FACTORS AFFECTING THE ECONOMICS OF TRASHING

A T WYNNE[1] and R VAN ANTWERPEN[2]

*[1]South African Cane Growers' Association, PO Box 88,
Mount Edgecombe, 4300, South Africa*
*[2]South African Sugar Association Experiment Station, P/Bag X02,
Mount Edgecombe, 4300, South Africa*

Abstract

The trashing versus burning debate has been raging for many years, where trashing is defined as the physical separation of leaf material from the cane 'stick' prior to transporting the cane stick to the mill. This paper steers away from the environmental debate and focuses on the economics of trashing versus burning. Trashed cane can generally be supplied quicker than burnt cane, reducing sucrose deterioration and improving cane quality. A reasonable trash blanket left in the field after trashing inhibits weeds, thereby reducing herbicide costs. The additional organic matter above and below the soil surface improves moisture retention and soil health, which can significantly improve cane yields and profits. Trashing, however, is not appropriate in wet, low lying and cooler areas because the trash blanket increases the risk of stools rotting and inhibits ratooning respectively. The volume of trashed cane is also higher than burnt cane, which increases transport costs. In addition, extra trash delivered to the mill may necessitate upgrading the mill's processing facilities. In November 2002, a multi-disciplinary working group was set up to compile an appropriate spreadsheet model. The results to date support *a priori* expectations that, although trashing should be promoted under certain conditions in the South African sugar industry, further research is required in the following areas: (i) yield benefits of trashing under different circumstances, (ii) cane composition of different varieties, (iii) rates of cane deterioration, (iv) influence of density on transport costs, (v) labour productivity under different trashing regimes, (vi) the costs associated with alleviating bottlenecks at the sugar mills should trashing be widely adopted, (vii) the temperature effect in higher altitude areas, and (viii) the economics of trashed cane under irrigation.

Introduction

The trashing versus burning debate has been raging for many years, where trashing is defined as the physical separation of leaf material from the cane 'stick' prior to transporting the cane stick to the mill. Some environmentalists claim that removing the leaf material by burning impacts negatively on air quality. Obviously smoke and ash are a concern, but the beneficial impact of oxygen production through photosynthesis during the growing season is expected to result in a net benefit. The sometimes emotive environmental lobby has pressurised many industries and some governments to institute policies that ban or regulate cane burning, forcing growers to trash (Richard, 2002). This paper steers away from the environmental debate and focuses on the economics of trashing versus burning.

Trashed cane can generally be supplied faster than burnt cane, reducing sucrose deterioration and improving cane quality (Wood *et al.*, 1972). Growers can move from one field to another in response to weather patterns and other factors without much preparation. Therefore, scheduling is also easier and there are no nuisance complaints from the public concerning smoke and ash. A reasonable trash blanket (or mulch layer) left in the field after trashing inhibits weeds and reduces herbicide costs (Lorenzi *et al.*, 1989). The additional organic matter above and below the soil surface improves moisture retention (Gosnell, 1970; Denmead *et al.*, 1997) and soil health (Wood, 1991; Graham *et al.*, 1999), which can significantly improve cane yields (Jadhav, 1995; McIntyre *et al.*, 1995) and profits.

However, trashing is not appropriate in wet, low lying areas because the trash blanket increases the risk of stools rotting, and in the cooler areas inhibits ratooning (Murombo *et al.*, 1997). Trashing also results in a slower harvesting process because of the extra time required to physically separate the trash from the cane stick; this is true for mechanical and manual harvesting practices (de Beer *et al.*, 1995) and has a cost attached. Transporting trashed cane is also more costly because it takes up volume, as it has a lower density than burnt cane (de Beer et al., 1989; Rozeff, 1995). This reduces profits, as more equipment is required over a given period and additional trash delivered to the mill may necessitate upgrading of the mill's processing facilities (Reid and Lionnet, 1989). Processing problems are aggravated further during rain because more soil clings to the trash, and is subsequently delivered to the mill.

