Information Sheet

4.5 Managing deterioration losses in cane quality between harvesting and crushing

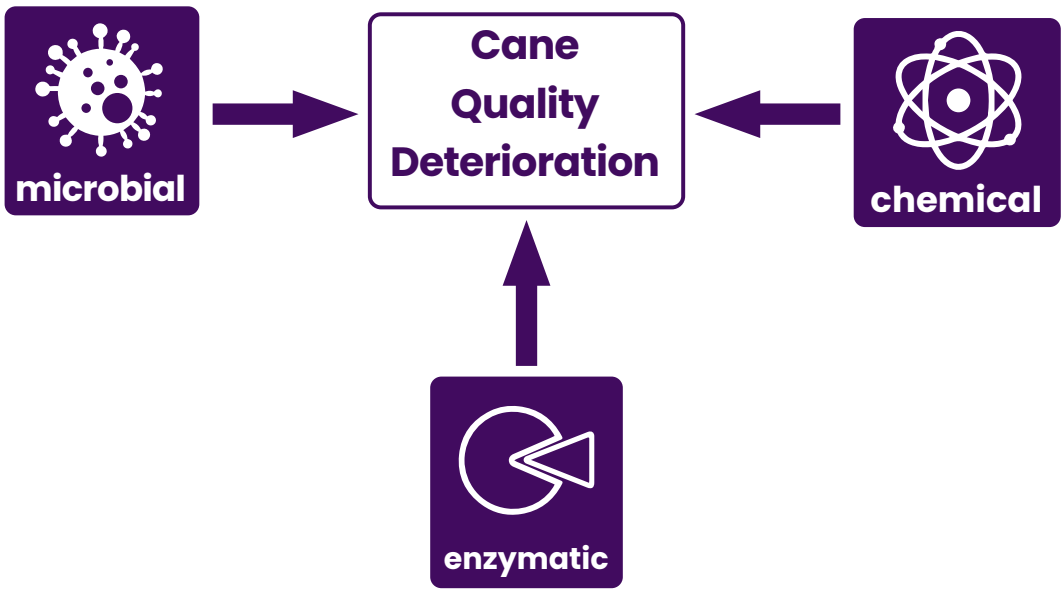
Introduction

Both growers and millers would benefit greatly if it were possible to process cane immediately after it is harvested, although, in practice, this is not logistically possible. Delays between harvesting and crushing of three to four days, and sometimes much longer, are common, resulting in lower recoverable sucrose due to deterioration losses. Such long delays are extremely detrimental to the economy of the South African sugar industry.

To reap maximum reward under the RV cane payment system (*see Information Sheet 4.1 Cane Quality Management under the RV Cane Payment System*) cane consignments delivered to the mill should be high in sucrose content and low in non-sucrose constituents. The objective of farming for high sucrose yield per hectare gets derailed when the high sucrose content of the harvested cane is not maintained until crushing.

The process of cane quality deterioration

Any form of physical injury inflicted on cane stalks during harvesting, be it through burning or cutting, triggers the process of quality deterioration. When cane is harvested unburned, either by hand or mechanical harvesters, the process of deterioration starts from the moment the stalks are physically detached from the stools. In the case of burned cane, deterioration starts immediately after burning.



The problem with cane deterioration is that it specifically targets the sucrose stored inside the stalks. There are essentially three pathways, occurring simultaneously inside the cane stalk, through which sucrose losses occur during deterioration, namely, microbial, enzymatic and chemical.

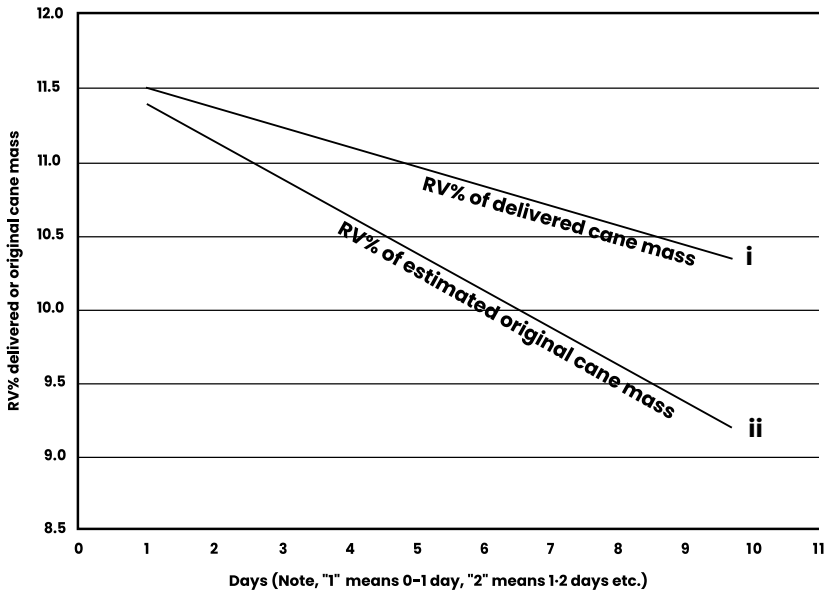
• **Microbial** infection of injured stalks is the dominant pathway through which deterioration losses occur. This pathway is very sensitive to factors during harvesting influencing microbial infection such as burning and air temperature, rainfall and humidity, cane cleanliness (degree of contamination of cane by wet soil), billet length during mechanical harvesting, and the degree of physical injury (entry points for microbial infection) to whole stalks or billets. Upon infection, these microbes literally consume the stored sucrose inside the stalks and simultaneously produce deterioration products (e.g. dextran and mannitol) that negatively affect multiple processes inside the mill. In cases of severe contamination with deteriorated cane, the complete stoppage of the mill could occur. These secondary losses in the mill could increase the loss of sucrose by at least a further 20% over a 96-hour delay, and by even more for longer delays. In a similar fashion, natural endophytes inside the cane stalk stay alive after harvesting and will consume stored sucrose as an energy source during the process of respiration, contributing to deterioration losses.

