REFEREED PAPER

A FINANCIAL ESTIMATION OF THE MILL AREA-SCALE BENEFITS OF VARIETY ADOPTION IN SOUTH AFRICA: A SIMPLISTIC APPROACH

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Abstract

The South African Sugarcane Research Institute has a well-established commercial variety breeding programme that is funded by the industry. Studies estimating the value delivered by varieties on commercial fields and at the mill-scale are limited. Therefore, SASRI initiated a study in conjunction with the South African Cane Growers' Association, and in collaboration with two milling companies, to estimate the potential increased industry proceeds of adopting new varieties on a farm (per hectare) and mill area-scale level (total RV tons harvested). While there are alternative methods to estimate the financial benefit, in this study, the analyses were compiled from two datasets: the Illovo Sugar (SA) Sezela estate and RCL Nkomazi production area. The results were extrapolated to the Sezela and Mpumalanga mill areas, respectively. Field production data from a five-year period (2010/11 to 2014/15) were used. For each production year, the average annualised RV yields (t/ha/annum) of a set of 'new' varieties were compared with an established 'current' older variety. The estimated financial benefits of adopting the 'new' varieties, with equal proportion, were then quantified based on the industry net divisible proceeds (2014/15 base year values). The estimated potential increased revenue was quantified after considering the SASRI variety development levy costs per annum. It was found that 'new' varieties produced higher RV yields than 'current' varieties on average for both the irrigated and dryland mill areas. The study confirmed that the adoption of newer varieties has the potential to significantly benefit the industry. A similar analysis can be conducted in other milling areas to estimate the financial benefit of new variety adoption and provide assurance to industry stakeholders of the value of continuing variety development. In addition, this analysis provides a method for a study that can focus on the payback period and return on investment for the variety breeding programme.

Keywords: sugarcane, variety adoption, variety development, recoverable value, economics, South Africa

Introduction

The South African Sugarcane Research Institute (SASRI) has a well-established sugarcane breeding and selection programme. Varieties suitable for commercial production are selected for specific agroclimatic regions in South Africa (coastal, midlands, and irrigated north). Since 2000, after the establishment of new selection programs on newly acquired research farms (Nuss, 1998), 30 commercial varieties have been released by SASRI. All new variety releases are based on superior recoverable value (RV) yields, with acceptable levels of pest and disease resistance, compared with currently available varieties. This superior performance is usually measured in structured variety trials at pre- and post-release levels. While superior performance in structured trials are confirmed through appropriate statistical analyses and

repetition of trials over many environments, actual commercial superiority of newer varieties is often more difficult to assess.

The improved yielding ability of new SASRI varieties has been widely demonstrated through experimental work (Ramburan, 2015a; Ramburan 2015b; Zhou, 2014; Zhou 2016). However, industry stakeholders have questioned whether these improved yields are also achievable under commercial conditions. Some stakeholders believed that newer varieties under commercial conditions were not achieving the expected gains demonstrated experimentally. In some cases, this perception was a barrier to variety adoption, with some regions being characterised by very stagnant variety proportion trends (Ramburan, 2013). In addition, a large portion of SASRI's annual budget is attributed to the breeding and selection programme and it is important to determine and demonstrate the value, in terms of additional income, that SASRI varieties deliver to the industry.

Given these considerations, SASRI initiated this study in conjunction with the South African Cane Growers' Association (SACGA) and two milling companies, Illovo Sugar (SA) and RCL, to estimate the yield benefits associated with production of new varieties in some of their areas. The objective of this study was to estimate the financial benefit, based on increased industry proceeds, of adopting newer varieties, released by SASRI, at a farm level and extrapolated to a mill area-scale level.

Materials and Methods

It is noted that there are alternative methods to determine the financial and economic benefit of variety adoption, such as a return on investment study and payback period calculation. However, this study focused on a simplistic approach that focused on the increased proceeds versus the cost to industry stakeholders, on an annual basis. Therefore, the annual SASRI levy portion attributed to variety development was considered, rather than an individual variety cost through the developmental phase.