In November 2002, a multi-disciplinary working group was set up at the South African Sugar Association Experiment Station (SASEX) to evaluate the costs and benefits between trashing and burning, and to compile an appropriate spreadsheet model. This paper presents the findings to date of this working group, and aims to (i) clarify the economic costs and benefits from harvest to crushing for both trashing and burning scenarios, and (ii) to identify areas that require further research. It is not the intention to list the many assumptions made in the model but rather to describe the process adopted. Although many of the assumptions still require verification, they are open to public scrutiny on request.

Overview of the spreadsheet model

The intention behind constructing the spreadsheet model was to create a management tool to help researchers, Extension Officers and growers alike to interrogate cane supply operations to facilitate a shift towards the most cost effective practice, knowing that trashing is not appropriate in all circumstances (especially at higher altitudes and on waterlogged soils). In essence the spreadsheet model is comprised of the 10 sheets summarised in Table 1.

Table 1. Description of the sheets in the spreadsheet model.

Sheet No.	Sheet name	Sheet objective
1	Start	Provides background to the spreadsheet model, an overview and instructions on how to use the model.
2	Input	Lists 79 variables that are likely to change frequently when comparing different operations.
3	Variable List	Lists all 429 variables that can be changed, most of which require specialist knowledge.
4	Agronomics	Quantifies the costs associated with yield decline, spreading tops and trash, herbicides and fertiliser application.
5	Delays	Given the harvesting and transport regime, the cane quality impacts of delays are calculated.
6	Losses	Given the impacts due to delays and the effectiveness of the trashing operation, the value of delivered cane is calculated.
7	Harvest	Labour productivity and the associated costs are used to calculate the total cost of the harvesting operation.

Table 1. continued

Sheet No.	Sheet name	Sheet objective
8	Transport	Given the impacts of delays and the transport regime used, the total cost of the transport operation is calculated.
9	Milling	The required milling capacity to crush the specified crop is determined and cost of additional milling capacity is calculated.
10	Summary	Provides the economic summary for both burn and trash scenarios and the difference in total Rands and Rands/hectare.

The first three sheets provide useful information to the user of the model, but do not warrant further explanation in this paper. Conversely, the assumptions related to yield made in the Agronomy sheet are key in determining whether trashing is more beneficial than burning. It is assumed that long term yield decline is greater in burnt cane than trashed cane, due to a faster reduction in soil health. Linear decline factors are applied to calculate expected yields over a 30-year period, which is consolidated on an economic basis by using 'net present value' with a discount rate of 5%. Furthermore, it is assumed that short term yield increases in trashed cane will be a function of (i) trash blanket thickness, (ii) total available moisture in the soil, (iii) the geographic region in which the cane is grown and (iv) general growing conditions affected by weather and management. These factors are incorporated into the model using relatively simple relationships and look-up tables. Although empirical evidence suggests that trashing should result in a higher cane yield per hectare in the longer term (van Antwerpen *et al.*, 2001), more research is required to qualify the benefits under varying circumstances. Table 2 provides an example of the agronomic costings for burnt cane; a similar exercise is done for trashed cane in the model.

Table 2. Agronomic sheet: costings for burnt cane.

Spreading Trash and Tops		**Man days/ha**	**Price/unit**	**Cost/ha**
Residue spread		2	21.5	43
Residue raked into piles and burnt		2	0	0
Total				43
Herbicides		**Rate/ha**	**Price/unit**	**Cost/ha**
Pre-emergence	Manual spraying	1.0	32.00	32.00
	Lasso - mix	4.5	30.00	135.00
	Diuron - mix	2.7	40.00	108.00
	Gramoxone - mix	1.5	30.00	45.00
	Total			320.00
Post-emergence	Manual spraying	1.0	32.00	32.00
	Gesapax	3.5	30.00	105.00
	MSMA	4.0	28.00	112.00
	Total			249.00
Manual	Hand hoeing - spot	2.0	32.00	64.00
Total				633.00
Fertiliser		**Rate/ha**	**Price/unit**	**Cost/ha**
Nitrogen		140	4.67	653.80
Phosphorous		20	10.76	215.20
Potassium		150	5.14	771.00
Manual application		3	32.00	96.00
Total				1736.00

