por corte como una aproximación al manejo específico por sitio. Se aplica una metodología económica para cuantificar el efecto monetario de cosechar a edades no adecuadas. Se muestra que el ARS varía con la edad de la caña al corte y también con el ingenio y el año de cosecha. Cortar a edades inapropiadas puede tener efectos económicos significativos.