AN ECONOMIC ANALYSIS OF: REVIEWING AND EXTENDING KNOWLEDGE OF FIBRE QUALITY ASSESSMENT AND EFFECTS OF CANE VARIETIES

Project 2017/001

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Evaluation completed by AgTrans.

1 Introduction

The following impact assessment has been carried out using the guidelines produced by the Council of Research and Development Corporations (CRRDC, 2018).

2 Background

Apart from yield and sugar content, important factors affecting a new sugarcane variety release are the characteristics of the resulting fibre that also affect its processing characteristics at the factory. This is because fibre characteristics and the resulting processing characteristics can impact on factory processing costs (Geoff Kent, pers. comm., 2019).

The level of fibre in cane supply can have a large impact on factory profitability. Issues associated with fibre content include:

- Low fibre may result in a need for purchasing some fuel replacement resources.
- High fibre may result in excess bagasse which leads to disposal costs.
- High fibre can result in greater sugar losses.
- High fibre may result in longer crushing seasons or alternatively, less sugar extraction.
- Where cogeneration capability exists, high fibre may be of value.

Apart from total fibre content, there are also fibre quality characteristics that can cause issues for factory processing. Historically, there are three characteristic measurements of varieties used to predict cane handling problems in milling; these include shear strength, impact resistance and short fibre content. Acceptable ranges for these parameters have been used including:

Impact resistance: 0.3 to 0.8

Shear strength: 10-38

Short fibre content: <60%

Within these parameters, a variety has been considered safe and should not be difficult to process by an Australian sugar cane factory.

A recent past SRA project (2015/081: Assessment of New Soft Cane Varieties) explored the impact of releasing soft cane varieties on the ability of factories to process such varieties and the associated processing costs. An economic assessment of 2015/081 that was based on a series of assumptions concluded important economic drivers included the extent of soft canes that might be produced/avoided in future, the magnitude of average unit costs of milling extremely soft canes, and the opportunity costs of not producing soft canes (e.g. via excluding higher sugar content of some soft canes).

Another small project was subsequently undertaken in 2016 to review the past fibre quality measurement data to enhance understanding of fibre measurements and varietal selection.

It was expected for this small project to lead into a further project that will provide earlier guidance in variety development and provide a feedback mechanism to plant breeders on the effect of varieties on factory operation and performance. This further project was the current project, Project 2017/001.

Project 2017/001 extended the earlier research by reviewing historical fibre quality measurement (FQM) data, and therefore improving the understanding of the variability of FQM properties within varieties and the effect of different varieties on factory operation and performance. The project explored how FQM measurements could be better utilised to guide variety development, and to identify the best way to measure and present FQM data for selection of varieties for release to industry.

3 Project objectives

The overall aim of Project SRA 2017/001 was to improve knowledge of the significance of fibre quality measurement data, to improve its value for variety selection and to provide guidance on further research work to utilise fibre quality requirements to guide variety development. Specific objectives were:

1) To better understand the effects of location, crop class and maturity on fibre quality measurements for different varieties by reviewing historical data and conducting a designed experiment.
2) To assess whether the condition of the SRA shredder, used to prepare samples for fibre quality measurements, affects the measured values by comparing measured values before and after the shredder refurbishment in 2016.
3) To identify how different varieties affect factory operation and performance by analysing historical data and seeking relationships between problem varieties and fibre quality measurements.
4) To review the safe range for existing fibre quality measurements taking into account measurement variability and values known to cause problems in the factory.
5) To identify other candidate fibre quality measurement methods from other sugar industries and other fibre industries.
6) To recommend better ways to present fibre quality measurement data for consideration by variety adoption committees.

4 Cost of investment for project 2017/001

Estimates of the total investment by Sugar Research Australia (SRA), the only funding body involved, are provided in Table 1.

TABLE 1: THE COSTS OF THE INVESTMENT IN PROJECT 2017/001 (NOMINAL $)

YEAR ENDED JUNE	SRA	TOTAL
2018	252,586	252,586
2019	10,211	10,211
Total	262,797	262,797

4.1 Program management and extension costs

The costs of administration and management of the investment are assumed to be included in the figures appearing in Table 1. The principal operators and potential beneficiaries associated with the processes and relationships explored in the project (the breeding program, growers, and sugarcane factory technologists) were all closely involved in the project so there was little need for any intensive extension and communication program.