The delays and losses sheets function in parallel. Average time delays for cane harvest and haulage operations help determine the effects of deterioration on cane quality using the model put forward by Loubser (2002), which takes temperature into account. The initial cane quality statistics are copied across from the losses sheet (i.e. before any delays are experienced). In the losses sheet the deterioration effects and estimates of the effectiveness of the trashing/burning process are combined to calculate the cane composition on delivery at the mill, and ultimately the average Recoverable Value (RV). Using the current RV price, an income per hectare is also generated. In most circumstances the delays associated with trashed cane are lower than burnt cane and less variable, which, coupled with expected yield increases, results in trashed cane having a higher income per hectare. Table 3 and 4 present outlines of what is contained in the delay and losses sheets respectively.

The main differences between burning and trashing in the harvesting process are (i) the additional cost of burning cane, and (ii) the reduced labour productivity associated with trashing cane. Inputs used in the harvesting sheet are broad and vary widely in practice. Interestingly, in a few areas, cane cutters prefer to trash cane where labour productivity (tons cut per day) is not significantly lower than burnt cane ([1]personal communication). An outline of the assumptions made in this sheet are presented in Table 5 for burnt cane. A similar exercise is done for trashed cane in the model.

Table 3. Delay sheet: time delays and deterioration effects for burnt cane.

Assumptions:

Mass Loss per day	0.8140%	=	0.03% per hour
Temperature	20	=	293 Kelvin
Total sucrose deterioration	1.0140%	=	0.02% per hour

Description	Delays (hours)	Tons Cane	MOISTURE Tons	MOISTURE %	SUCROSE Tons	SUCROSE %	NON- SUCROSE Tons	NON- SUCROSE %	FIBRE Tons	FIBRE %
Prior to harvest	0.0	59.8	41.6	69.63%	6.945	11.62%	1.2	1.95%	10.0	16.80%
At cutting	17.0	59.4	41.3	69.45%	6.915	11.64%	1.2	2.01%	10.0	16.90%
Infield load & transport	36.5	59.0	40.9	69.25%	6.882	11.66%	1.2	2.08%	10.0	17.01%
Tranship & haul	39.5	59.0	40.8	69.22%	6.877	11.66%	1.2	2.09%	10.0	17.02%
Payment	41.0	58.9	40.8	69.20%	6.874	11.67%	1.2	2.10%	10.0	17.03%

Table 4. Losses sheet: cane composition and average income per hectare for burnt cane.

Assumptions

RV Price	R 1,250
"d" factor	0.38974
"c" factor	0.01947

Description	Total	Tops	Leaves	Stalk	Residue	Transp	Loaded equivalent prior to harvest		Delivered for payment	
Transport		10%	10%							
Residue		90%	90%							
% fresh mass	100.00%	17.62%	6.95%	75.43%	22.11%	2.46%	77.89%			
Tons per ha	76.7	13.5	5.3	57.9	17.0	1.9	59.8			58.9
Sucrose	9.1%	0.2%	0.0%	12.00%	0.2%	0.0%	11.62%	6.9	11.67%	6.9
Non-sucrose	2.2%	3.8%	1.0%	2.00%	4.3%	0.5%	1.95%	1.2	2.10%	1.2
Fibre	20.3%	16.0%	89.0%	15.00%	94.5%	10.5%	14.86%	8.9	15.07%	8.9
Ash	1.6%	0.5%	0.5%	2.00%	0.9%	0.1%	1.94%	1.2	1.97%	1.2
Moisture	66.7%	79.5%	9.5%	69.0%	1.0%	89.0%	69.63%	41.6	69.20%	40.8
Total	100.0%	100.0%	100.0%	100.0%	100.9%	100.1%	100.0%	59.8	100.0%	58.9
RV	7.8%	-1.6%	-2.1%	10.9%	-3.3%	-0.4%	10.57%	6.3	10.55%	6.2
Rands/ha										7774

1 RR Fortmann, SASEX Regional Extension Officer, Zululand North, PO Box 180, Empangeni, 3880.

Table 5. Harvesting sheet: burning, cutting and labour costs for burnt cane.

