

## Influence of varieties, cane quality and post harvest losses on sugar recovery under different sugar industries of central U.P.

B L SHARMA and MANMOHAN SINGH

U P Council of Sugarcane Research, Shahjahanpur - 242 001

### ABSTRACT

A study on evaluation of varietal potential of some commonly cultivated cane cultivars, cut to crush losses and sugar industry processing losses in some sugar mills of central UP was done during 2012-13. The study was aimed at formulating strategies for increasing sugar production in the industry. Cane samples from standing crop at farmers' field, yard and fibrized cane were collected and analyzed in the mill laboratory for their quality characters. The results revealed loss in pol % in cane to the tune of 0.43 to 1.44 with a mean value of 0.75% between fresh and yard cane and 0.01 to 1.00 with a mean value of 0.55% between yard and fibrized cane. The total loss ranged from 0.70 to 1.82 with 1.30 % mean value indicating ambient loss due to staling during cut to crush. Additionally, average cumulative losses during milling process in molasses, bagasse and pressmud cake occurred 2.00 to 2.23 % having average value of 2.14%. Hence, a huge amount of sugar is being amalgamated in these by products against standard 2.00 % losses. Recommended cane varietal composition, harvesting on the basis of maturity survey, speedy transport system and maintaining minimum losses in milling process are the most important strategies to break the stagnancy in sugar recovery of the UP and north India as a whole.

**Key words:** post harvest losses, cane quality

Sugarcane is second most important cash crop after cotton which is elevating the economic condition of rural India, making self sufficient in sweeteners, providing multi facet opportunity to entrepreneurs and employment generation. Diversified usages of every part of this crop make this a very valuable commodity all over the world and untiring efforts are being made to increase the cane yield and sugar productivity. In a future projection, it has been estimated that during 2020 AD Indian scenario for sugarcane viz. sugarcane area, sugarcane production, average productivity and sugar recovery should be 5.5 million hectare, 500 million tons, 100 t/ha and over 11.0 % recovery, respectively, to feed this ever increasing population. The present scenario regarding cane productivity and sugar recovery is moving around 67.5 t/ha and 10.5 %, respectively. Thus, much effort has to be made to bridge this gap. More alarming situation is in the state UP where half of the sugar is produced, however, with much lower cane productivity viz. 60 t/ha and around 9.20% sugar recovery. In spite of evolution of the high yielding and high sugared promising varieties the authenticated goal for sugarcane and sugar has been lacking due to non adoption of the recommended practices by the farmers, varietal imbalance, cut to crush delay and processing losses in the sugar industry. A well ripened harvested crop may lose its sugar within a few days after harvest, which tends to increase further due to high

ambient temperature, pre-harvest burning, harvest and transportation injuries and microbial infestation (Siddhant *et al.* 2009; Larrahondo *et al.* 2002). Sucrose losses after the harvest of sugarcane and during the subsequent milling operation are the most serious problems in many sugar processing mills in India. Staling, beyond, 24 hours results in considerable loss in cane weight due to moisture loss and reduction in juice sucrose content due to inversion (Singh 2013). The stale canes reduce not only the recoverable sugar but also create losses by reducing mill and boiling house capacities and increases dextran content, loss of sugar in molasses (Solomon *et al.* 2006; Eggleston *et al.* 2008; Siddhant *et al.* 2009).

Studies have indicated that nearly 20-30% of total sucrose synthesized by sugarcane plant is lost during various stages of raw material handling and sugar mill processing. Post harvest cane deterioration affects both growers because of loss in weight and sugar industry due to reduced recovery. Thus, evaluation of the quality status of different commonly cultivated cane cultivars from farmers' field, cut to crush losses and losses in milling process are of immense importance to make strategies for varietal balance and controlling these constraints which ultimately result into an increase in the sugar productivity. Keeping that in view the present investigation was undertaken in eight sugar mills of central Uttar Pradesh under subtropical tract of India.

## MATERIALS AND METHODS

Eight sugar mills situated in central UP viz. Hargaon (Sitapur), Tilhar (Shahjahanpur), Bisalpur (Pilibhit), Roza (Shahjahanpur), Aira (Lakhimpur Kheri), Puranpur (Pilibhit), Parley G (Bahraich) and Chilwaria (Bahraich) were evaluated for quality of commonly cultivated cane varieties and mill processing losses during crushing season 2012-13 starting from December 2012 to April 2013. Fresh field representative samples of cane varieties were obtained from farmers' fields in the natural condition; representative yard cane samples from bullock carts, trucks and trolley were also drawn and thoroughly mix for quality analysis. The cane samples thus collected were weighed, extracted for juice % through a electrically driven cane crusher and processed for analysis with the help of sugar mills quality assessment laboratory.

