The derivation of the RV formula for cane payment

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Abstract

This paper describes the general derivation and development of the RV formula for distributing proceeds between Growers in the South African Sugar Industry. The formula introduces the parameters of sugar cane quality such as the sucrose , fibre and non-sucrose content of the cane and financial parameters such as the value of the sugar and molasses made from the sugar cane. The formula determines a value for a Grower's cane relative to that of other Growers supplying sugar cane to the Industry.

Introduction

For the past number of years the growers have been remunerated for the sugar cane they delivered to a mill by having the growers share of the Industrial proceeds ,arising from sugar and molasses sales, available for distribution ,allocated to each grower in proportion to the quantity of sucrose delivered by that grower to the mill. This system of cane payment did not take into account the quality of the sucrose delivered to the mill and in so doing ignored the specific value of the production of sugar and molasses that could be made from that cane. Growers were remunerated as if they delivered average quality sucrose to the mill. The South African Sugar Industry is in competition with all other producers of sugar world wide and therefore must remain a competitive low cost producer in order to survive into the future. The South African Industry believed that the incentive for growers to deliver better quality sucrose could be improved and that such an improvement would lead to more saleable production from the same area under cultivation and improve the Industry's international competitiveness.

Quality Parameters.

The primary constituents of sugar cane are ; fibre (F), moisture , and brix. Brix is made up of sucrose (S) and non-sucrose (N) , the non-sucrose being mostly reducing sugars. The quantity of fibre and non-sucrose present in a consignment of sugar cane both detract from the quantity of crystalline

sugar that a factory can extract from the cane . In an ISSCT paper in 1974 titled "proposal for the evaluation of cane and sugar in identical units at standardised factory efficiency "by A Van Hengel, he proposed a formula that has been proven with time to be a reliable estimate of the amount of crystal that could be expected to be made from cane, the ERC(estimated recoverable crystal) formula .

Estimating the Sugar production from cane

The ERC formula is ERC%cane = aS-bN-cF where a is a factor estimating the undetermined losses in a factory (a is typically 0.98) b is defined as

$$b = \frac{\text{tons N in molasses and sugar}}{\text{Tons N in cane}} \times \frac{\text{tons S in molasses}}{\text{tons N in molasses}}$$

And:

$$C = \frac{\text{tons non-sucrose in bagasse}}{\text{Tons fibre in cane}}$$

a is calculated from a known volume of ERC and b ,c ,S,N, and F and therefore is essentially a correction factor described as the "undetermined losses " at any milling plant.

The parameters a, b and c are specific to each milling factory ,although very similar for each mill , and if the ERC formula were to be used in an industrial context to predict the quantity of sugar that would be made from each consignment of cane delivered to a mill by a grower , in an industry where each Grower is paid a "pan territorial " price for his cane i.e. as if he delivered his cane to the average mill in the industry the parameters a,b and c would have to be averaged across all mills in the industry. Further ,in order to remove any seasonal variation in these data it was decided to calculate a three year rolling average of these data . Therefore when using the ERC formula to estimate industrial production and equating the estimate to actual production one has to introduce a correction factor R ,being the proportion of estimated crystal in production such that ;

Sugar production (t) = RxERC

The calculation of R in the presence of a in recent years varies above and below 1 from year to year by very small units, indicating the reliability of the formula.

Removing the a factor from the formula.

In the context of trying to estimate sugar production from 16 mills in South Africa and as a result of averaging data from those mills on a three year rolling basis and then the need to introduce the R factor ,it was considered unnecessary to have both a and R, and the a factor was therefore removed from the calculation to estimate the volume of sugar that could be made from a growers cane. The consequence of this decision is that the R factor now will vary more from 1 than in the presence of the a factor and will account for all of the inequality.

SR(sugar recovery)= Rx (S-bN-cF)

Estimating molasses production.

The other saleable product made from cane is molasses and the molasses primarily constitutes the non crystallisable sugars present in the sugar cane. The quantity of molasses produced is a function of the volume of N in the cane although the relative volumes of molasses production are also controlled in the milling process.

Many different formulae were evaluated using industrial data , various statistical manipulations of the data were carried out by the author in order to try and produce a reliable regression relationship between the volume of N delivered to a mill and the volume of molasses produced. Non of the formulae derived or tested produced a better relation than the simple ratio of the tons of molasses produced as a ratio to the tons of N in cane delivered to the mill or mills . A factor m is calculated being the ratio of molasses produced to N delivered averaged across all mills on a three year rolling average basis

m= tons molasses produced /tons N delivered

Therefore the estimated volume of molasses(EM) made from cane is;
EM= Nm

Estimating the value of the products made from cane

Given that it is possible to estimate the volume of both sugar and molasses it is then possible to estimate the value of the cane on that basis.

CP(cane price)= SV(sugar value)+MV (molasses value)

The sugar value in cane is dependant on the average price the industry receives (P^s) for both local and international sales and the share of those proceeds that growers enjoy G (currently some 0.64)

$SV= SRxGxP^s$

$SV= Rx(S-bN-cF)xGxP^s$

The molasses value MV is the product of the volume of molasses and the price of molasses P^m;

$MV= NxmxP^mxG$

So cane price $CP= Rx(S-bN-cF)xGxP^s + NxmxP^mG$ --------(1)

Multiplying the terms inside the brackets by the terms outside the brackets and removing the convention of x for multiplication yields;

$CP=RSGP^s-bNGP^sR-cFGP^sR+NmP^mG$

In order to simplify the equation multiply the last term by RbP^s/RbP^s (ie 1) and interposing terms 2 and 3

$CP=RSGP^s-cFGP^sR-bNGP^sR+NmP^mGRbP^s/RbP^s$

Rearranging the last two terms

$CP=RSGP^s-cFGP^sR-b(1-mP^m/RbP^s)NGRP^s$

Call the term $b(1-mP^m/RbP^s)$ $=d$

Then $CP= RSGP^s-dNGRP^s-cFGP^sR$

Taking RGP^s out side of a bracket gives

$CP=(S-dN-cF)GRP^s$ (similar in shape to SV) --------(2)

Call the term in brackets RV being the" relative value" of the cane

The equations (1) and (2) are identical.

Conclusion

The cane payment formula has been changed to include parameters of sucrose quality and will reward growers for the value of the products that can be made from the cane .The formula is sensitive to the changes in relative value of both sugar and molasses. The incentives that are created by this RV formula are less than those a simple ERC formula would create because the value of the molasses created by the diversion of sugars to that end and away from making sugar is recognised and is therefore more correct than a simple ERC. As the molasses value tends to zero so the formula tends to a simple ERC formula because d tends to b.

The paper prepared by Dr G Moor shows the implications of a change to the industrial incentives of a move to this new cane pricing formula that includes cane quality , sugar and molasses value parameters.