Burning					**R/ton**
Number of beaters per ha		2 at	R 12.00	per ha	0.40
Number of indunas per ha		0.2 at	R 17.00	per ha	0.06
Tanker & Labour Transport		1 tractor hrs per day @	63.65	per hour	0.01
Sundries	1 litres petrol / ha		3.80	per litre	0.06
Total Burning Cost					0.53

Cutting

Percentage windrow	0%	Number of cutters per Induna	40
Percentage stack	90%		
Percentage bundle	10%		

Labour	**No**	**Wage R/day**	**Rations R/day**	**Windrow t/day**	**Stack t/day**	**Bundle t/day**	**R/ton**
Cutter	2052	30	5	8.01	4.20	6.56	8.03
Induna	52	45	5				0.29
Total							8.32

Labour Transport	0.66 tractor hrs per day @	63.65 per hour		0.01
Labour Tools	5 knives per cutter @	16.28	167032.8	
	4 files per cutter @	12.55	103010.4	
	2 smocks per cutter @	21.36	87661.44	
	Total		357704.6	0.21
Total Labour Cost				8.54

Payload is the critical factor in transport economics. Trashed cane invariably has a higher fibre content in terms of trash and tops, which means the average payload is reduced because of the lower density. The additional equipment required to deliver the same cane stick tonnage attracts a significant cost, which is quantified in the transport sheet. Here, relative density differences between trashed and burnt cane are assumed to be a function of fibre percentage at the different delay stages, as per the calculations in the delay sheet. Table 6 summarises the transport costs associated with the adoption of specific equipment for burnt cane. A similar exercise is done for trashed cane in the model. Updating variables and assumptions in each sheet, particularly the transport sheet, often requires specialist input.

Table 6. Transport sheet: assumptions and calculations for burnt cane.

DESCRIPTION		INFIELD LOADER	INFIELD TRACTOR	TRAILER	TRANSHIPMENT MOBILE CRANE		ROAD TRUCK	TRAILER
Operations (1 = Yes, 0 = No)		1	1		1		1	
Haulage Inputs:	Loadrate	22	22	22	30	30	30	30
	Payload			6			30	30
Haulage Calcs:	Cycle time		35	35			220	220
	Total Trips per day		1291	1291			258	258
	Trips Pos per Day.		28	28			5	5
	Vehicles Req	23	47	47	17	17	53	53
	Hrs/day/Veh.		16	16			18	18
	Work Cycle		31	31			200	200
	Hrs or km/Year	3307	3101	3101	3281	3281	63136	63136
Cost/Ton		R 3.59	R 6.10	R 0.79	R 1.08	R 2.22	R 18.03	R 3.13
Total cost/Ton		R 3.59		R 6.89		R 3.30		R 21.16

For most applications, the milling sheet will not be relevant because the analysis of one particular grower's operation is unlikely to effect milling performance. The milling sheet was nevertheless included, to investigate the potential impacts on milling performance if all growers in a mill area adopted trashing, and the economic consequences thereof. Three potential scenarios exist to accommodate the extra mass of cane trash: season length can be extended, milling capacity can be increased and/or a combination of the two. Given the assumptions made, the results indicate that the miller will benefit if the entire mill area adopts trashing, even after the installation of additional capacity. Table 7 presents the hypothetical calculation of additional capacity costs, assuming season length remains constant. This amounts to an approximate investment of R38.6 million, or R4.1 million if annualised over 10 years at a discount rate of 10%.