Approach

Production datasets from the Illovo Sugar (SA) Sezela estate and the RCL Nkomazi production area, consisting of individual field data from a five-year period (2010/11 to 2014/15), were used in the analysis. The area planted to each variety was expressed as a percentage of total area, of each production area, for each of the five years, to examine changes in variety proportions. These trends allowed for the identification of appropriate 'current' and 'new' varieties that could be compared with each other. For example, a newer variety could only be compared with an existing variety if there were sufficient fields planted to the 'new' variety (i.e. an acceptable sample size). One established and widely grown 'current' variety was used in each dataset. Variety N12 was identified as the 'current' variety for the Illovo Sugar (SA) Sezela estate, and N39, N41 and N47 were regarded as the "new" varieties. Variety N41 and N47 were only harvested from the 2012/13 and 2013/14 season, respectively. Variety N14 was identified as the 'current' variety for RCL Nkomazi production area, and N25, N36, N40 and N41 were regarded as the 'new' varieties.

For each production year, the average RV yields (expressed as tons RV/ha/annum) of the 'current' versus 'new' varieties were calculated and compared with each other separately for each production area. These RV yields were independent of field and management characteristics such as soil type, time of harvest, or ratoon age. This simplistic approach was selected to account for variations in relative performance of varieties when compared under different production scenarios. For example, variety A may outperform variety B on a sandy soil in a drought affected year; however, the opposite may be true in a normal year or on a different soil type. Each scenario tested would produce a different result, which would then

have to be averaged out. Therefore, for the purpose of this study, a broad calculation of average performance across production conditions was considered more appropriate.

In addition, as per SASRI best management practice, a minimum of three different varieties should be cultivated on a farm, and it is recommended that no more than 33% of the area under cane be comprised of any one variety. Therefore, equal proportions of "new" varieties grown in the mill-scale production areas were assumed. For verification, the differences in actual RV yields between the 'new' and 'current' varieties were compared to the results gained from experimental trials.

Tables 1 and 2 provide a summary of the data utilised in this study, per variety. There is variation in terms of RV yields, which can be expected on commercial fields. The average variation can be reduced by increasing the sample size. However, this was not considered in this analysis. The tables also display the large number of fields planted with 'current' varieties compared to 'new' varieties, which increases the variation of results.

Table 1. Summary of variety data used in this analysis from the Sezela Illovo (SA) Estate, 2010/11 to 2014/15 milling season.

Variety	No. of fields	Avg. ratoon age	Max RV t/ha	Min RV t/ha
		2010/11		
N12	36	4.72	26.1	0.3
N39	7	2.86	8.0	0.5
		2011/12		
N12	21	4.29	7.2	3.0
N39	6	3.17	5.6	2.7
		2012/13		
N12	28	3.18	8.2	3.3
N39	5	4.00	7.8	5.3
N47	2	3.50	8.8	8.4
		2013/14		
N12	26	5.23	35.0	1.2
N39	20	3.40	10.5	0.0
N41	3	1.67	15.2	7.1
N47	9	1.89	10.6	3.3
		2014/15		
N12	15	4.40	7.5	3.0
N39	21	3.90	8.7	3.6
N41	8	1.25	10.2	2.5
N47	11	2.55	8.6	3.0

Table 2. Summary of variety data used in this analysis from the RCL Nkomazi production area, 2010/11 to 2014/15 milling season.

Variety	No. of fields	Avg. ratoon age	Max RV t/ha	Min RV t/ha
		2010/11		
N14	124	8.00	26.09	1.49
N25	191	6.13	19.69	4.16
N36	73	2.18	21.73	5.06
N40	2	1.00	15.91	14.30
N41	2	0.50	17.40	10.52
		2011/12		
N14	142	7.92	19.93	4.76
N25	160	7.18	28.00	4.25
N36	98	2.32	22.45	5.25
N40	4	1.00	16.15	13.67
N41	3	1.00	17.31	14.10
		2012/13		
N14	122	8.20	20.17	4.82
N25	114	8.01	17.69	6.84
N36	111	2.54	24.34	6.78
N40	3	2.33	16.57	13.46
N41	6	1.00	18.22	8.52
		2013/14		
N14	123	8.25	19.62	6.75
N25	110	9.08	20.27	7.53
N36	171	2.45	25.24	6.68
N40	3	3.33	16.34	13.65
N41	10	1.30	16.73	10.02
		2014/15		
N14	110	8.51	17.98	6.52
N25	91	9.91	28.01	3.97
N36	178	3.26	22.80	6.08
N40	5	2.20	17.03	12.90
N41	12	1.83	21.19	7.68

The differences in actual RV yields were used to quantify the change in industry revenue of the ‘new’ variety adoption. This was estimated using the industry net divisible proceeds RV Price, as well as harvest-to-mill costs for the 2014/15 season, as the base year. The harvest-to-mill cane costs included the harvesting operation (cut and stack assumed), loading, transhipment, reloading into hilo for haulage to mill and the transport to mill. It was necessary to include the harvest-to-mill costs, because these cost increase when harvesting additional cane (in cane tons) and the net of this calculation is important to determine the overall financial benefit. It was assumed that milling costs remained the same for the ‘current’ and ‘new’ varieties.