5 Activities and outputs

A brief summary of the principal activities undertaken in the project follows:

1) Historical fibre quality data (1600 measurements) held by SRA from the sugarcane breeding program were analysed to improve understanding of the effects of various factors that were influencing the measures of fibre quality (e.g. factors such as maturity, genetics, and seasonal differences).
2) Data on fibre quality characteristics on sugarcane factory operations and performance across a number of seasons and different factories were assembled and analysed; in addition, consultations with factory technologists were held. The analysis and consultations were to improve understanding of the effects of fibre and identify important relationships between fibre characteristics and processing operations and costs. Data from seven seasons across four factories were analysed.
3) A factorial experiment was undertaken in the Bundaberg region to ascertain the potential effect of variety, crop class and crop age on fibre quality measures.
4) A review of alternative methods of measuring fibre to those currently employed was undertaken. The methods included fibre quality measurements used in other industries and in other world sugar industries with the purpose of assessing the value of any new methods that might be introduced.
5) An analysis of the fibre quality data produced before and after the refurbishment in 2016 of the shredder used to prepare samples for fibre quality measurements was undertaken.

A brief summary of the outputs from the above activities follows:

1) The review of the fibre quality measurement program operating within the SRA sugarcane breeding program (including the three fibre quality measurements of shear strength, impact resistance and short fibre content) concluded that fibre quality results for a variety are reasonably consistent, compared to the effects caused by year, region and crop class.
2) By undertaking a historical analysis of factory data, the project delivered an improved understanding of the relationships between fibre quality and varietal performance and milling. It was concluded that varieties with short fibres did cause higher processing costs but, in some cases, may still provide a higher return from sugar yield and other factory impacts (higher revenues and or/lower costs). Hence, their continuing progress through the selection program may be worthwhile in a whole of industry context; this would occur if the value of additional sugar and other factory impacts from such a variety exceeded any additional processing costs.
3) Shear strength is the fibre quality measurement that is most repeatable, irrespective of crop class or maturity. The three fibre quality measurements correlated quite well in one region and one season (but not so well across regions or across seasons) (Geoff Kent, pers. comm., 2019).
4) No promising measurement alternatives to current measures were identified after consultations with overseas sugarcane industries and other Australian fibre industries including cotton, forestry, pulp and paper and textiles. However, the review highlighted the relative difficulties in fibre quality measurement for sugarcane compared to other industries.
5) Data analysis concluded that the refurbishment of the SRA shredder in 2016 did not influence the resulting values of fibre quality measurements.
6) It was concluded the current fibre quality measurements being undertaken are the most useful indicators of sugarcane fibre quality, and the existing ranges of the three fibre quality measurements should remain as base criteria.
7) Potential changes suggested for future consideration included:
   - There was potential for earlier measurements of existing fibre measures in the varietal development process; however, it was pointed out this would involve a significant increase in associated measurement costs.
   - It may be possible to reduce the cost of earlier testing if testing for short fibre only was conducted as this was the measure most important in driving additional factory costs.
   - A second “fibre box” containing fibre content and short fibre content, in addition to the traditional “fibre box” containing impact resistance and shear strength was recommended. It was also recommended that the “fibre box” have a grey boundary to reflect the standard error of the measurements.

6 Outcomes

A summary of the important potential outcomes of the project follows:

1) Some changes in the three fibre quality measurements are currently being considered by SRA.
2) The project brief specifically excluded looking at the use of SpectraCane and NIR calibrations for earlier measurement of fibre quality. A project based on this formed part of last year's call for proposals (Geoff Kent, pers. comm., 2019).
3) It is unclear as to which single measurement is best. Short fibre content seems to correlate better with factory effects, but shear strength seems a more reliable measurement (Geoff Kent, pers. comm., 2019).
4) The most likely change could be an earlier application of the test for short fibre content within the varietal improvement program.
5) Applying such a test earlier than currently, and the associated discarding of some prospective varieties with high levels of short fibre, would allow other prospective varieties to continue in the program.
6) When discarding prospective varieties with > 60% short fibres, there may need to be some consideration of other attributes of such varieties where it may be considered that such attributes may present a case for their continuation in the program, at least to the next stage in the program.
7) Such a policy may result in a higher rate of progress in the varietal improvement program with regard to pursuing its overall objective of maximising the release of new varieties that maximise the overall net returns to grower and processors.

