Cane Washing Losses – Part 1

By H. S. Birkett & J. M. Stein
Audubon Sugar Institute, LSU Agricultural Center

Abstract

The washing of sugar cane prior to processing has been practiced in Louisiana for about 50 years. The washing of cane followed the introduction of mechanical cane cutting and loading that was introduced during the Second World War.

The mechanical harvesting of whole stalk cane with soldier harvesters was universal in Louisiana until 1993. Since 1994, the use of combine harvesters that cut the cane into small billets (typically 6 to 14" in length) has increasingly gained in popularity. Combine harvesters currently (2003) account for over 85% of the cane delivered to Louisiana factories (B. Legendre – personal communication).

This paper presents results on the washing of both whole stalk and billet cane. These results were obtained during the 1998, 1999 and 2000 crop years. In particular, the loss of sugar on washing, the efficiency of dirt removal by washing, and the quantity of cane wash water entrained with the washed cane are quantified.

The primary results obtained are that sugar losses due to cane washing range from 1.4 to 14.4 lb pol/ton of cane and averaged 6.3 lb/ton cane. The efficiency of the dirt removal by washing varied from 0.48 to 96% and averaged 51.5%. The quantity of cane wash water adhering to the washed cane that entered the factory averaged 7.5% with a maximum of 29%.

These results differ greatly from a study on whole stalk cane washing conducted by one Louisiana factory about 15 years ago that indicated cane washing pol losses of about 2 lb pol/ton cane, a washing efficiency of 70-80%, with a corresponding entrainment of cane wash water in the 3-5% range when washing cane with 2 gpm/tcd (gallons per minute per ton of cane per day).

Ash Content of Delivered and Prepared Cane

The ash content of clean cane for Louisiana is typically about 0.5% (Birkett and Stein, unpublished data). Ash % cane for 26 samples of clean cane analyzed in 1997 are shown in Figure 1. The increase in ash content of delivered cane and washed cane over that of clean cane can be used to calculate the efficiency of cane washing.

Cane deliveries are cored at the factory to obtain representative samples of the delivered cane for cane payment purposes

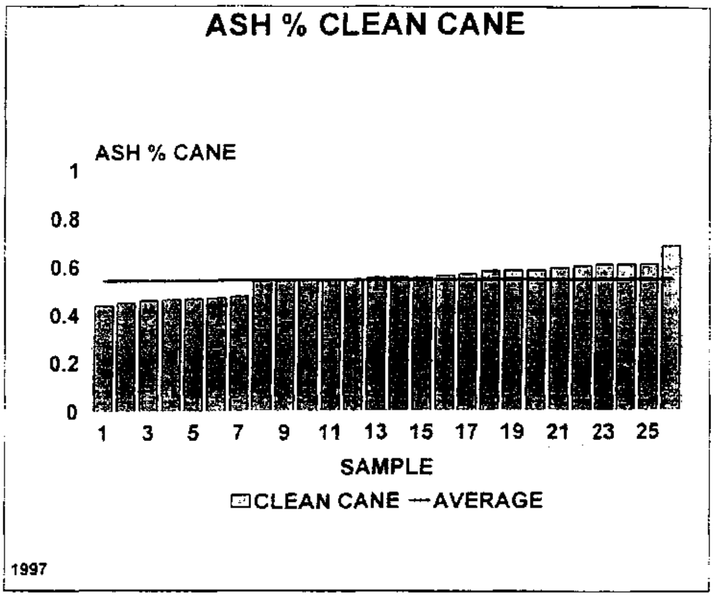

Figure 1. Ash % cane for clean cane samples.

(Birkett, 1977). The sample tube on the corers used in Louisiana enter the cane deliveries from the top at an angle of about 45°. The core tubes are 6" in diameter and typically obtain a sample of about 12 lb. The cane sample is prepared for analysis by shredding the sample in a prebreaker. The cane fiber and ash content of the shredded cane samples were then determined. The ash % cane was determined by carbonizing dried samples at 600°F for 1.5 hours, followed by ashing to constant weight at 1080°F using a muffle furnace (modified ash of peat method, AOAC 1990). The cane fiber was determined by disintegrating the cane sample in water using a commercial Waring Blendor, followed by collecting and washing the fiber using a 400 mesh screen.

The delivered cane is washed and prepared using knives and/or shredders before entering the mill or diffuser. Representative samples of the prepared cane leaving the cane preparation equipment were analyzed for both cane fiber and ash content.