Area harvested per annum were assumed to remain fixed/unchanged at the mill-scale level, with the 5-year average area recorded as 24 083 ha and 41 089 ha for the Sezela and Mpumalanga milling areas, respectively (SACGA, 2016). In this simplistic approach, the total revenue change of new variety adoption, per milling area, was calculated by extrapolating the RV yields for a combination of the 'new' varieties, to the average area under cane. The average benefit was then converted to a per ha and per RV ton, accounting for the SASRI variety development costs. Therefore, the financial benefit at the mill-area scale was estimated by the average increased proceeds of the 'new' versus 'current' variety, and subtracting the annual SASRI variety development cost.

Assumptions

To carry out the analysis the following assumptions had to be applied:

- The impacts of climatic conditions, soil types and water availability are beyond the scope of this study.
- No difference in planting and ratoon costs across varieties.
- No difference in irrigation costs across varieties.
- No differential varietal ratoon decline.
- 2014/15 season used as base year for costs and net divisible proceeds (R5369.67/ RV ton combined total miller and grower RV Price).
- 2014/15 portion of SASRI levy, accounted for in Industry Costs, used for variety development was used as the annual cost to industry stakeholders in this study (R36.90 per ton saleable sugar).
- Cut and stack harvest operation assumed for all farms, with total extraction cost (harvesting, loading, infield haulage and transhipment into hilo) being R75/ cane ton (2014/15 season value).
- Haulage cost to mill being R65/cane ton (2014/15 season value).
- Harvest-to-mill costs = extraction plus haulage cost to mill.
- Milling costs remained the same for the 'current' and 'new' varieties.
- Farm management factor remains the same across farms.
- Data received was assumed correct with regards to field variety proportion.
- The area under cane and harvest area for the Sezela and Mpumalanga milling areas are assumed to remain the same for the five-year period.

These assumptions provide the framework within which the following analysis could take place.

Results and Discussion

RV yield comparisons

Figure 1 shows the annualised RV yield benefits of varieties N39, N41, and N47 relative to N12 from experimental trials conducted in the coastal regions of the industry. Figure 2 shows the annualised RV yield benefits of varieties N25, N36, N40 and N41 relative to N14 from experimental trials conducted in the irrigated region. In both regions, the relative benefits of these 'new' varieties compared to the 'current' (N12 and N14) varieties determined experimentally were used to verify the results of the commercial production datasets.