Juice samples were analyzed for their brix, sucrose % and purity coefficient and simultaneously bagasse samples obtained after crushing were also analyzed for their bagasse pol after extraction in a rapipole extacter by the method of Meade and Chen (1977). Pol % in cane was calculated by combining pol % in juice and pol % in bagasse. Fibrized cane samples were collected just after cane fibrizer of the mill and analyzed directly for pol % in cane after extraction in a rapipole extractor as per standard procedure. The representative samples of mill processing by-products like press-mud cake, bagasse and molasses were collected and analyzed for sugar content through the procedure adopted by Verma (1988). The sugar losses in individual by-products were calculated and added to provide cumulative losses. All the analyses were done in triplicate in the laboratory of the concerning sugar mills and the data thus obtained were processed.

## RESULTS AND DISCUSSION

Quality indices of the fresh cane commonly cultivated in the mill zone area, mix yard cane and fibrized cane, losses in Pol % in cane during staling from harvesting to crushing and milling losses in molasses, bagasse and press mud cake in different sugar mills are presented in Tables 1-4. Figures 1-3 delineates the month wise quality performance of prevalent

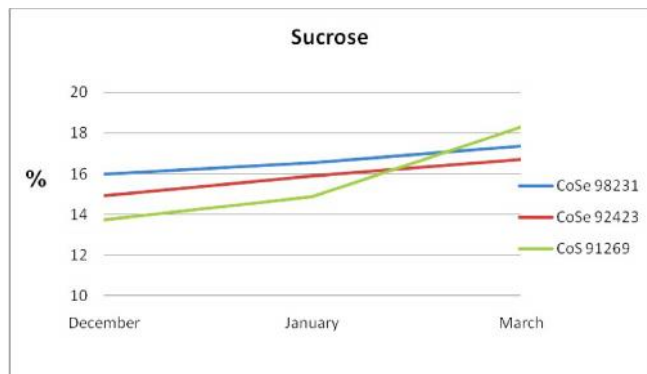


Fig 1 Month wise quality performance of prevalent and most commonly cultivated cultivars in central UP

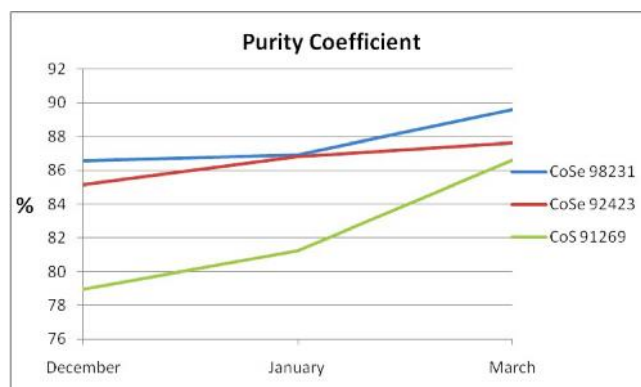


Fig 2 Month wise quality performance of prevalent and most commonly cultivated cultivars in central UP

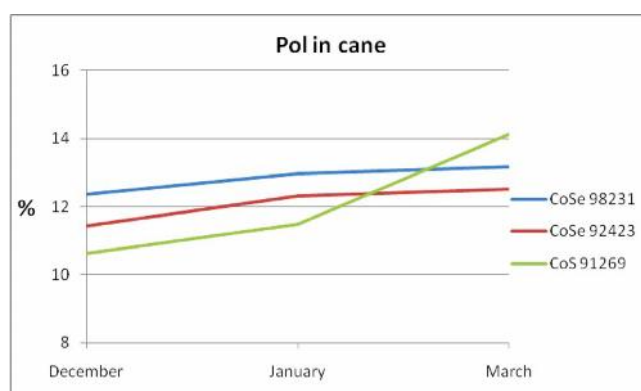


Fig 3 Month wise quality performance of prevalent and most commonly cultivated cultivars in central UP

and most commonly cultivated cane varieties in the mills zone area of central UP.

