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SHORT COMMUNICATION

QUANTIFYING THE CONTRIBUTION OF RESIDUE RETENTION AND FERTILISER USE TO THE FINANCIAL VIABILITY OF A RAINFED SUGARCANE CROP

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Abstract

Growers are currently in a tough financial situation, which is made worse by the very high cost of fertiliser and diesel. This has led to investigations into the impact of reducing the input costs associated with fertiliser application. The data for this paper were taken from the long-term burning and mulching field experiment (BT1), SASRI's rainfall records and SASRI's Mechanisation Reports (No. 1 and 2, 2023). The treatments of BT1 are: a) burned with tops removed (Bto); b) burned with tops scattered (Bt); and c) not burned with the retention of all residues as a mulch (M). These treatments were either fertilised (F) or unfertilised (Fo). Data covering the last three crop cycles, from 1995 to 2022, were used for this paper. The varieties used in this period were N16, N27 and N41, and the crops were harvested annually in September. The baseline treatment for this paper was BtF (a management practice followed by the majority of sugarcane growers). The monetary value of the unfertilised and mulched treatment (MFo) was occasionally higher than that of the baseline treatment, where the rainfall was low, which indicates the importance and value of residue retention as a best-management practice in years of drought. The main outcome of this work was that crops from the rainfed regions must be fertilised at all times to obtain the best income.

Keywords: BT1, economics, residue, mulching, fertiliser, nutrient recycling

Introduction

The input costs to produce crops have escalated dramatically in recent times, both globally and in South Africa. High fertiliser prices contribute to a significant portion of this increase, which typically contribute to about 15% of the overall sugarcane farming input costs. Fertiliser prices have escalated by between 30 and 70% in the 2021/2022 season and by about the same margins over the last five years, since the price was relatively stable before 2021. This has raised the question of how significant the contribution of fertiliser is for sugarcane production? Are recycled nutrients and the potential water saving from mulching sufficient to produce an economical crop, in the absence of fertiliser? The mean nitrogen (N), phosphorus (P) and potassium (K) content of several varieties is 53 kg, 8 kg and 132 kg per 10 tons of mulch, respectively (van Antwerpen *et al*., 2001). The amount of residue at harvest is about 20% of the stalk yield delivered and the distribution between brown and green leaves is approximately 50% each (Donaldson *et al*., 2008). The water-saving potential of a mulch is about 90 mm/year rainfall at Mount Edgecombe (Thompson, 1965) and between 15 to 25% of irrigated water in the Komatipoort region (Olivier and Singles, 2015). The objective of this paper was to determine if a no-fertiliser application strategy can be justified where sugarcane residue is retained after harvest, due to the high cost of fertiliser.

Methods and Materials

The data for this paper were taken from SASRI's rainfed long-term burning and mulching field experiment (BT1), from rainfall records, SASRI Mechanisation Reports (No. 1 and 2, 2023), and the 'c' and 'd' factors used in the Recoverable Value (RV) formula. The BT1 treatments were: a) burned (cool burns early in the morning), with tops removed (Bto); b) burned, with tops scattered (Bt); and c) not burned, with the retention of all residues as a mulch (M). These treatments were either fertilised (F) or unfertilised (Fo). Although the BT1 trial was started in 1939 and replanted seven times with newer varieties, only data from the last 26 years (1995 till 2022) were used because the first release of the 'c' and 'd' factors required in the calculation of the RV value was in 1995 (Wynne *et al*., 2009). The RV % cane values were converted to RV t/ha by multiplying it with the stalk yield (t/ha). The March 2023 RV price of R6521.14/RV ton was used to convert the RV t/ha to RV R/ha. From this, the cost of NPK fertiliser (R7249/ha based on 140, 30 and 140 kg/ha NPK, respectively, and valued at 16.89, 44.93 and 25.26 R/kg, respectively) (Prince, 2023) and its application cost (R454/ha; SASRI Mechanisation Report No. 2, 2023) was subtracted from the treatments receiving fertiliser (BtoF, BtF and MF). Assuming a 15 000-ton crop to be transported 15 km to the mill using an 8-ton truck, the following costs were taken into account. The sum of infield loading (R20.11/t), haulage to the loading zone (R22.32/t), transloading (R25.65/t) and haulage to the mill (R48.41/t) was subtracted from all the treatments (SASRI Mechanisation Report no. 1, Examples 3 and 4, 2023). The effect of rainfall on production was also considered and was split into two crop stages: before and after the canopy closure. Although short in duration (approximately 150 days from October to February) the largest percentage of rain per crop is received during this period (Table 1) and the crop response differences due to rainfall are mainly associated with the amount received before the canopy closure (van Antwerpen *et al*., 2006). A scenario where the field is burnt in preparation for harvesting, but the residue after harvest is retained and spread, was used as the norm (BtF). All management options (fertilised versus unfertilised and burning versus not burning) from the BT1 trial were compared against this norm. Other factors impacting the production costs, such as labour, chemicals and weeding, were assumed to have a negligible impact on the results between the treatments (i.e. fertilised versus unfertilised).

