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SHORT COMMUNICATION

Evaluating relative contribution of extraneous matter along with quantitative and qualitative loss in cane harvested by mechanical harvester compared to manual harvesting

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Abstract
The cultivation of sugarcane is very labour intensive especially during planting and at harvesting time. Timely supply of harvested cane to the sugar mills significantly affects the sugar recovery of mills. Delayed harvests cause greater yield loss and quality as well. Now mechanical harvesters are introduced as promising machinery for the timely and efficient management of harvesting process. So, a study was conducted to quantify top cane, trash and contribution of extraneous matter in mechanical and manual harvested cane at different sugar mills viz., Saraswati Sugar Mills (Yamuna Nagar), Piccadily Agro Industries Ltd. Bhadson (Karnal) and Karnal Coop. Sugar Mills (Karnal) with total six locations during April, 2019. The results have shown that the extraneous matters (on mean basis) was found higher in mechanical harvested cane for trash (1.7%), green top (5.7%) along with cut portion (8.1%). In case of manual harvested, trash and green top was 1.0 and 2.9%, respectively without any cut portion (setts). The presence of higher extraneous matter consequently reduced juice quality in mechanical harvested as compared to manual harvest cane and mechanical harvested (cane portion). There was 0.33 unit decrease in the sugar recovery (5%) in mechanical harvested mixed cane produce including cane portion, green top and trash as compared to mechanical harvested cane portion only. Similarly, there was 0.71 unit decrease in the sugar recovery in the mechanical harvested mix produce as compared to manual harvested cane.

Keywords: Sugarcane; Mechanical harvesting; Green top; Cut portion; Trash and Juice quality

Introduction

Sugarcane is an important commercial crop grown over an area of 0.96 lakh hectares with production of 77.3 lakh tonnes in Haryana during 2019-20 (Anonymous, 2021). It is the main source of sugar, gur and khandsari production in the state as well as national level. The cultivation of sugarcane is very labour intensive especially during sowing and at harvesting time. Timely supply of harvested cane to the sugar mills significantly affects the sugar recovery of mills. Delayed harvests cause greater yield loss in yield and quality as well. But scarcity of labor during harvesting season limits the timely harvesting of cane (Yadav et al. 2003). So to overcome this situation, now mechanical harvesters are introduced as promising machineries for the timely and efficient management of harvesting process. The labor scarcity during harvesting time can be easily managed with the adoption of harvester. Moreover, hike in prices for harvesting in recent years causing serious problem to sugarcane growers. This technology is new to Haryana state sugarcane farmers' and sugar mills, but it has shown its remarkable growth potential in Maharashtra and Tamil Nadu states of the country (Murali and Balakrishnan 2012).

However, the acceptance of mechanical harvested cane by the sugar mill is a problem due to various factors such as greater addition/mixing of extraneous matter (tops/trash) with harvested produce along with cut (mid/side) setts that subsequently affects the sugar recovery (Ma et

al. 2014; Singh and Solomon 2003). A study has shown that with 1% of trash addition reduced sugar recovery by 0.1% (Ahmed and Alam-Eldin 2013). The proportion of trash/green tops comes along with mechanical harvested cane can be variable and depends on various factors viz., sugarcane varieties, soil types and harvester nature. This strongly influences extraneous matter in final cane produce for crushing in sugar mill. Although, in manual harvesting about 100-150 kg of green top is supplied to mill for each 100 q cane because it is used for making rope (Junna) to tie up the cane. Farmers generally makes cane bundles of about 30-35 kg and bind each of these bundles with two ropes (green leaves top/ matter and each of weight about 500-700 gm) after manual harvesting. However, most of the sugar mills, hired contractual labours to collect this extraneous matter before crushing with cane for efficient crushing and sugar recovery. Extraneous matter is supplied to mills in case of mechanical harvesting seems more and as the major portion of this extraneous matter is part of harvested cane which cannot be easily separated. Hence there is need to study comparative contribution of extraneous matter in harvested cane. So by keeping in view of all these factors, the study was planned with objective to quantify fraction of extraneous matter coming with harvested cane in mechanical and manual harvesting.

Materials and Methods

A study was conducted with the objective to quantify top cane, trash ratio and contribution of extraneous matter of cane harvested by mechanical harvester as compared to manual harvesting and comparative contribution of extraneous matter by these two methods in final cane harvested at different sugar mills viz., Saraswati Sugar Mills (Yamuna Nagar), Piccadily Agro Industries Ltd. Bhadson (Karnal) and Karnal Coop. Sugar Mills (Karnal) during 2019 in the month of April dated 09 (Co 0238), 11 (CoH 160), 12 (Co 8272), 18 (Co 0118), 19 (Co 0118) and 21 (Co 0238)] with total six locations. Three locations were in Yamuna Nagar, two in Karnal and one in Ambala districts of Haryana. The same mechanical harvester (model AUSTOFT 4000, CNH Industrial Pvt. Ltd.) employed at each of the location (Fig 1). In case of mechanical harvested, from each sites two samples were drawn from trolley, while for manual harvesting observation were recorded at

