SUGARCANE – POST HARVEST CANE QUALITY DETERIORATION AND MANAGEMENT

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Abstract: Sugarcane is a very perishable raw material both for sugar factory crushing and for jaggery making. The production and sustaining mechanism of sucrose inside the cane is very sensitive both for production and inversion. It undergoes quick cane / quality deterioration after cane harvest resulting in to substantial lose in economic and product i.e., sucrose. The over all cane recovery or sugar / jaggery production depends on efficient management of raw material, selection of quality cane, timely supply of clean cane and processing efficiency etc. In India whole stalk grew cane is manually harvested but inspite of this practice, sucrose losses after harvest are enormous. This field loss in commercial cane sugar (CCS) some times exceeds 1.0 unit per day per unit during the late crushing period i.e., March onwards. A recent survey of some North Indian Sugar units has revealed that nearly 1.0 to 1.3 units pol in cane is lost form the field to milling tandem during manual crushing season i.e from December to February. Procurement of clean quality cane (undeteriorated) without subjected to biotic and abiotic is a prime most prerequisite for quality white sugar and jaggery production. Factors leading to cane quality deterioration are weather, Maturity, Green and burnt cane, Mechanical harvesting Cane variety. Further the consequences of delayed crushing are stale cane includes loss in Commercial Cane Sugar (CCS), loss in sucrose, increase of invert sugar, increase in dextran (ppm), decrease in pH. Based on research findings quick and efficient transport of harvested cane within 24 hours of harvest to minimise postharvest losses. Under mechanical harvesting, the chopped cane should be crushed within 12 hours of cane harvest. In general, no control measure is practicable except to minimize the time lag between harvesting and milling. However, if the above some said measures we followed we can minimize the cane quality deterioration to some extent and can protect the concomitant sugar recovery.

Keywords: Post harvest cane quality deterioration, Commercial cane sugar, loss in cane weight, loss in sucrose, Invert sugars, Dextran (PPM), pH.

Introduction: Sugarcane is a very perishable raw material both for sugar factory crushing and for jaggery making. The production and sustaining mechanism of sucrose inside the cane is very sensitive both for production and inversion. It undergoes quick cane / quality deterioration after cane harvest resulting in to substantial lose in economic and product i.e., sucrose. The over all cane recovery or sugar / jaggery production depends on efficient management of raw material, selection of quality cane, timely supply of clean cane and processing efficiency etc.

In India whole stalk grew cane is manually harvested but inspite of this practice, sucrose losses after harvest are enormous. This field loss in commercial cane sugar (CCS) some times exceeds 1.0 unit per day per unit during the late crushing period i.e., March onwards. A recent survey of some North Indian Sugar units has revealed that nearly 1.0 to 1.3 units pol in cane is lost form the field to milling tandem during manual crushing season i.e from December to February. The existing cane harvesting and supply management system in cane growing belt has some inherent lacunae which entails high sugar losses after harvest of sugarcane crop due to cane quality deterioration.

Procurement of clean quality cane (undeteriorated) without subjected to biotic and abiotic is a prime most prerequisite for quality white sugar and jaggery production. However there are some constraints encounters in sugarcane growing areas both at farmers and factory level. These constraints considerably delay the milling of harvested crop and affect the quality of raw material and resulting in poor sugar recovery.