7 Impacts

Impacts and potential impacts of the investment in Project 2017-001 are:

- Increased confidence that the existing fibre quality measurements being used in the varietal improvement program are relevant and the best available to the industry from a sugarcane factory perspective.
- A higher rate of progress in the varietal improvement program offset to some extent by increased testing for short fibres earlier in the program, so removing varieties that would occupy space in the ensuing trials for other potential varietal candidates.
- Additional costs of earlier testing for clones with short fibre percentage
- Less varieties rejected in the final stages of the varietal improvement program.
- Some potentially avoided increased factory costs of having to manage new varieties still with a high proportion of short fibres.

A summary of the principal types of potential impacts associated with the outcomes of the project is shown in Table 2.

TABLE 2: CATEGORIES OF PRINCIPAL POTENTIAL IMPACTS FROM THE INVESTMENT

ECONOMIC • Increased confidence in the set of existing fibre quality measurements. • Improved capacity of sugar factory technicians regarding fibre quality measurements and their use in managing factory operations and costs. • Reduced costs of breeding clones to final stages where they may be rejected based on short fibre content. • Higher rate of progress regarding sugarcane yield and commercial cane sugar (ccs) from elimination of varieties with high levels of short fibres earlier in the breeding program. • Additional costs of earlier testing for clones with short fibre percentage (testing at the stage of Final Assessment Trial Repeats).
ENVIRONMENTAL • Nil

SOCIAL
• Potential regional spillovers from the improved value of a variety mix that maximises net revenues for both growers and factories.

7.1 Public versus private impacts

Any key potential impacts will be private and captured by both sugarcane growers and sugarcane factories. The impacts will be driven by lowered factory processing costs offset partially by higher fibre measurement costs in the varietal improvement program and, potentially a small reduction in sugar value produced. Public impacts will potentially include some small spillover regional impacts from the private sector profitability gains.

7.2 Distribution of impacts along the supply chain

Any potential future impacts associated with this project will most likely accrue to sugarcane producers and sugarcane factories, but the distribution of impacts will depend on any decision rules that are developed regarding the exclusion of short fibre varieties from progression in the varietal improvement program.

7.3 Impacts on other primary industries

There are not likely to be any direct impacts to other agricultural industries from the investment.

7.4 Match with national, state and SRA priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 3. The investment contributes primarily to Rural RD&E Priorities 1 and 4, and to Science and Research Priority 1 and potentially Priority 6.

TABLE 3: AUSTRALIAN GOVERNMENT RESEARCH PRIORITIES

AUSTRALIAN GOVERNMENT	
RURAL RD&E PRIORITIES (EST. 2015)	**SCIENCE AND RESEARCH PRIORITIES (EST. 2015)**
1) Advanced technology	1) Food
2) Biosecurity	2) Soil and Water
3) Soil, water and managing natural resources	3) Transport
4) Adoption of R&D	4) Cybersecurity
	5) Energy and Resources
	6) Manufacturing
	7) Environmental Change
	8) Health

Sources: DAWR (2015) and OCS (2016)

7.5 SRA Key Focus Areas

SRA's key focus areas are presented in Table 4. Project 2017/001 addressed KFA 1,5 and 8.

TABLE 4: SRA STRATEGIC FOCUS AREAS AND DESIRED OUTCOMES

KEY FOCUS AREA (KFA)	OUTCOMES
1) Optimally adapted varieties, plant breeding and release	Increased sugarcane yield and commercial cane sugar (CCS)
2) Soil health, nutrient management and environmental sustainability	Better soil health, reduced nutrient losses and improved water quality
3) Pest, disease and weed management	Reduced or avoided yield losses and/or added input costs
4) Farming systems and harvesting	Improved farm input-output efficiencies and profitability

5) Milling efficiency and technology	Optimised production, improved capital utilisation and waste minimisation
6) Product diversification and value adding	Diversified revenue streams and product innovation
7) Knowledge and technology transfer and adoption	Accelerated adoption of new technology and practice change
8) Collaboration and capability development	Enhanced industry and research capability and capacity
9) Organisational effectiveness	Increased investor satisfaction and returns on investment

Source: SRA Strategic Plan (2018)

8 Valuation of impacts

8.1 Impact valued

The impact valued is the net gain to industry revenue from earlier testing for one of the existing three fibre quality traits.