Results

The BT1 treatment that was burnt with tops retained and the crop fertilised (BtF) represents the practice followed by most growers, and it was used as the baseline in all the comparisons. It had the best RV income 13 times out of the 26 years of data used for this paper, and the results were consistent, irrespective of the variety (Table 1). However, the mean RV income was very similar to that of the mulched with applied fertiliser (MF) treatment. The MF treatment recorded the highest income only six times, and it had the second-highest mean RV income by a small margin of -R53/ha, compared to the BtF treatment. This result confirms that, when residue amounts are considered in moderation, it is not the amount of residue that is important, but that the available residue is retained as a mulch.

The highest RV income from the burning treatment with all residues removed and fertilised (BtoF) occurred four times. The highest income for BtoF was obtained from every plant crop (Table 1). The reason is not clear, but all treatments had a bare surface for the duration of the plant crop and the rainfall was below the long-term annual mean (LTM) of 950 mm/ann on every occasion. The other two occasions during which the BtoF treatment recorded the highest income was for the ratoon crops, where the rainfall was higher than the LTM.

The highest RV income from the unfertilised mulched treatment (MFo) occurred three times during the N27 crop cycle over the period from 2003 to 2010, when the annual rainfall was below 950 mm/ann. This implied that the effect of a shortage of water on the crop yield was greater than the shortage of nutrients (MFo compared to all other treatments in 2005, 2006 and 2010) and it underlined the important contribution of residue for sustaining the yields, in the absence of fertiliser. It also illustrated the importance and value of residue retention as a best-management practice, particularly during drought years.

For treatments receiving fertiliser, the RV income that was lost by not retaining residue after a cool burn was R4845/ha (BtoF, compared to the BtF treatment). The RV income lost by MF was only R53/ha, when compared to BtF. The mean RV income lost, when the BtF treatment was compared to treatments not receiving fertiliser, were much larger at R24475 (MFo), R27776 (BtFo) and R39276/ha (BtoFo). From this, it is evident that within treatments receiving no fertiliser (Fo), the RV losses increased as the residue retention amounts decreased (MFo < BtFo < BtoFo).

By burning and comparing the residues removed to the residues retained in the absence of fertiliser (BtoFo, compared to the BtFo treatment), the loss in RV income for BtoFo was R11500/ha. Comparing the same treatments, but where fertiliser was applied (BtoF, compared to the BtF treatment), the relative RV gain was R4845/ha in favour of residue retention. Thus, the gain where fertiliser was applied was much less, compared to where no fertiliser was applied, which illustrates the value of residue retention in the absence of fertiliser. However, comparing the mean of all the fertilised treatments against the mean of all the unfertilised treatments showed a mean gain of R28877/ha in favour of those that were fertilised (calculated from data given in Table 1). These results show that nutrients recycled from the retained residue do have value, but it is not sufficient to justify a no-fertiliser application policy.

In order to obtain an RV income performance index, the F/Fo ratio was calculated for the Bto, Bt and M treatments, followed by averaging across all ratios per variety (calculated from Table 1). The mean index per crop cycle (per variety) was regressed against the mean annual rainfall per cycle and it yielded a positive relationship, with a coefficient of determination (r^2) of 0.999, thus showing that the RV income was also strongly related to rainfall.