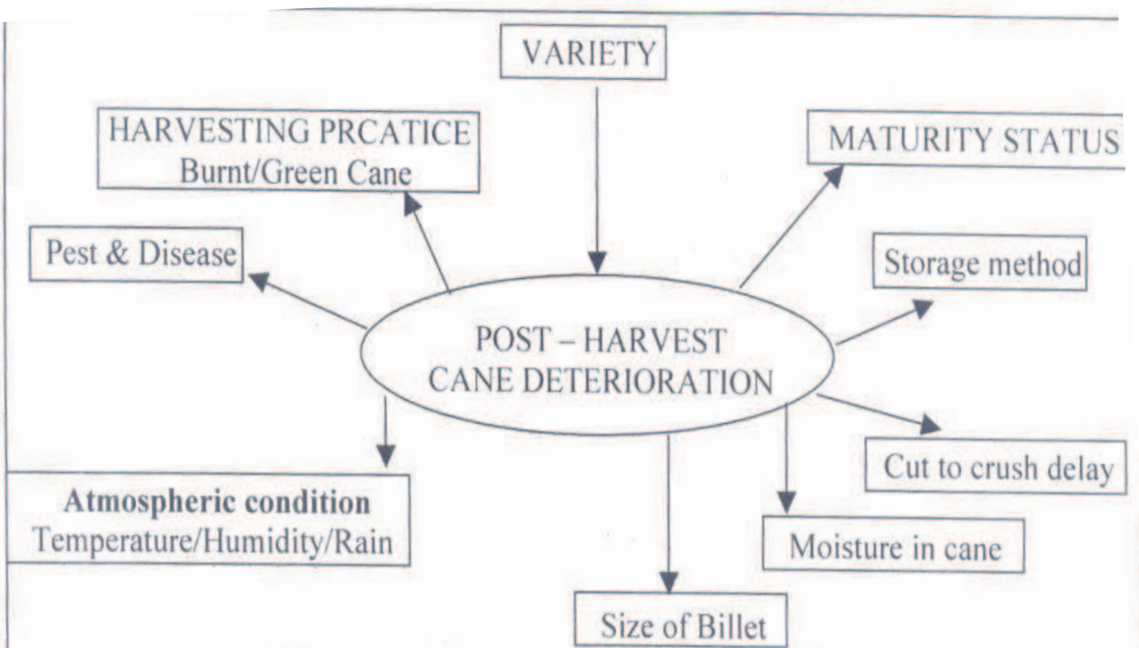
1. Lack of adoption of scientific harvesting schedule based on cane maturity which is mainly due to non adoption of planting pattern according to maturity groups.
2. Extending crushing period in April / May months at more than 40oC weather temperature.
3. Advanced harvesting prior to supply to mills.
4. Limited day crushing capacity of crushers of factories resulting into staling of cane at yards.
5. Poor transport and improper road facilities leading to inordinate delay of transport of harvested cane from field to factory.
6. Absence of knowledge and supervision in supply of clean cane.
7. Frequent break down of cane crushing due to power failure and also due to ware and tare off of old machinery.

8. Lack of understanding / knowledge on mill sanitation.
9. Delayed crushing of machine harvested cane (Billets).

Postharvest cane quality deterioration:

The following are often encountered problems to post harvest cane staling at the field and mill yard.

1. Nature of sugarcane varieties growing sugar factory operational areas.
2. Condition of cane i.e., mature / overmatured / immature / burnt / detopping etc.
3. Maturity status of the crop.
4. Method of harvesting i.e manual or machine.
5. Prevailing weather conditions i.e., temperature, relative humidity and rainfall etc.
6. Time lag between cane harvesting and crushing.
7. Method and duration of storage of cane (Open storage or pile storage)
8. Cane billets size (Small or long).
9. Sanitation condition at cane yard and at crushing yard.
10. Crop case study i.e., crop subjected to biotic and aboitic conditions etc.
11. Crop grown under problematic soils.
12. Cane supply with extraneous material.



Causes of Post harvest Sugar Losses

Metabolic changes inside the cane after harvest along with prevailing weather
conditions , high temperatures, microbial infestation and other factors such as destruction of sucrose, high inversion rate, loss of moisture from cane are the reasons for lowering recovery under cane quality deterioration.

Factors leading to cane quality deterioration:

Weather : Higher temperature is very much deleterious to cane quality. Higher temperatures more than 40oC and low relative humidity (25-35%) enhances inversion and thereby deteriorates cane quality very faster.

Maturity : The fully matured cane will not deteriorate as rapidly as either immature or over mature cane. The process of cane quality deteriorations is faster in summer months.

Green and burnt cane : The behavior of burnt and unburnt canes will be in different manner with respect to cane quality deterioration. Cane quality deterioration under delayed crushing is very faster in burnt cane than green / unburnt cane due to loss of cane moisture coupled with inversion of sucrose.

Mechanical harvesting : Cane quality deterioration after cane harvesting is very quick or faster in billet harvesting (mechanical) than whole cane harvesting (manual) due to more area exposure to weather and more ways to enter microbia and also more ways to loss cane moisture which results into faster sucrose inversion.

Cane variety : Sugarcane variety play a pivotal role in sugar recovery depending on the climate and management practices followed. Some varieties like 98A168, 97A85, 87A298, 2000A226, 2000A56, 2000A62 , 2000A70 and 2000A213 less prone to quality deterioration (less than 10%) even at 72 hours after cane harvest. But there is no exception for mechanical harvesting. For any variety to avoid cane quality deterioration invariably it should be crusher immediately within 24 hours of cane harvest but for billet harvesting (machine) it should be crushed within 12 hours of cane harvest to protect the sugar recovery (Table 1 &2).