A summary of the key assumptions made is shown in Table 5.

TABLE 5: SUMMARY OF ASSUMPTIONS

VARIABLE	ASSUMPTION	SOURCE
GENERAL ASSUMPTIONS		
Average area of sugarcane	386,000 ha	Average over past 15 years (2003-2017); Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES, 2017)
Counterfactual (no earlier additional fibre quality testing)		
Progress in sugar gain from breeding program	1.2 kg per ha per annum	Agtrans Research, based partly on SRA (2017), p14
Sugar value	$450 tonne	Agtrans Research
SCENARIO WITH EARLIER TESTING		
Cost of short fibre testing brought forward and applied to a greater number of lines	$50,000 per annum	Agtrans Research
Year in which fibre testing commences	2022	Agtrans Research
Progress in sugar gain from breeding program	7.5% over base = 1.29 kg per annum	Agtrans Research
Lag between short fibre variety testing and commencement of impact	4 years	Agtrans Research
RISK FACTORS		
Probability of outcome that short fibre testing at the Final Assessment Trial Repeats (FAT-R) stage will be adopted	100%	Agtrans Research
Probability of impact given successful outcome	75%	

Among the reasons for these potential impacts not being valued were the subjective nature of confidence and knowledge, and the difficulty of making credible assumptions regarding the probability and industry costs of variety rejection and any increased factory processing costs.

9 Results

All past costs and benefits were expressed in 2018/19-dollar terms using the Implicit Price Deflator for GDP. All benefits after 2018/19 were expressed in 2018/19-dollar terms. All costs and benefits were discounted to 2018/19 using a discount rate of 5%. A Re-investment rate of 5% was used for estimating the Modified Internal Rate of Return (MIRR). The base analysis used the best estimates of each variable, notwithstanding a high level of uncertainty for many of the estimates. All analyses ran for a period of 30 years after the last year of investment (2017/18).

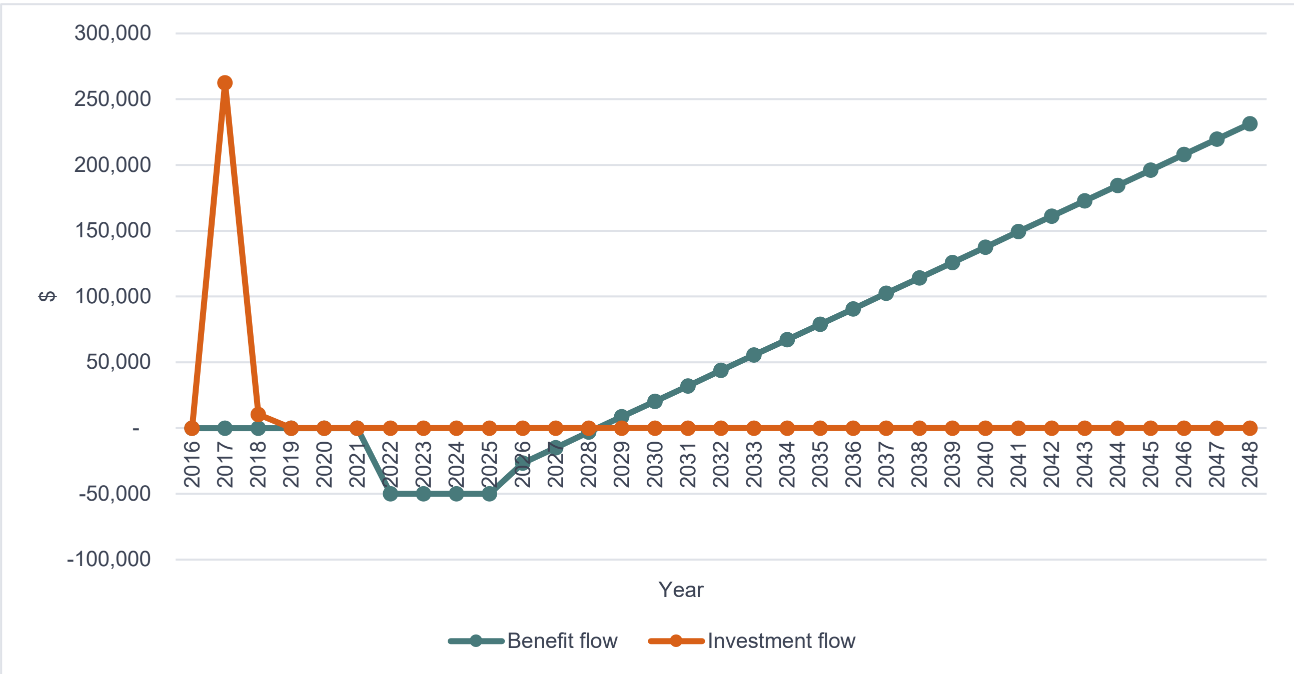
The investment criteria are reported for the total investment and the SRA investment in Table 6. Results for the SRA investment are the same for total investment as SRA was the only funding body.