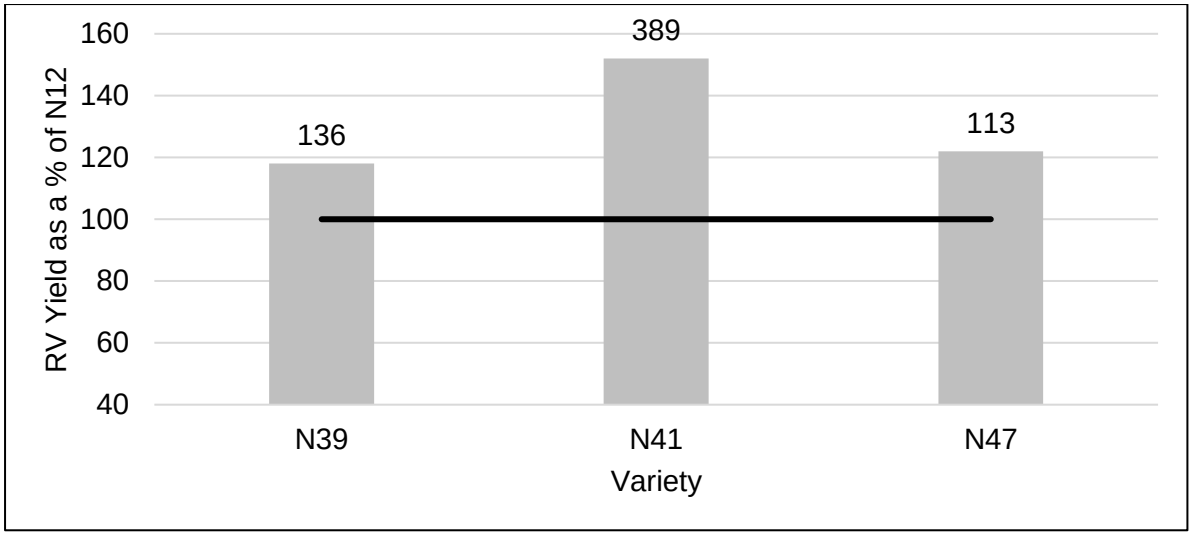

Figure 1. Annualised RV yield benefit of N39, N41 and N47 (expressed as a percentage of N12) from variety trials conducted in the coastal region of the industry. The number of crops used to calculate averages per variety are indicated as data labels. The solid black line represents N12.

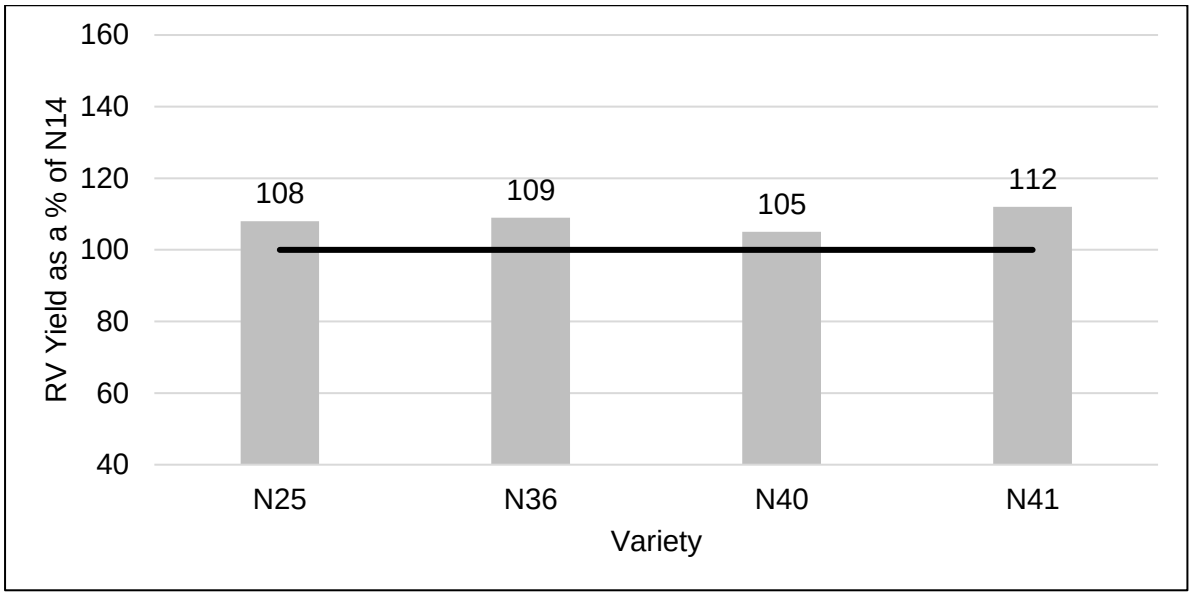

Figure 2. Annualised RV yield benefit of N25, N36, N40 and N41 (expressed as a percentage of N14) from variety trials conducted in the irrigated region of the industry. The number of crops used to calculate averages per variety are indicated as data labels. The solid black line represents N14.

Figures 3 and 4 show the average annualised RV yields of selected varieties from the Sezela and RCL Nkomazi production area, respectively, which are well aligned with the above-mentioned experiment trends in Figures 1 and 2.

At the Illovo Sugar (SA) Sezela estate (Figure 3), RV yields of the 'new' varieties (N39, N41 and N47) were generally higher than the 'current' variety (N12). In two (2011 and 2013) of the five years considered, N39 produced lower RV yields than N12. The magnitude of yield improvement due to new varieties varied with season. For example, the yield improvement due to adoption of N41 varied from approximately 3.6 tons RV/ha/annum in 2013 to just 0.8 tons RV/ha/annum in 2014. This variation may be attributed to seasonal differences in climate

and management practices, and therefore supports the approach of using an average over seasons to estimate overall value.