The individual data and average for 43 ash determinations are presented in Figure 2. The ash % cored cane figures ranged from 1.2 to 7.0% with an average of 3.2%. The ash content of the prepared cane varied from 0.6 to 5.2% with an average of 1.7%. For reference, the average ash content of clean cane samples (0.54%) is also plotted. The ash level is slightly below

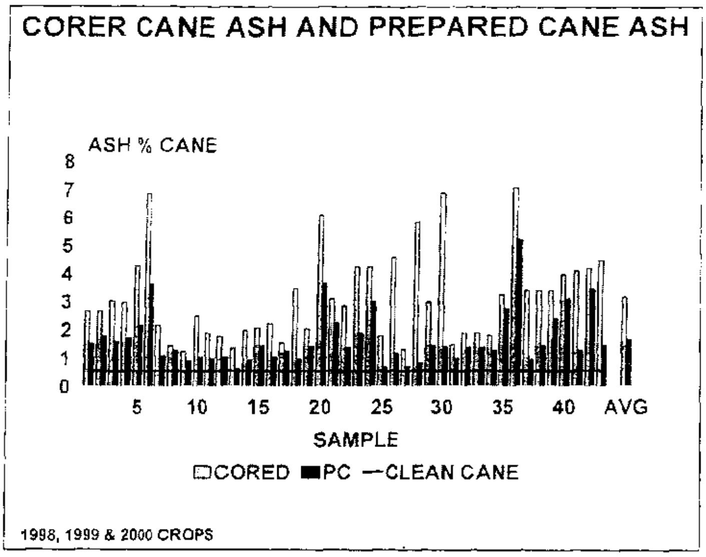

Figure 2. Ash % cane for cored cane and prepared cane samples.

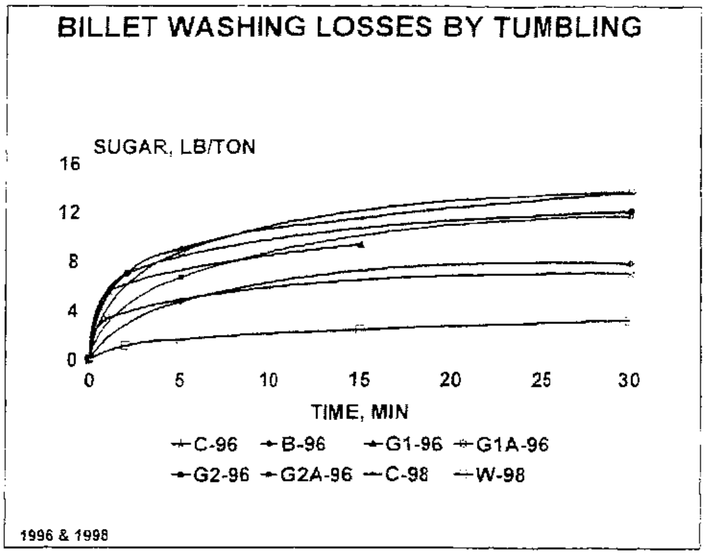

Figure 3. Billet washing losses versus time.

South African reports of 0.6 and 0.8% ash content in clean cane (Lamusse and Munsamy, 1979; Reid and Lionnet, 1989).

It will be noted that while the ash content of clean cane is about 0.5%, the average ash content of the delivered cane was 3.2%, and after cane washing the average ash content declined to 1.7%.

Controlled Billet Washing Losses - Using Preparation Index Tumbler

In order to determine how washing time and billet condition affect billet washing losses, the cane preparation index (PI) apparatus was used to conduct billet washing experiments. The cane preparation index unit consists of a tumbler that rotates at 19 rpm. The unit holds four bottles having a capacity of 4 liters each. Billet cane from commercial cane deliveries was obtained at several factories for testing. Between 650 and 2200 grams (depending on volume) of cane billets were loaded into the four-liter bottles and water added until the water level in the bottles was about 80%. The bottles were then quickly placed in the preparation index unit and rotated. After varying lengths of time, water samples were withdrawn and analyzed for pol content. The sugar concentration in the water was sufficiently high (300 to 10,000 ppm) that accurate pol readings on a 2-decimal polariscope were possible. In this paper, pol, sucrose and sugar are used interchangeably as the differences between them is less than the experimental error in the determination of the washing losses.

Figure 3 shows the quantity of sugar lost for various billets (8 tests) for tumbling times from 2 to 30 minutes. It will be noted that initially sugar losses increase rapidly and then level off. Of interest is that after 30 minutes of tumbling sugar losses varied from 4 to 14 lb pol/ton cane. The wide variation in washing losses is related to the condition of the billets. Some of the billets were relatively clean cut, while others were very jagged exposing many more ruptured cane cells. The much higher washing losses for damaged billets suggests that cane washing losses can be reduced by monitoring the conditions of the combine harvester's blades and replacing them when clean cuts are no longer achieved.