Taking only the fertilised associated costs into account, the mean income of the unfertilised treatments (no fertiliser associated costs) was at R33324/ha, less than 50%, compared to R67122/ha for the fertilised treatments after subtracting the fertiliser-associated costs. The fertiliser costs reduced the RV income by 10%. The impact of loading and transport (in the absence of fertiliser-associated costs) on the RV income was 11.8% (Std Dev 0.098%) averaged across all treatments, but with only a 0.03% difference between the means of the fertilised and unfertilised treatments. This strengthens the assumption that the impact of production factors, such as labour, chemicals and weeding, is negligible when the fertilised and unfertilised treatments are compared.

Table 1. Partial Gross margin above the allocated costs (R/ha) of each BT1 treatment since 1995 and rainfall (mm) received before and after canopy closure. The highest values obtained per crop are in bold

Year	Ratoon	BtoFo	BtFo	MFo	BtoF	BtF	MF	Rainfall mm		
								Total	Before canopy	After canopy
1995	N16 2	26717	34650	38618	39784	47586	**57652**	968	422	**546**
1996	3	24647	31876	32831	65653	**67177**	54928	1302	**745**	557
1997	4	25694	36740	39474	69659	**78903**	77747	907	414	**493**
1998	5	20020	27032	33881	57011	57995	**69639**	960	**556**	404
1999	6	17888	27630	34104	44861	52029	**63574**	794	**534**	259
2000	7	20472	32746	30388	**84943**	83454	80887	1443	**1192**	251
2001	8	15207	27395	21481	41971	**53008**	52956	761	**527**	235
2003	N27 0	23537	27929	29446	**41881**	41345	34979	596	**351**	246
2004	1	33634	53745	54595	63924	**66858**	64939	861	**520**	342
2005	2	30168	37953	**48446**	28465	28411	40667	561	**370**	191
2006	3	23763	28641	**44998**	39929	41656	40363	864	**454**	410
2007	4	23499	33701	44218	**58260**	53768	55704	1096	547	**550**
2008	5	20206	28148	37950	57702	**63770**	54138	846	**650**	196
2009	6	18881	28077	35182	32697	**44827**	44211	725	**488**	237
2010	7	15841	27095	**33003**	17913	30921	30921	721	**571**	150
2011	8	16512	25784	27473	32273	**39856**	35298	1145	**577**	569
2012	9	16401	29127	30205	38681	43853	**44086**	1242	550	**692**
2013	10	14294	26965	31077	50334	**58631**	56545	1155	**733**	422
2015	N41 0	18964	31899	27142	**62454**	62138	55186	846	**522**	324
2016	1	19242	36064	33995	47035	**57026**	53304	1050	428	**622**
2017	2	23164	43172	44261	74815	**77357**	74071	940	438	**502**
2018	3	16842	29452	31845	71301	**77459**	71748	1037	**672**	365
2019	4	16599	30753	33156	68606	72040	**82602**	1073	389	**684**
2020	5	12945	24114	28296	62794	59297	**66578**	996	**574**	422
2021	6	27573	46174	44054	106923	**121737**	118090	1422	**788**	634
2022	7	13800	28644	31212	71850	**76588**	75503	1691	601	**1089**
Mean	N16	21521	31153	32968	57697	62879	65340	1019	627	392
Mean	N27	21522	31560	37872	42005	46718	45623	892	528	364
Mean	N41	18641	33784	34245	70722	75455	74635	1132	552	580
Mean (all data)		20635	32135	35436	55066	59911	59858	B = Burn		
Compared to BtF		-39276	-27776	-24475	-4845		-53	to = No Tops		
Compared to MFo		-14801	-3301					t = With Tops		
Compared to BtFo		-11500						M = Mulched Fo = No Fertiliser		

Conclusions

The monetary benefits of a mulch, in the absence of fertiliser, are not sufficient to justify a no-fertiliser application policy under rainfed conditions. Therefore, withholding fertiliser is not recommended.

When fertilised, the monetary benefit of a cool burn with the retention of the unburnt residue is significant, compared to a scorched-earth policy, and it is as good as green-cane harvesting, with all the residues retained. The latter is the recommended practice for coastal rainfed regions, with the exception of wet valley bottoms and soils with a high water table.

Although evidence was found to suggest that the RV profitability increases with the amount of the residue retained, what is more important is that the available residue is retained as a mulch in coastal regions.

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