Figure 1. Working of mechanical harvesters (AUSTOFT 4000, CNH Industrial Pvt. Ltd)

three sites. Each sample was separately weighed and separated as green tops, trash, clean cane, cut portion and mud etc. The samples were then evaluated for their relative contribution of extraneous matter (%) such as green top, cut portion and trash in harvested cane. The same samples were analyzed for quality parameters (%) brix, pol, purity, extraction and recovery, wherever feasible in coordination with sugar mills quality control laboratory except for location 6. Brix represent the % of total soluble solids present in the juice sample and it was measured by hydrometer. Pol (%) was measured from the juice by saccharimeter. Purity was calculated with the ratio of pol and brix in percentage.

Results and Discussion

This study has shown that mechanical harvesting resulted in higher values for extraneous matter (%) trash and green tops compared to manual harvesting. Moreover, higher values (3.72-10.77 %) have been recorded for the cut portion (side or mid) in the mechanical harvested setts, which were absent in manual harvested cane.

In mechanical harvested cane, the (chopped billets) ranged from 75.35-93.39% with mean value 85.12%, trash (%) from 1.03 to 2.46% with mean value 1.73%, green tops (%) from 1.84-12.14% with mean value 5.72% and cut portion from 3.72 to 10.77% with mean value 8.08%. In case of manual harvested, clean cane ranged from 94.13 to 97.87% with mean value 95.92%, trash values 0.9 to 1.25% with mean value 1.02%, green tops 1.21 to 4.56% with mean values 2.91%, while the cut portion (setts) were absent in this case (Table 1, Fig 2). The green top portion (1.8-12.1%) and trash (1.0-2.5%) was found more in mechanical harvested produce as compared to manual. Further, greater portion of cut setts

Table 1: Mean values (two samples) of each variety for trash, green top and cut portion under mechanical and manual harvesting

Location	Variety	Cane portion (%)	Trash (%)	Green top (%)	Damaged cane (%)
		Mechanical harvested			
1.	Co 0238	93.39	1.03	1.84	3.72
2.	CoH 160	84.18	1.74	5.07	8.99
3.	CoS 08272	87.62	1.24	4.63	10.77
4.	Co 0118	84.54	2.06	4.42	8.8
5.	Co 0118	75.35	1.9	12.14	10.58
6.	Co 0238	85.64	2.46	6.26	5.61
	Mean	85.12	1.73	5.72	8.08
		Manual harvested			
2.	CoH 160	95.76	1.25	2.96	0
3.	CoS 08272	94.13	0.9	4.56	0
5.	Co 0118	97.87	0.91	1.21	0
	Mean	95.92	1.02	2.91	0

Figure 2. Separation of mechanical harvested cane in different portions (trash, green top and cut) at different Sugar Mills

(side/mid) in harvested produce could make setts (chopped billets) more vulnerable to losses for moisture and sugar recovery. Due to smaller size harvested cane (setts) along with greater surface area, tendency of the mechanical harvested produce to moisture loss and quality deterioration could be more as compared to manual harvested long stalks.

The results have shown higher amount of extraneous matter i.e. trash (1-2.5%) and green tops (2.0-12.1%) in the final harvested cane in mechanical harvester as compared to manual harvested with 0.9-1.3 and 1.2-4.6%, respectively that consequently reduced the quality attributes of cane (Table 2) at each of the location.

The recovery in the mechanical harvested of only cane varies from 9.96 to 12.55 with average of 11.2 % at four locations (Table 2). Whereas, the recovery of mixed cane including cut portion, green top and trash varies from 9.32 to 12.45% with average of 10.87% at four locations. Simultaneously, the recovery in manual harvested only cane portion varies from 11.63 to 13.17 with the average of 12.13% at three locations, whereas at these locations the recovery of mixed cane including cut portion, green top and trash varies from 11.10 to 12.50% with average of 11.43% (Table 2). The data (Table 2) clearly indicate that there was 0.33 unit decrease in the sugar recovery in mechanical harvested mixed cane produce (10.87%) including green top, trash portion, as compared to mechanical harvested only cane portion (11.2%). Similarly, there was 0.71 unit decrease in the sugar recovery in the mechanical harvested mix produce (11.43%) as compared to manual harvested cane (12.14%) for location 2, 3 and 5. Similar reduction was observed in other

Figure 3. Collection and removal of green tops in manual harvested cane by hired contractual labors

quality parameters under mechanical harvesting. Higher extraction (47.5), purity (86.5), pol (18.2) and brix (21.0) were recorded in manual harvested cane as compared to mechanical harvested mix produce with values 43.7, 85.4, 17.3, and 20.2, respectively (Table 2). Ma et al. 2014 reported that mixing of extraneous matter (tops/trash) with harvested produce affects the sugar recovery. A similar study also showed that with 1% of trash addition sugar recovery reduced by 0.1% (Ahmed and Alam-Eldin 2013). That's why most of the sugar mills, hired contractual labours to collect extraneous matter in manual harvested system before cane crushing for efficient crushing and sugar recovery (Fig 3).