The average of 12 washing loss tests for three years are plotted in Figure 4. This data indicates that most of the pol losses occur during the first 10 minutes, and that very little additional pol losses are incurred for washing times longer than 30 minutes. It was assumed that washing losses were zero at time zero.

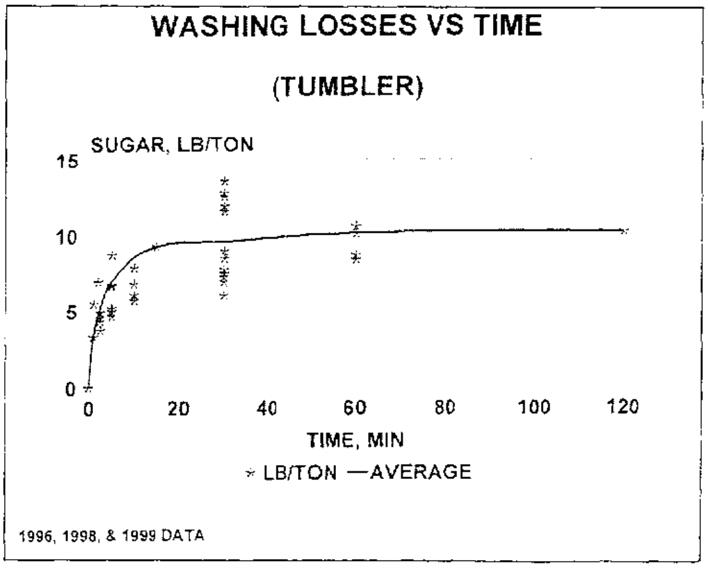

Figure 4. Average washing losses versus time.

In order to quantify the effect that damaged billets have on washing losses, billets from a commercial cane delivery were obtained and separated into two fractions. One fraction was composed of the least damaged billets, and the second fraction was composed of the most damaged billets. Both fractions were tumbled in the preparation index tumbler for 30 min-

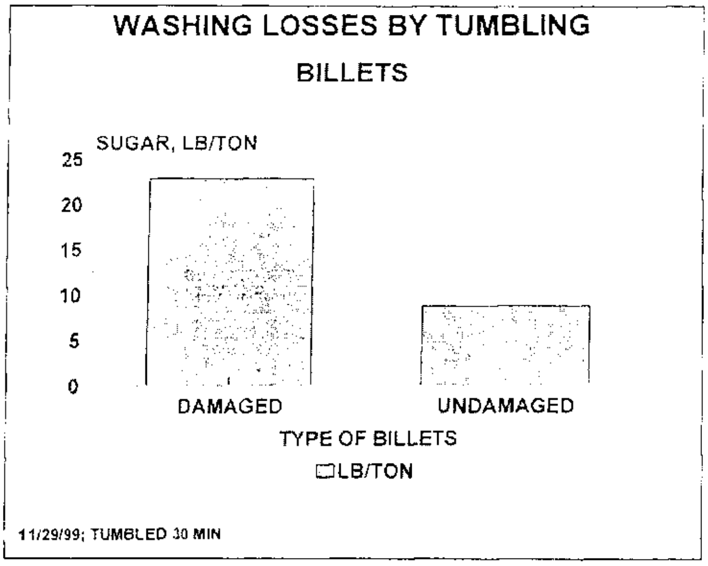

Figure 5. Washing losses for damaged and undamaged billets.

utes. The wash water was then analyzed and the pol losses calculated. These results are shown in Figure 5.

It will be noted that the washing losses for undamaged billets were 8.7 lb pol/ton cane, while for the damaged billets the washing losses increased to 22.8 lb pol/ton cane.

The effect that billet length has on cane washing losses was also investigated. In this test, two field conveyances of cane were obtained from the same field. For one of the loads, the harvester was set to produce short billets that had an average length of 5.25". For the other load, the harvester was set to produce longer billets that had an average length of 9.55". For each of the loads, the cane was separated into three fractions – one consisting of undamaged billets, one consisting of damaged billets and one consisting of the trash (leaves and tops). The weight of each fraction was determined. Each of the three samples was washed in the preparation index tumbler for 30 minutes to determine the quantity of sugar lost on washing. In addition, the washing losses that would have occurred if the