Consequences of delayed crushing or stale cane :

Loss in cane weight: Cane starts to lose weight by drying out as soon as it is harvested. The percentage of loss varies widely with temperature, humidity, wind speed, variety and method of storage etc. the loss in cane weight is more in chopped cane (mechanical) rather than whole cane harvesting (manual) under delayed crushing situations. It accounts to nearly 7 – 10% after72 hours of staling under normal weather prevailing conditions. A variety tolerant to cane quality deterioration plays a vital role in degree of deterioration after cane harvest and also the pace of cane quality deterioration changes with prevailing temperatures (Table 1 & 2).

a) **Loss in Commercial Cane Sugar (CCS) :** On an average 2.5units of CCS per day is the loss of 72 hours of delayed crushing.

b) **Loss in sucrose :** Loss in sucrose may vary with the variety, storage condition and time lag between harvesting to milling. It ranges from 14-23% pol in 72 hours of cane harvesting.

c) **Increase of invert sugar :** The inversion product i.e., reducing sugars or inverts sugars increases to a quantum during the period of storage accounts 90 – 95% in its quality within 72 hours after cane harvest.

d) **Increase in dextran (ppm) :** Under delayed crushing the cane quality deterioration is notified by abnormal increase in dextran ppm which is an invert sugar leading to juice quality deterioration resulting in poor sugar recovery.

e) **pH :** The juice pH will be decreased with a pace of increase of time lag between harvesting and crushing due to increased microbial activity coupled with inversion of sugars in the juice leading to cane quality deterioration results in poor sugar recovery.

Table –1 : Performance of sugarcane clones / varieties under post harvest, cane quality determination of 72 hrs. after cane harvest, (12th month February)

Sugarcane clones (12 month, Feb)	pH			% sucrose			% > in RS over 72 hah	% < cane wt. over 72 hah	Dextran ppm at 72 hah	TAI at 72 hah	Glucose Coefficient at 72 hah
	0hrs	72 hah	% < over 72hah	0hrs	72 hah	% < over 72hah					
2000A241 (W)	**4.8**	**4.2**	**12.50**	**19.93**	**18.01**	**9.63**	**20.0**	**16.45**	**120**	**15.85**	**1.33**
2000A241 (P)	**5.1**	**4.1**	**19.60**	**19.85**	**16.73**	**15.71**	**26.8**	**18.48**	**240**	**18.92**	**1.73**
2000A226 (W)	4.9	4.7	4.08	20.57	19.98	2.86	14.28	11.52	60	11.28	1.20
2000A226 (P)	4.9	4.4	10.20	20.86	19.77	5.23	20.0	12.60	80	13.62	1.26
2000A63(W)	4.8	4.6	4.17	21.59	21.20	1.81	15.38	3.74	60	11.30	1.35
2000A63(P)	4.6	4.3	6.52	22.40	19.91	11.11	23.33	9.41	120	24.21	1.42
2000A70 (W)	4.9	4.7	4.08	21.42	21.05	1.72	10.52	4.02	30	11.69	0.99
2000A70 (P)	4.8	4.4	8.33	20.88	19.08	8.62	15.78	7.32	140	15.92	1.15
2000A213 (W)	4.8	4.6	4.16	19.87	18.81	5.33	16.32	4.93	40	11.30	1.28
2000A213 (P)	4.6	4.1	10.86	22.78	19.96	12.37	25.0	9.67	120	24.24	1.45
2000A62 (W)	4.8	4.6	4.16	20.61	18.96	8.01	7.40	8.14	60	8.01	1.53
2000A62 (P)	4.8	4.3	10.41	21.00	18.06	14.00	26.0	13.15	120	12.54	1.61
CoC 01061(W)	**4.7**	**4.2**	**12.76**	**20.59**	**18.15**	**11.85**	**25.0**	**6.63**	**70**	**17.64**	**1.38**
CoC 01061(P)	**4.7**	**4.0**	**14.89**	**21.77**	**18.04**	**17.13**	**35.0**	**16.17**	**110**	**18.82**	**1.50**
Co6907(W)	**4.8**	**4.2**	**12.5**	**21.05**	**16.13**	**22.15**	**20.0**	**11.36**	**140**	**15.13**	**1.40**
Co 6907(P)	**4.9**	**4.1**	**16.32**	**21.44**	**15.60**	**27.23**	**26.19**	**13.40**	**240**	**18.36**	**1.86**
2000A105(W)	**4.9**	**4.3**	**12.24**	**17.39**	**15.38**	**11.55**	**18.18**	**16.39**	**120**	**19.56**	**2.53**
2000A105(P)	**5.0**	**4.2**	**16.00**	**18.75**	**14.84**	**20.85**	**25.71**	**22.77**	**220**	**21.38**	**2.96**

2000A56(W)	4.7	4.5	4.26	19.54	19.20	1.74	10.52	8.08	60	16.80	1.09
2000A56(P)	4.7	4.1	12.76	18.59	17.20	7.47	18.18	17.08	80	17.84	1.51

W = whole cane, P = small billets, RS= reducing sugars, TAI = Titrable acidity Index, hah = hours after harvest

Table –2 : Performance of sugarcane clones / varieties under post harvest, cane quality determination of 72 hrs. after cane harvest (13th month, March)