At the RCL Nkomazi production area (Figure 4), the 'current variety (N14) was outperformed by N36 across all years, while the relative performance of N25 fluctuated with seasons. Variety N40 performed consistently well across the five years in which it was harvested, while the average performance of N41 was superior to N14.

The yield difference observed between N25 and N14 can be explained by the relatively lower cane yields obtained on lower potential soils compared to those obtained on the medium to higher potential soils. Variety N25 was more commonly planted on the lower potential and sandy soils while N14 was only planted on the medium to higher potential soils. When these varieties are planted on the same soil type, N25 typically outperforms N14 (personal communication[1]).

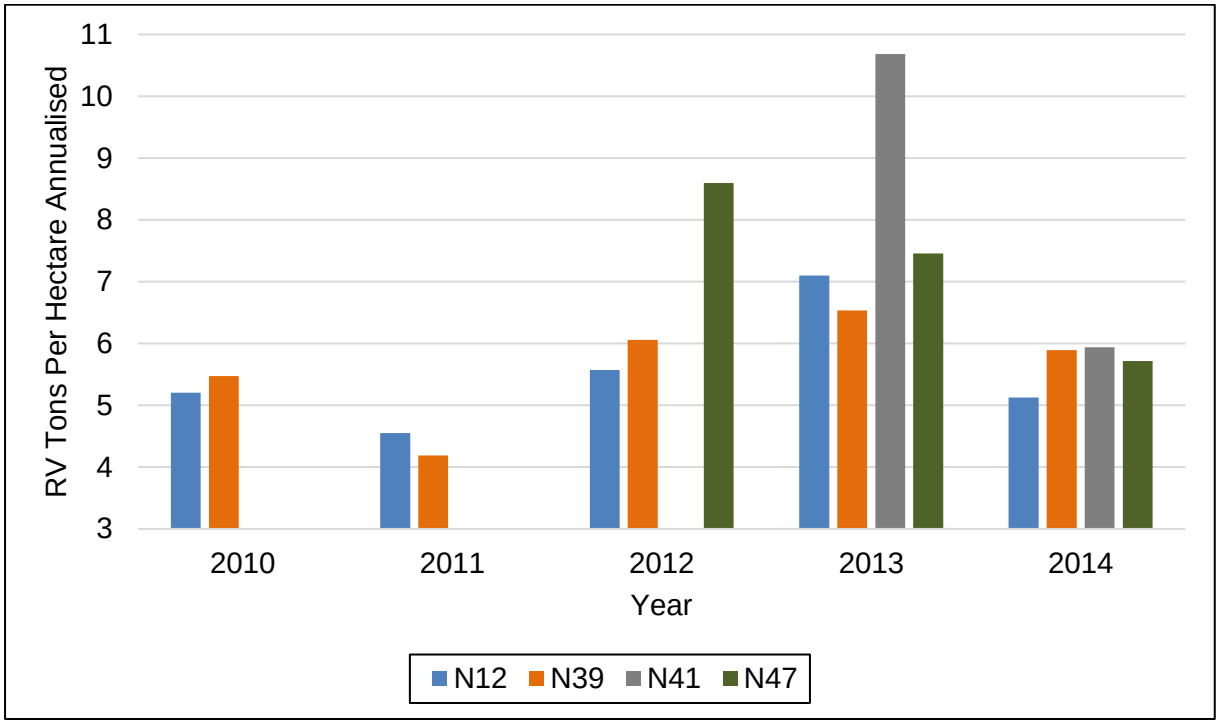

Figure 3. The average RV Tons per variety per hectare annualised for the Sezela Illovo Sugar (SA) Estate, 2010/11 to 2014/15 milling seasons.