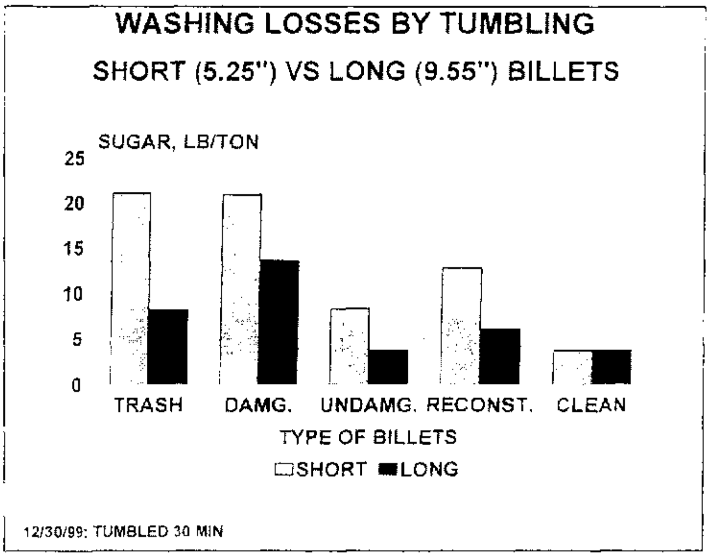

Figure 6. Washing losses for long and short billets.

delivered cane (i.e. the sum of all three fractions) had been washed was calculated from the individual component washing losses and their respective weights. This is shown on the graph as the "reconstituted" cane. Finally, stalks of clean cane (burned and stripped) from the same field were cut into 5.25" and 9.55" billets using a cane knife that yielded very clean cuts.

The results of the above test are shown in Figure 6.

It will be noted that washing losses for each of the three fractions of the short billets were about double those obtained for the long billets. The washing losses for the knife cut billets were the same for both the long and the short billets. It was expected that the long billets, because of the fewer cuts per ton of cane, would have yielded lower sugar losses. Because these losses were only 3-4 lb pol/ton cane it was more difficult to determine these losses. It would be expected that if this experiment was repeated several times that the longer knife cut billets would have yielded lower washing losses than the shorter knife cut billets.

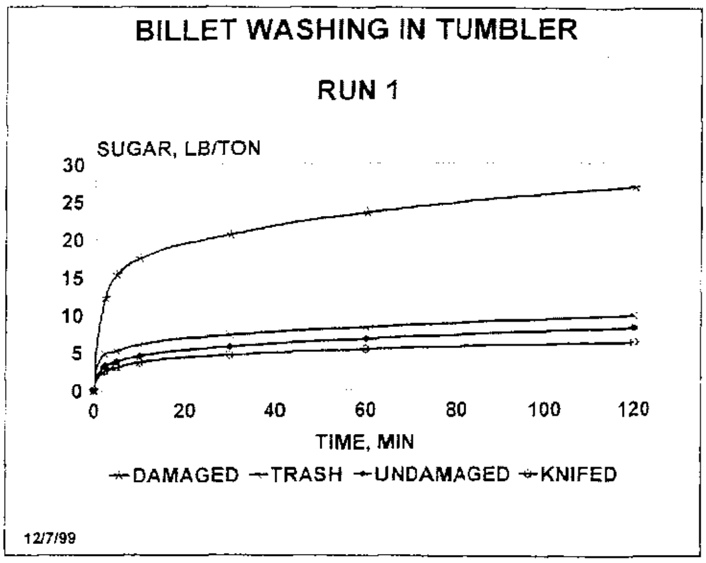

Figure 7. Washing losses for different fractions of billets over

The high sugar losses associated with trash washing were presumably due to the juice expressed by the cutting operation being absorbed by the adjacent leaves.

A series of four tests was conducted on washing billets from a commercial cane delivery. The washing losses were performed in the preparation index tumbler. The delivered cane billets were separated into three fractions – damaged billets, trash and undamaged billets. A fourth fraction consisting of knife cut (cleanly cut) billets of the same length were also included. The washing losses for the first of these four runs is shown in Figure 7. The quantity of sugar lost was determined using the phenol-sulfuric acid method (Dubois et al, 1956; Chorn and Hugo, 1984; SASTA, 1985).