Perusal of the results indicated that only three cane cultivars viz. 'CoSe 98231', 'CoSe 92423' and 'CoS 91269' were found prevalent in most of the mill zone area. Sporadic cultivation was of the others and standard recommended ratio of early maturing: mid late maturing viz. 40:60 were not followed which is utmost important to obtain higher sugar recovery from the sugar mills. Analytical results obtained from different sugar mills in December revealed that fresh cane samples obtained from Tilhar sugar mill zone showed 14.70% sucrose and 82.08% juice purity indicating there by immaturity of the cultivars being crushed by sugar mill in this zone compared to the standard 16.0% sucrose and 85% juice purity for mature cane. Alarming situation in this zone regarding juice quality appeared in cultivar 'CoS 91269', a rejected one, which showed 13.73 % sucrose, 78.95 % purity coefficient and 10.64 Pol % in cane in December. However, the same cultivar had 18.31% sucrose, 86.61% purity coefficient and 14.14 pol % in cane in March suggesting that this cultivar should be crushed during March onward (Table 1). It is also apparent from figures 1-3 that there was a drastic increase in quality traits from January till March in the cultivar 'CoS 91269' among the most commonly cultivated varieties in this area. In general, quality

Table 1. Quality performance of fresh cane commonly cultivated under different sugar mills in central UP

Sugar Mill Variety	December			Mean Dec.	January			Mean Jan.	March	April	Mean Over the locations
	Hargaon	Tilhar	Bisalpur		Roza	Puranpur	Aira		Parle-G	Chilwaria	
CoS 97264	Sucrose	-	-	-	16.13	15.29	-	<b>15.71</b>	-	-	<b>15.71</b>
	Purity	-	-	-	86.16	87.27	-	<b>86.71</b>	-	-	<b>86.11</b>
	Pol in Cane	-	-	-	12.93	11.05	-	<b>11.99</b>	-	-	<b>11.99</b>
CoSe 98231	Sucrose	-	15.73	16.22	<b>15.97</b>	16.65	-	<b>16.55</b>	<b>17.35</b>	-	<b>16.49</b>
	Purity	-	84.30	88.82	<b>86.56</b>	86.90	-	<b>86.90</b>	<b>89.61</b>	-	<b>87.41</b>
	Pol in Cane	-	12.74	12.01	<b>12.37</b>	12.96	-	<b>12.96</b>	<b>13.17</b>	-	<b>12.72</b>
CoLk 8102	Sucrose	-	14.08	-	<b>14.08</b>	-	-	-	-	-	<b>14.08</b>
	Purity	-	82.39	-	<b>82.39</b>	-	-	-	-	-	<b>82.39</b>
	Pol in Cane	-	11.52	-	<b>11.52</b>	-	-	-	-	-	<b>11.52</b>
CoS 91269	Sucrose	-	13.73	-	<b>13.73</b>	14.88	-	<b>14.88</b>	<b>18.31</b>	17.67	<b>16.15</b>
	Purity	-	78.95	-	<b>78.95</b>	81.22	-	<b>81.22</b>	<b>86.61</b>	85.82	<b>83.15</b>
	Pol in Cane	-	10.64	-	<b>10.64</b>	11.48	-	<b>11.48</b>	<b>14.14</b>	13.16	<b>12.35</b>
CoSe 92423	Sucrose	15.02	15.26	14.47	<b>14.91</b>	15.92	16.10	<b>15.89</b>	<b>16.71</b>	-	<b>15.59</b>
	Purity	85.05	82.67	87.75	<b>85.15</b>	86.71	88.36	<b>86.83</b>	<b>87.62</b>	-	<b>86.23</b>
	Pol in Cane	11.51	11.55	11.24	<b>11.43</b>	12.47	11.51	<b>12.32</b>	<b>12.51</b>	-	<b>11.97</b>
CoS 767	Sucrose	-	-	-	-	-	14.99	<b>14.99</b>	-	-	<b>14.99</b>
	Purity	-	-	-	-	-	87.55	<b>87.55</b>	-	-	<b>87.55</b>
	Pol in Cane	-	-	-	-	-	12.19	<b>12.19</b>	-	-	<b>12.19</b>
CoS 8436	Sucrose	18.02	-	16.59	<b>17.30</b>	-	-	-	-	-	<b>17.30</b>
	Purity	88.07	-	87.56	<b>87.81</b>	-	-	-	-	-	<b>87.81</b>
	Pol in Cane	13.16	-	12.35	<b>12.75</b>	-	-	-	-	-	<b>12.75</b>
CoSe 95422	Sucrose	-	-	-	-	-	17.57	<b>17.57</b>	<b>17.84</b>	-	<b>17.70</b>
	Purity	-	-	-	-	-	89.90	<b>89.90</b>	<b>89.33</b>	-	<b>89.61</b>
	Pol in Cane	-	-	-	-	-	14.36	<b>14.36</b>	<b>13.58</b>	-	<b>13.97</b>
CoSA 83 (Un-known)	Sucrose	13.79	-	-	<b>13.79</b>	-	-	-	-	-	<b>13.79</b>
	Purity	84.29	-	-	<b>84.29</b>	-	-	-	-	-	<b>84.29</b>
	Pol in Cane	11.27	-	-	<b>11.27</b>	-	-	-	-	-	<b>11.27</b>
CoS 92263	Sucrose	-	-	13.84	<b>13.84</b>	-	-	-	-	-	<b>13.84</b>
	Purity	-	-	86.01	<b>86.01</b>	-	-	-	-	-	<b>86.01</b>
	Pol in Cane	-	-	10.70	<b>10.70</b>	-	-	-	-	-	<b>10.70</b>
	Sucrose	<b>15.61</b>	<b>14.70</b>	<b>15.28</b>	<b>15.19</b>	<b>15.89</b>	<b>16.07</b>	<b>15.88</b>	<b>17.55</b>	<b>17.67</b>	<b>16.05 (13.79-17.70)</b>
Mean	Purity	<b>85.80</b>	<b>82.08</b>	<b>87.53</b>	<b>85.13</b>	<b>85.25</b>	<b>87.81</b>	<b>86.89</b>	<b>88.29</b>	<b>85.82</b>	<b>86.27 (82.39-89.61)</b>
	Pol in Cane	<b>11.98</b>	<b>11.61</b>	<b>11.57</b>	<b>11.72</b>	<b>12.46</b>	<b>11.28</b>	<b>13.18</b>	<b>12.30</b>	<b>13.35</b>	<b>12.32 (10.70-13.97)</b>