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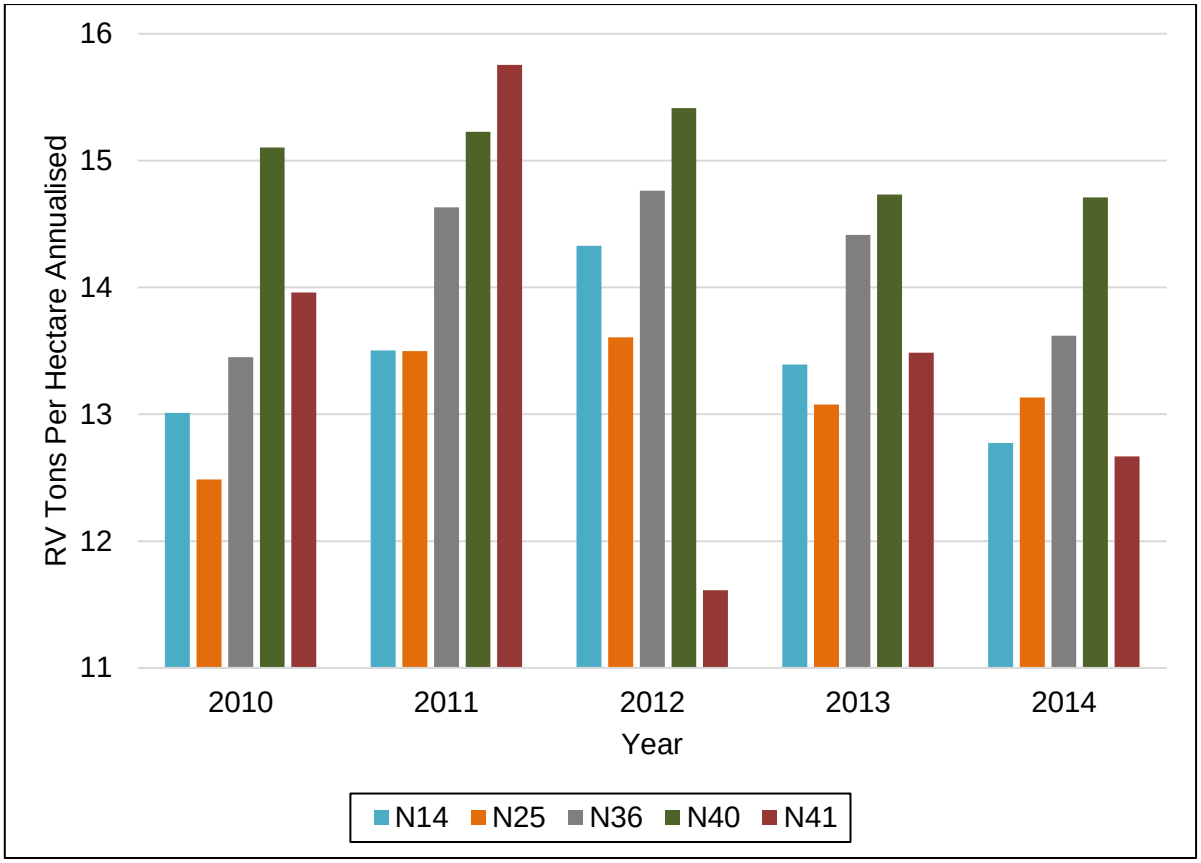

Figure 4. The average RV Tons per variety per hectare annualised for the RCL Nkomazi production area, 2010/11 to 2014/15 milling seasons

Financial benefit analysis

The next step in the analysis was to assign value to the RV tons produced by the 'new' varieties compared to the 'current' varieties. Figures 5 and 6 below present the five-year average benefit of adopting the 'new' varieties, for the Sezela estate and RCL Nkomazi production areas, respectively, after considering changes in harvest-to-mill costs. In general, as reported in Figures 1 and 2, there is benefit in the adoption of the 'new' varieties over the 'current' varieties.

The 5-year average results illustrated in Figures 5 and 6 were then extrapolated to the Sezela and Mpumalanga milling areas, respectively, based on the average area harvested per mill area. Tables 3 and 4 display the average Sezela and Mpumalanga mill-scale area extrapolated results, respectively. The overall benefit to the industry is significant for both the Sezela and Mpumalanga milling areas, even after considering the annual portion of the SASRI levy, for variety development, paid by industry stakeholders. The potential benefits are shared according to the industry division of proceeds between growers and millers.