Table 7. Milling sheet: calculation of additional capacity for trashed cane.

Millers Income					
Millers Gross Income					163,178,633
Less annual investment in additional capacity					R 4,096,585
Millers Adjusted Gross Income					159,082,048

Detailed Description	**Fibre**	**Sucrose**	**Non-Suc.**	**Brix**	**Raw Sugar**
Existing Design tons / hr	53.5	41.5	7.5	48.9	35.7
Average Cane Quality	15.32%	11.35%	2.03%	13.38%	9.77%
Variation	1.53%	1.14%	0.20%	1.34%	0.98%
Upper limit	16.85%	12.49%	2.23%	14.71%	10.74%
Required tons / hr	61.2	45.3	8.1	53.4	39.0
Additional Capacity required	7.6	3.9	0.6	4.5	3.3
Cost per ton/hr	2,500,000	2,500,000	2,500,000	-	2,500,000
Additional Capacity Required	19,069,582	9,677,642	1,584,343	-	8,286,587

Table 8. Summary sheet: economic comparison between burning and trashing.

Summary Description	**Burn** Total (R)	**Burn** R per Ha	**Trash** Total (R)	**Trash** R per Ha	**Difference** Total (R)	**Difference** R per Ha
Grower Income	217,675,482	7,774	240,332,615	8,583	22,657,132	809.18
Agronomy	-67,536,000	-2,412	-51,455,600	-1,838	16,080,400	574.30
Harvesting	-17,448,893	-623	-37,602,254	-1,343	-20,153,361	-719.76
Infield loading	-6,014,036	-215	-6,829,174	-244	-815,138	-29.11
Infield Transport	-11,524,306	-412	-15,073,564	-538	-3,549,258	-126.76
Transhipment	-5,514,431	-197	-6,237,654	-223	-723,223	-25.83
Haulage	-35,405,331	-1,264	-40,178,188	-1,435	-4,772,857	-170.46
Season length costs		-	-	-	-	0.00
Growing Margin	**74,232,485**	**2,651**	**82,956,180**	**2,963**	**8,723,695**	**311.56**
Milling Income	149,309,296	5,332	163,178,633	5,828	13,869,337	495.33
Capacity costs	-	-	-4,096,585	-146	-4,096,585	-146.31
Season length costs		-	-	-	-	0.00
Milling Margin	**149,309,296**	**5,332**	**159,082,048**	**5,682**	**9,772,753**	**349.03**
Total Margin	**223,541,781**	**7,984**	**242,038,228**	**8,644**	**18,496,448**	**660.59**

Table 8 presents an economic summary of the comparison between burning and trashing. These figures should be interpreted with caution, because (i) many of the assumptions are generic in nature and are not applicable in all circumstances, and (ii) some of the assumptions used are estimates and still require further verification. Nevertheless, the results are within *a priori* expectations. Trashing is expected to have a yield benefit due to improved soil health and better retention of soil moisture. Agronomic costs should be lower because the trash blanket suppresses weeds and results in less herbicide applications. Higher harvesting costs are expected, mainly because of reduced labour productivity. Similarly, transport costs should be higher because of the lower density of trashed cane and the corresponding impact on payloads necessitating additional equipment. Although mill performance is expected to be compromised, the results indicate there is a significant net benefit to the miller through increased sugar production even after the installation of additional capacity. In total, trashing has an economic advantage over burning in the order of R18.5 million for the hypothetical mill area modelled. The grower's share amounts to an additional R312 per hectare.