Sugarcane clones (13 month,Mar)	pH			% sucrose			% > in RS over 72 hah	% < cane wt. over 72 hah	Dextran ppm at 72 hah	TAI at 72 hah	Glucose Coefficient at 72 hah
	0hrs	72 hah	% < over 72 hah	0hrs	72 hah	% < over 72hah					
2000A241 (W)	**4.8**	**4.2**	**12.50**	**19.62**	**17.16**	**12.53**	**136.6**	**17.03**	**320**	**22.14**	**1.98**
2000A241 (P)	**4.9**	**4.0**	**18.86**	**19.85**	**17.04**	**14.15**	**164.8**	**19.24**	**520**	**28.00**	**2.96**
2000A226 (W)	4.8	4.6	4.17	19.05	18.12	4.88	56.0	12.63	80	19.21	1.28
2000A226 (P)	4.9	4.3	12.24	18.65	17.83	8.68	131.0	16.16	160	24.36	3.89
2000A63(W)	4.9	4.7	4.08	20.16	18.62	7.63	66.0	13.26	120	15.62	1.64
2000A63(P)	4.9	4.3	12.74	19.92	17.65	11.39	96.96	19.38	220	22.38	2.63
2000A70 (W)	4.8	4.7	4.17	21.6	19.83	8.19	66.60	12.96	80	18.66	2.31
2000A70 (P)	4.8	4.3	10.42	16.02	14.16	12.23	136.8	23.85	160	21.83	4.45
2000A213 (W)	4.8	4.6	4.17	15.58	14.12	9.37	63.5	19.25	250	14.10	3.02
2000A213 (P)	4.9	4.3	12.24	18.61	16.22	12.84	93.6	26.36	320	20.46	3.68
2000A62 (W)	4.8	4.7	2.08	18.4	16.23	11.79	82.15	16.63	100	16.26	1.94
2000A62 (P)	4.9	4.4	10.20	19.88	17.16	13.68	161.70	19.23	210	22.38	4.36
CoC 01061(W)	**4.9**	**4.1**	**16.32**	**17.66**	**15.08**	**14.61**	**97.14**	**16.05**	**250**	**36.23**	**2.79**
CoC 01061(P)	**4.9**	**4.0**	**18.36**	**16.01**	**13.06**	**18.42**	**177.24**	**20.59**	**400**	**40.10**	**3.08**
Co6907(W)	**4.8**	**4.3**	**10.42**	**16.05**	**13.06**	**18.62**	**78.0**	**25.99**	**460**	**20.34**	**3.57**
Co 6907(P)	**4.9**	**4.0**	**18.36**	**16.16**	**13.62**	**19.43**	**93.52**	**36.38**	**490**	**29.48**	**8.26**
2000A105(W)	**4.9**	**4.1**	**16.33**	**17.86**	**15.18**	**15.05**	**203.3**	**19.93**	**310**	**20.46**	**5.75**
2000A105(P)	**4.9**	**4.0**	**18.36**	**19.62**	**16.06**	**18.14**	**240.4**	**26.10**	**340**	**37.55**	**11.13**
2000A56(W)	4.8	4.4	8.33	20.08	19.01	5.32	57.14	14.80	90	18.19	3.52
2000A56(P)	4.9	4.1	16.32	21.05	19.16	8.79	87.27	16.10	180	21.62	5.34

W = whole cane, P = small billets, RS= reducing sugars, TAI = Titrable acidity Index, hah = hours after harvest

Based on research findings of several authors, the following suggestions need to
be implemented, these will greatly reduce post harvest sucrose looses and thereby improves sugar recovery.

1. Quick and efficient transport of harvested cane within 24 hours of harvest to minimise postharvest losses. Under mechanical harvesting, the chopped cane should be crushed within 12 hours of cane harvest.
2. Supply of clean cane free from trash, mud, roots and leaves.
3. Supply of cane with less chopping to avoid more exposure area to climate.
4. Well management of cane under biotic , abiotic stresses and cane under problematic soils.
5. Supply of mature cane.
6. Adopting sugarcane varieties tolerant to post harvest cane quality deterioration (cane with hard rind and waxy coating).

7. Storing of harvested cane in shade covering with trash and sprinkling water to avoid moisture loss.
8. Post harvest spray on cane bundles with sodium metasilicate, bactericidal formulations, bactrinol 100% / polycide / formalin to arrest inversion.
9. Judicial application P & K fertilisers to maintain keeping quality of the cane, thereby reducing cane quality deterioration.
10. In general, no control measure is practicable except to minimize the time lag
11. between harvesting and milling. However, if the above some said measures we followed we can minimize the cane quality deterioration to some extent and can protect the concomitant sugar recovery.
12. Courtesy from the reports of S. Asokan (1998), S.Solomon et.al., (2008) and A.K. Rathore et.al., (2013).

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