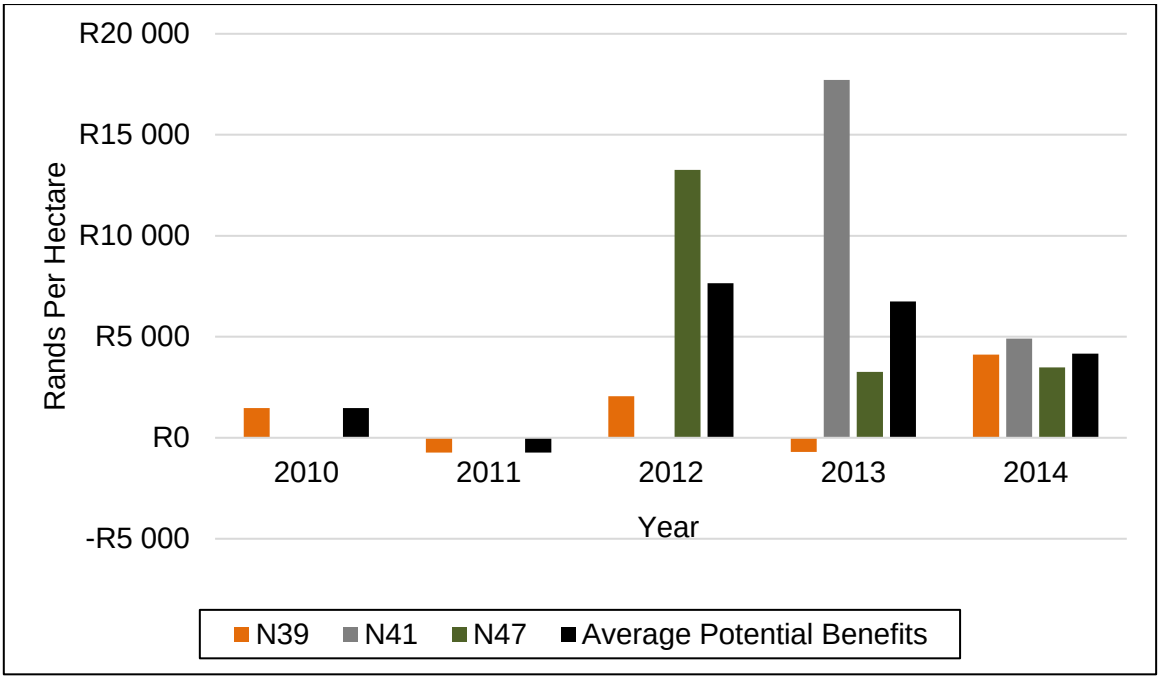

Figure 5. The benefit in Rands per hectare of adopting 'new' varieties over N12, taking additional harvest-to-mill costs into account, Sezela Illovo Sugar (SA) Estate, 2010/11 to 2014/15 milling seasons.