Conclusion

Although the model needs to be developed further and many of the assumptions tested, the results to date support *a priori* expectations that trashing should be promoted under certain conditions in the South African sugar industry. The challenge ahead is how to best facilitate this change. Given the trying economic circumstances the industry finds itself in at present more growers might be prepared to consider moving away from burning in an attempt to improve their yields and economic margins. A renewed interest in renewable energy in South Africa might be the catalyst for the miller to upgrade their boilers for electricity production, in which case the miller might actively promote trashing and install the required capacity to handle the extra fibre loadings. The need for both millers and growers to become more efficient is increasing, but the rate of change depends on the size of the expected net benefit and the capacity of decision makers and managers to take on added responsibilities. Nevertheless, the rate of change should be facilitated through information dissemination by extension. It is also important that multidisciplinary teams continue to work together on complex issues to improve the information base on which sound economic decisions can be made. Further investigation and research is required in the following areas: (i) yield benefits of trashing under different circumstances, (ii) cane composition of different varieties, (iii) rates of cane deterioration, (iv) influence of density on transport costs, (v) labour productivity under different trashing regimes and (vi) the costs associated with de-bottlenecking sugar mills if trashing is widely adopted, (vii) the temperature effect in higher altitude areas, and (viii) the economics of trashed cane under irrigation.

Acknowledgements

Numerous individuals, in addition to the authors, were involved in detailing the technical parameters used to compile the spreadsheet model described in this paper, notably L Fenwick, N Lecler, G Leslie, E Meyer, J Meyer, D Nixon, K Redshaw, M Smit, R Stranack and J Wiseman.

REFERENCES

de Beer AG, Boast MMW and Worlock B (1989). The agricultural consequences of harvesting sugarcane containing various amounts of tops and trash. *Proc S Afr Sug Technol Ass* 63: 107-110.

de Beer AG, Hudson C, Meyer E and Seigmund B (1995). Green cane harvesting and trash management. *Proc int Soc Sug Cane Technol* 22: 133-141.

Denmead OT, Mayocchi CL and Dunin FX (1997). Does green cane harvesting conserve soil water? *Proc Aust Soc Sug Technol* 19: 139-146.

Gosnell JM (1970). Optimum irrigation levels for cane under burnt and trashed conditions. *Proc S Afr Sug Technol Ass* 44: 121-130.

Graham MH, Haynes RJ and Meyer JH (1999). Green cane harvesting promotes accumulation of soil organic matter and an improvement in soil health. *Proc S Afr Sug Technol Ass* 73: 53-57.

Jadhav SB (1995). Effect of incorporation of sugarcane trash on cane productivity and soil fertility. *Proc int Soc Sug Cane Technol* 22: 104-109.

Lorenzi HJ, Gandini MO and Gazon AL (1989). Trash blankets: the potential to control weeds and the effect on ratoon cane development. *Proc int Soc Sug Cane Technol* 20: 571-575.

Loubser RC (2002). Model for estimating effects of harvesting practices on factory output. *Proc S Afr Sug Technol Ass* 76: 42-50.

McIntyre G, Seeruttun S and Barbe C (1995). Trash management in mauritian sugarcane plantations. *Proc int Soc Sug Cane Technol* 22: 213-216.

Murombo M, Takavarasha E and Wiseman J (1997). Green cane harvesting at Mkwasine Estate, Zimbabwe. *Proc S Afr Sug Technol Ass* 71: 30-32.

Reid MJ and Lionnet GRE (1989). The effect of tops and trash on cane milling based on trials at Maidstone. *Proc S Afr Sug Technol Ass* 63: 3-6.

Richard C (2002). Cane planter: Cane burning. *Int Sug J* 102(12): 6, 20.

Rozeff N (1995). Harvest comparisons of green and burned sugarcane in Texas. *Int Sug J* 95(11): 501-506.

van Antwerpen R, Meyer JH and Turner PET (2001). The effects of cane trash on yield and nutrition from the long-term field trial at Mount Edgecombe. *Proc S Afr Sug Technol Ass* 75: 235-241.

Wood AW (1991). Management of crop residues following green harvesting of sugarcane in North Queensland. *Soil Till Res* 20: 69-85.

Wood RA, du Toit JL and Bruijn J (1972). Deterioration in whole stalk sugarcane. *Proc S Afr Sug Technol Ass* 46: 151-157.