Table 2 Quality performance of mix yard cane and fibrized cane commonly cultivated under different sugar mills in central UP

		December			January			March	April	Over the locations	
Sugar Mill		Hargaon	Tilhar	Bisalpur	Roza	Puranpur	Aira	Parle-G	Chilwaria	Range	Mean
Mix yard cane	Sucrose %	15.39	14.43	-	15.40	13.41	15.74	17.55	17.59	13.41-17.59	<b>15.70</b>
	Purity Coefficient	85.22	81.27	-	84.95	80.64	86.05	83.93	83.66	80.64-86.05	<b>83.67</b>
	Pol % in Cane	11.29	10.82	-	11.63	9.84	12.66	12.92	12.60	9.84-12.92	<b>11.68</b>
Fibrized cane	Pol % in Cane	11.28	10.03	9.78	11.06	9.46	11.97	11.92	12.19	9.46-12.19	<b>10.96</b>

characters of the cultivars increased from December to March and thereafter a slight decrease was observed.

Analysis of fresh cane samples collected from Hargaon, Tilhar, Bisalpur, Roza, Aira, Puranpur, Parley- G and Chilwaria sugar mills zone depicted that the average sucrose %, purity coefficient and Pol % in cane of the test varieties ranged from

13.79 to 17.70, 82.39 to 89.61 and 10.70 to 13.97 with a mean value of 16.05, 86.27 and 12.32, respectively, over the locations. Analytical results of the mix cultivar samples collected from cane yard revealed that sucrose % ranging from 13.41 to 17.59 (mean 15.70), purity coefficient from 80.64 to 86.05 (mean 83.67), pol% in cane from 9.84 to 12.92 (mean

Table 3 Difference in Pol % in cane during staling from harvesting to crushing in different sugar mills of central UP.

Sugar Mill	December				January		March	April	Over the locations	
	Hargaon	Tilhar	Bisalpur	Roza	Puran-pur	Aira	Parle-G	Chilwaria	Range	Mean
Between fresh and mix yard cane (unit)	0.69	0.79	-	0.83	1.44	0.52	0.43	0.56	0.43-1.44	<b>0.75</b>
Between yard and fibrized cane (unit)	0.01	0.79	-	0.57	0.38	0.69	1.00	0.41	0.01-1.00	<b>0.55</b>
<b>Total</b>	<b>0.70</b>	<b>1.58</b>	<b>1.79</b>	<b>1.40</b>	<b>1.82</b>	<b>1.21</b>	<b>1.43</b>	<b>0.97</b>	<b>0.70-1.82</b>	<b>1.30</b>

Table 4 Losses of sugar in different by- products during processing in different sugar mills of central UP