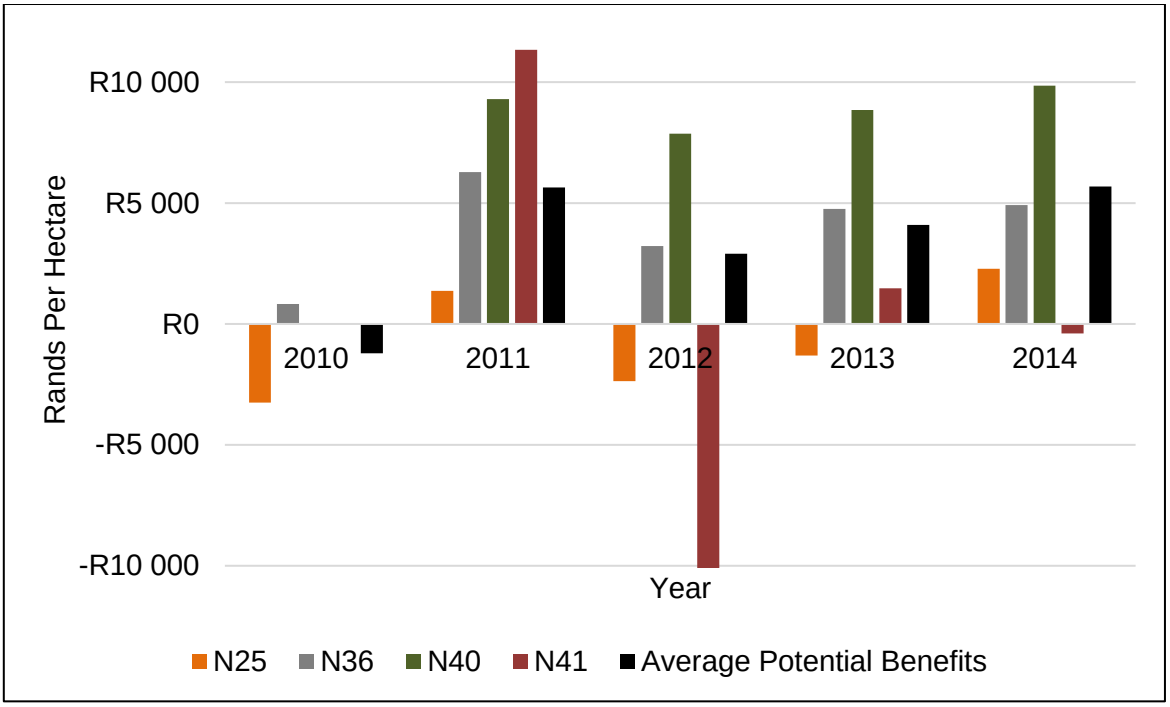

Figure 6. The benefit in Rands per hectare of adopting 'new' varieties over N14, taking additional harvest-to-mill costs into account, RCL Nkomazi production area, 2010/11 to 2014/15 milling seasons.

Table 3. Sezela Mill area average grower and miller gains by adopting the 'new' varieties (N39, N41, N47) over the 'current' variety (N12), 2010/11 to 2014/15 milling seasons.

Total mill area benefit of N39 over N12	R3 839 507
Total mill area benefit of N41 over N12	R90 538 756
Total mill area benefit of N47 over N12	R56 467 698
Combined benefit of 'new' varieties over 'current' variety	R150 845 961
SASRI variety development levy	-R7 572 389
Benefit after paying for SASRI development levy	R143 273 572
Benefit per ha harvested per annum for planting 'new' varieties	R5 949
Benefit per RV ton/ annum for planting 'new' varieties	R844
Benefit per cane ton/ annum for planting 'new' varieties	R102

The Mpumalanga benefit would be significantly higher if N25 was removed from the analysis. The lower benefit in Mpumalanga benefit compared to Sezela can be due to RV yields differences generally being lower in irrigated versus dryland conditions, as previously depicted in Figures 1 and 2. Due to the vast difference in agronomic and climatic conditions, it is not advisable to compare the benefits of dryland and irrigated areas.

Table 4. Mpumalanga area combined average grower and miller gains achieved by adopting the 'new' varieties (N25, N36, N40, N41) over the 'current' variety (N14), 2010/11 to 2014/15 milling seasons.

Total mill area benefit of N25 over N14	-R10 699 091
Total mill area benefit of N36 over N14	R34 107 652
Total mill area benefit of N40 over N14	R72 147 609
Total mill area benefit of N41 over N14	R4 131 505
Combined benefit of 'new' varieties over 'current' variety	R99 687 675
SASRI variety development levy	-R17 480 674
Potential after paying for SASRI development levy	R82 207 002
Benefit per ha harvested per annum for planting 'new' varieties	R2 001
Benefit per RV ton/ annum for planting 'new' varieties	R162
Benefit per cane ton/ annum for planting 'new' varieties	R21

It should also be noted that there are reservations made to the extrapolation at the mill scale. It is broadly assumed that the same variety proportion is used throughout the mill area and growing conditions remain the same. The results are expected to differ, due to, for example, varying climatic conditions, soil type, topography, aspect, as well as water availability. Without a comprehensive survey, it is difficult to obtain individual grower field data, especially in KwaZulu-Natal. This could also be due to growers not maintaining and/or updating farm records. It is recommended that the results from this study be verified with a larger sample area, as well as in other milling areas. Furthermore, due to the limited period of five years data, an annually updated database of the variety results from the two milling companies, is recommended, which, over time, is likely to reduce the average variation in results.

Conclusions

The analysis conducted in this study provided insight into the importance and value to industry stakeholders of adopting new varieties. Overall the analysis provided in this study showed a clear increase in revenue of adopting new varieties developed by SASRI. Therefore, growers are advised to introduce new varieties that are suitable and recommended for their specific region as part of their annual replant programme, in order to improve their overall production and profitability.

A similar analysis can be conducted in the future for other milling areas, based on a sample of large estates or farms, where accurate historical records are maintained. No varietal ratoon age decline was assumed in this study, and it is recommended for improvement that follow-up studies take this into account. While this study focused on the benefit of variety adoption, further research can be conducted to determine the breakeven payback period for specific variety development.

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