• Another contributor to deterioration losses is through naturally occurring **enzymes** (e.g. invertases) inside the stalks. These enzymes are more active under warm conditions, so the temperature during harvesting plays an important role in determining the amount of sucrose lost through this pathway. Interestingly, the more immature the cane, the higher the invertase content of the stalks. Particularly during the early-season (summer/autumn), when it is warm and the cane is fast-growing and immature, this pathway could contribute significantly to total deterioration losses. The same could happen during the late-season, when crop growth resumes after winter and temperatures start to warm up.

• **Chemical** deterioration happens inside injured stalks when the stored sucrose gets exposed to acidic conditions (low pH) due to cellular damage. The acidic conditions trigger the chemical inversion (breakdown) of sucrose to non-sucrose. However, at the typical temperature range during harvesting, the contribution of this process to total deterioration losses is the least of the three pathways.

The rate of cane quality deterioration

The graph below shows typical rates of quality deterioration, measured as Recoverable value % (RV%), determined on i) actual delivered cane mass, and ii) estimated original cane mass (bearing in mind that cane loses mass from the moment it is harvested).



[Adapted from Harris (2017). Determining the cost of post-harvest deterioration in a South African sugarcane supply chain. *Proc S Afr Sug Technol Ass*. 90: 200-215]

The RV deterioration rate based on estimated original cane mass amounts to approximately 0.25 RV percentage units for every 24 hours of harvest to crush delay. This implies that a sugarcane crop with a RV of 13% before burning could lose 0.75 percentage units and drop to a RV of 12.25% over a 72-hour period.

Other factors affecting cane deterioration

Climatic factors

The rate of cane deterioration between harvesting and crushing varies considerably with the prevailing weather conditions, being most rapid in the hot humid summer months. The process of deterioration is characterised by a continuous decline in both juice purity and sucrose content, although the latter may be initially obscured (masked) by a simultaneous drying out (desiccation) of the stalks and respiration, leading to weight loss.

This is an extremely important concept, because growers may sometimes see a slight increase in the RV% of cane consignments delivered from a field over the first few days following harvesting. This could easily be perceived as a gain in productivity, but in reality, this is merely a concentration effect as a result of stalk desiccation and weight loss. This temporarily masks the detrimental chemical, enzymatic and microbial deterioration processes already in progress. It is important to understand, that once the green leaf canopy is killed by burning, or removed during cutting, no further sucrose production by the plant can occur. There will therefore be no further gains in sucrose content, only losses.

Pre-harvest burning

Pre-harvest burning has an adverse impact on the stalks because the stalk rind typically gets exposed to temperatures of anything between 98°C – 400°C. Exposure to such high temperatures for even a few seconds causes the stalk rind to fracture, which causes cellular damage and creates multiple entry points for microbial infection. Therefore, unburned cane generally deteriorates more slowly than burned cane cut immediately. However, due to more rapid conversion of sucrose to reducing sugars, the juice purity of unburned harvested cane usually declines more rapidly than that of burnt harvested cane during the first few days after harvest, though subsequently, deterioration rates in burned cane overtake those in unburnt cane.

Cane which is burned and left standing, even for a short period of time, often shows a more rapid deterioration rate than cane which is burned and cut immediately. Also, the dilution effect caused by uptake of water from the soil by the living root system after burning may reduce recoverable sucrose. This emphasises the importance of burning only enough cane to meet the requirements for one day's allocation.

Mechanised harvesting

Machine harvested cane billets, whether from burnt or unburnt fields, deteriorates much more rapidly than whole stalks due to the higher degree of physical damage, which again emphasises the importance of transporting cane to the mill as soon as possible. In Australia, where all the cane is machine harvested, for a grower to avoid penalties the allowable cut to crush delay is generally not more than 12 hours.

Managing deterioration losses

It is very important that the harvested cane reaches the mill and is crushed as soon as possible after burning or cutting (i.e. on the same day as harvesting). Where burning is practised, the best time to burn is at dawn. Evening burns increase the delay to crushing by 10 to 11 hours. Where enough cane is burned for two days' allocation, the delay is increased by a further 24 hours, and if burning is only done once a week the delay is increased by at least 60 hours.

Burning at dawn also often reduces the burn temperature, which will inflict less physical damage on the stalk rind. Cutting green cane eliminates the burning delay and reduces physical damage, thus resulting in fresher cane being delivered to the mill.

Rainfall and wet in-field conditions after the burning of cane are also undesirable, because it temporarily stalls harvesting and in-field cane extraction from the affected fields, thereby increasing deterioration losses because of extended harvest to crush delays. Taking cognisance of weather forecasts when planning burning schedules are therefore advisable.

A concerted effort is urgently needed to reduce the overall burn or cut to crush delay in our industry. This would involve the following:

- More green cane harvesting.
- Ensuring that most cane, burned or cut, leaves the field on the same day.
- More group or contract harvesting which would increase co-ordination, collaboration and efficiency
- Matching of daily burning allocations and harvesting fronts to the DRD to enable same day delivery of harvested cane.
- Scheduling deliveries of cane in higher capacity vehicles across the day will reduce over-fleeting, the number of daily vehicle trips and vehicle queues at the mill.

According to the Bonsucro Production Standard* the recommended maximum thresholds for delays between harvesting and crushing for various harvesting systems are:

Machine-harvested = 16 hours.

Manual-harvested unburned cane = 24 hours.

Manual-harvested burned cane = 48 hours.

* Bonsucronsucro Production Standard version 5.1, January 2022. https://bonsucro.com

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