Earlier greater addition/mixing of extraneous matter (tops/trash) with harvested produce along during mechanical harvesting of sugarcane was reported by Ma et al. (2014), Singh and Solomon (2003). However, the proportion of trash/green tops comes along with mechanical harvested cane can be variable and depends on various factors viz., sugarcane varieties, soil types and type of harvester (Ma et al. 2014).

Further, during the study (in personal communication with farmer, sugar mill staffs and harvester operater) that harvester requires wider spacing (minimum 4 feet). Further, effective distribution of cane residue and trash on soil surface within the plots acts as organic mulch and conserve soil moisture. Regarding mill/factory point of view, mechanical harvesting could save initial energy of cutting before crushing operation is started with in the mill. But there is need to fine tune or modify implements/machineries such as simple trolley to hydraulic ones and or cane bundle up lifter in mills. New hydraulic trolleys are required for proper clearing of trolleys, otherwise farmers have to spend extra time and labour to clean trolley as lifting machine failed to hold the small size setts. Further, there is also need to strengthen the crushing schedule so that timely crushing can be performed. Due to heavy size of machinery soil compaction is very frequent and can be effectively reduced by lowering axle loads, traffic in specific tracks, avoid use in wet soils. Soil compaction is an ill factor that likely to be associated with mechanical harvester, hence requires sub-soiler in alternate years or 3 to 4 years.

Conclusion

The extraneous matter (on mean basis) was found higher in mechanical harvested cane for trash (1.7%), green top (5.7%), and cut portion (8.1%). In case of manual harvested, trash and green top was only 1.0 and 2.1%, respectively,

Table 2. Comparative effect of mechanical and manual harvesting on sugarcane quality and sugar recovery (mean values)

Cane quality Parameter	Location 1	Location 2	Location 3	Location 4	Location 5	Average
Mechanical harvested mix produce						
Brix (%)	18.02	19.8	21.30	21.52	-	20.16
Pol (%)	14.27	16.73	18.27	18.78	-	17.01
Purity (%)	79.19	83.35	85.77	87.27	-	83.90
Extraction (%)	60.25	41.66	40.36	60.25	-	50.63
Recovery (%)	9.32	11.10	12.45	10.61	-	10.87
Cane portion only-						
Brix (%)	18.02	20.10	21.42	21.76	-	20.32
Pol (%)	15.07	17	18.40	19.01	-	17.37
Purity (%)	80.93	84.60	85.92	87.34	-	84.70
Extraction (%)	49.88	42.84	42.92	60.51	-	49.04
Recovery (%)	9.96	11.51	12.55	10.78	-	11.2
Mechanical harvested mix produce						
Brix (%)		19.8	21.30	-	19.61	20.23
Pol (%)		16.73	18.27	-	17.05	17.35
Purity (%)		83.35	85.77	-	86.97	85.36
Extraction(%)		41.66	40.36	-	49.08	43.70
Recovery (%)		11.10	12.45	-	10.74	11.43
Manual Harvested Cane						
Brix (%)		20.06	22.26	-	20.73	21.02
Pol (%)		17.11	19.25	-	18.2	18.19
Purity (%)		85.29	86.48	-	87.76	86.51
Extraction (%)		44.92	45.22	-	52.22	47.45
Recovery (%)		11.63	13.17	-	11.61	12.14

*Mix: includes cane portion with green top, trash and cut portion in final harvested produce

without any cut portion (setts). The presence and higher values of extraneous matter consequently reduced juice quality in mechanical harvested as compared to manual harvest cane and cane portion of mechnical harvested. There was 0.33 unit decrease in the sugar recovery in mechanical harvested mixed cane produce including green top and trash portion compared to mechanical harvested cane portion only. Similarly, there was 0.71 unit decrease in the sugar recovery in the mechanical harvested mix produce as compared to manual harvested cane. Higher amount of extraneous matters in mechanical harvested is likely to reduce sugar recovery. There is need to fine tune the sugarcane harvester with high capacity air blower to remove the green top and sugarcane trash. While for farmers, there is need to modify implements/machineries such as simple trolley to hydraulic ones. Further for mills, there is need to strengthen the cane crushing schedule for timely crushing and adjustment of cane bundle up lifter in mills. Further research work is needed to strengthen factory performance, cane quality by quantifying magnitude in sugar recovery and infield cane losses upon mechanical harvested with large sample size/locations.

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