The billets that were cleanly cut using the cane knife had the lowest losses at only 6 lb pol/ton cane after 2 hours of washing. The undamaged billets yielded pol losses of 8 lb pol/ton cane

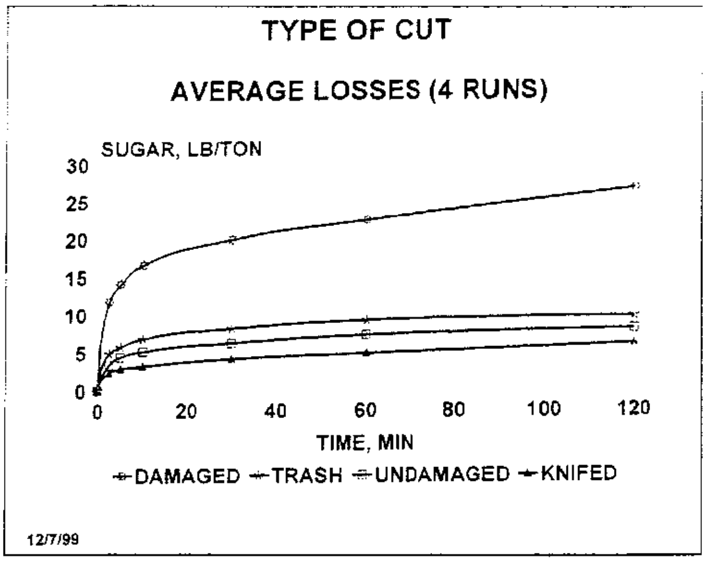

Figure 8. Average washing losses for different fractions of billets over time.

after 2 hours. The trash resulted in washing losses of 10 lb pol /ton cane after 2 hours of washing. The damaged billets showed the highest washing losses at 27 lb pol/ton cane.

The four replicate runs yielded very similar results. The average washing loss results obtained for the average of all four runs is shown in Figure 8.

The average distribution of the undamaged, damaged and trash components of the cane delivery are shown in the pie chart in Figure 9.

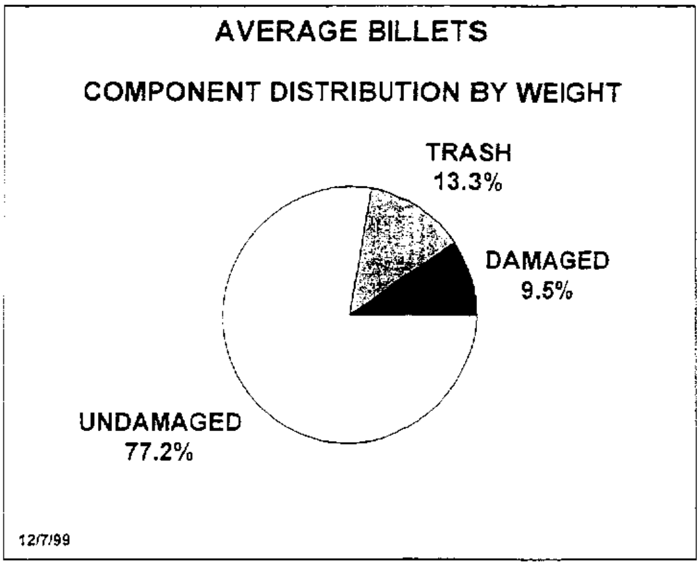

Figure 9. Component distribution by weight of average billets.

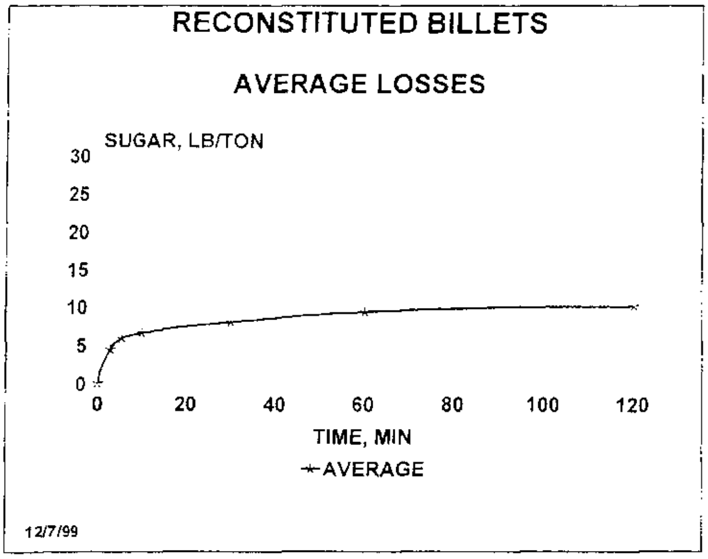

Figure 10. Average washing losses of reconstituted billets.

Combining the three individual component washing losses with their relative weights, the pol losses for washing the gross delivered cane was calculated. These results are shown in Figure 10. Losses ranged from 4.4 lb sugar/ton cane in 2-1/2 minutes to about 10 lb/ton in 2 hours.

Editor's note: Part 2 of "Cane Washing Losses" will appear in the October 2004 issue of *Sugar Journal*. SJ