Sugar Mill		December				January		March	April	Over the locations	
		Hargaon	Tilhar	Bisal-pur	Roza	Puran-pur	Aira	Parle-G	Chilwaria	Range	Mean
Mill processing Losses (% of cane)	Molasses	1.41	1.469	1.28	1.353	1.287	1.46	1.413	1.362	1.28-1.469	<b>1.38</b>
	Bagasse	0.60	0.728	0.87	0.664	0.799	0.52	0.817	0.559	0.52-0.87	<b>0.695</b>
	Pressmud cake	0.072	0.0710	0.074	0.062	0.072	0.05	0.051	0.080	0.05-0.080	<b>0.0665</b>
<b>Total Loss</b>		<b>2.080</b>	<b>2.268</b>	<b>2.22</b>	<b>2.079</b>	<b>2.158</b>	<b>2.03</b>	<b>2.281</b>	<b>2.001</b>	<b>2.001-2.281</b>	<b>2.139</b>

11.68), over the locations, which is quite lower than fresh cane. Further, decrease in pol % in cane were noticed in the samples obtained from the fibrizor of the sugar mills which ranged from 9.46 to 12.19 with a mean value of 10.96 of central UP (Table 2). Perusal of data regarding cut to crush losses revealed that under these mills pol % in cane deterioration between fresh and mixed yard cane ranged from 0.43 to 1.44 with a mean value of 0.75 and between yard and fibrized cane ranged from 0.01 to 1.00 with a mean value of 0.55. Conclusively, the total losses were observed to the tune of 0.70 to 1.82 with a mean value of 1.30 % indicating enormous loss in sugar content resulting into decrease in sugar recovery of the mills merely due to cut till crush time lapse (Table 3).

Studies revealed that soon after the harvest of sugarcane, endogenous invertase enzyme gets activated, converts sucrose into glucose, fructose and acts as a cause of self quality deterioration. The other type of deterioration which is known as bio-deterioration is caused by soil born microorganisms (bacteria) mainly *Leuconostoc* sp. (*L. mesenteroides* and *L. dextranum*). These microorganisms convert sucrose into polysaccharides, such as dextran and are often associated with the deterioration of cane entering through the cut ends. This bacterium has the ability to synthesize alpha-glucon polysaccharides (dextran) from sucrose through an extracellular enzyme called dextransucrase. Besides loss of sucrose, the presence of dextran even in very small amount create problems in filtration, clarification, crystallization and alters the shape of sugar crystals thereby affecting the quality of sugar (Clarke 1997; Jimenez 2009). A number of scientists

(Magdum and Kadam 1996; Solomon *et al.* 2007; Solomon 2000; Siddhant *et al.* 2009) experimented on post harvest deterioration of sugarcane and reported enormous loss of sugar content and weight loss due to staling resulting into low recovery of industry and monetary loss to the farmers. The biological losses such as inversion of sucrose by plant and microbial invertases, dextran and organic acids formation by microorganisms are largely responsible for loss of recoverable sugar. Additionally, the formation of organic acids such as lactic acid, acetic acid and butyric acid produced by the microorganisms leads to lowering of juice pH and loss of sucrose content also and thus reduced sugar recovery.

Sugar mill processing losses in molasses, bagasse and press mud cake (PMC) were evaluated in each sugar mill through random sampling which showed that sugar losses in molasses were highest ranging from 1.28 to 1.47 with a mean value of 1.38% followed by bagasse which ranged from 0.52 to 0.87 with a mean 0.69 % and PMC ranged from 0.05 to 0.08 with a mean 0.07 %. Consequently, the total sugar losses were found to be 2.00 to 2.23 % having average value 2.14%, over the locations (Table 4). This clearly indicated the higher total losses in these by-products as compared to standard fixed (2.00) which would have adversely affected the mill sugar recovery. There are some modernized sugar mills in UP also which have even lower than 2.0% total losses in these by-products. Therefore, these losses can also be minimized to a certain level to obtain higher sugar recovery by adopting modern milling technologies. A planned mill sanitation programme and use of biocide to restrict the microbial infestation in milling process

can also mitigate these loss problems to some extent and elevate the sugar output which should be adopted.

Needless to say that cane cultivars have the potentials for better sugar recovery but a number of constraints are prevailing in this part of the country apart from climatic constraints like incumbency of late rains during maturity period, dense fog, frost, less sunshine etc. Thus, varietal balance in the mill zone area (Early : Mid late – 40 : 60), replacement of older varieties with newer ones, balance fertilizer application, protection of cane crop from disease and pests, maturity survey before crushing, crushing schedule strictly as per variety, minimization in cut to crush delay and milling losses should be followed to obtain maximum potentials from the cane cultivars. If these measures are adopted strictly, the gap between northern India and other parts of the country in cane productivity and sugar recovery can be narrowed down and this will fulfill sugarcane and sugar projections needed in the future.

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