TABLE 5: INVESTMENT CRITERIA FOR TOTAL INVESTMENT AND TOTAL BENEFITS (DISCOUNT RATE 5%)

INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($)	0.00	-0.12	-0.19	-0.07	0.14	0.40	0.68
Present value of costs ($)	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Net present value ($)	-0.28	-0.40	-0.47	-0.35	-0.14	0.12	0.40
Benefit–cost ratio	0.00	-0.44	-0.66	-0.26	0.49	1.42	2.41
Internal Rate of Return (%)	negative	negative	negative	negative	2.5	6.3	8.2
Modified internal rate of return (%)	negative	negative	negative	negative	3.1	5.9	7.2

The annual cash flow of undiscounted benefits and costs for the total investment are shown in Figure 1.

FIGURE 1: ANNUAL CASH FLOW OF UNDISCOUNTED BENEFITS AND COSTS



9.1 Sensitivity analyses

Sensitivity analyses were carried out for several variables and results are reported in Tables 6 to 8. All sensitivity analyses were performed on the total investment only using a 5% discount rate (with the exception of Table 6) with benefits taken over the 30-year period. All other parameters were held at their base values.

Table 6 shows there is a very high sensitivity to the discount rate, largely due to the long period of time over which the benefits are delivered. At a discount rate of 10%, the net present value is negative.

TABLE 6: SENSITIVITY TO DISCOUNT RATE (TOTAL INVESTMENT, 30 YEARS)

CRITERION	DISCOUNT RATE		
	0%	BASE (5%)	10%
Present value of benefits ($m)	2.40	0.68	0.17
Present value of costs ($m)	0.27	0.28	0.29
Net present value ($m)	2.13	0.40	-0.13
Benefit-cost ratio	8.95	2.41	0.57

Table 7 provides a sensitivity analysis for the assumption regarding the genetic gain assumed. Results show that the investment criteria are highly sensitive to changes in the genetic gain assumption. Given the other assumptions, the break-even genetic gain was an increase of 5.5% in the 1.2 kg per ha per annum base assumption for existing genetic gain.

TABLE 7: SENSITIVITY TO GENETIC GAIN ASSUMPTIONS WITH EARLIER SHORT FIBRE TESTING (TOTAL INVESTMENT, 5% DISCOUNT RATE, 30 YEARS)

CRITERION	GENETIC GAIN INCREASE		
	5%	7.5% (Base)	10%
Present value of benefits ($m)	0.23	0.68	1.13
Present value of costs ($m)	0.28	0.28	0.28
Net present value ($m)	-0.05	0.40	0.85
Benefit-cost ratio	0.81	2.41	4.02

Table 8 provides a sensitivity analysis for the assumption regarding the cost of the earlier testing for short fibre. Given the spread of values used, results show that the investment criteria are sensitive to this assumption, with a breakeven cost being $79,400 per annum.

TABLE 8: SENSITIVITY TO COST OF EARLIER SHORT FIBRE TESTING (TOTAL INVESTMENT, 5% DISCOUNT RATE, 30 YEARS)

CRITERION	ASSUMPTION FOR ADDITIONAL COSTS ($ PER ANNUM)		
	75,000	50,000 (BASE)	25,000
Present value of benefits ($m)	0.34	0.68	1.02
Present value of costs ($m)	0.28	0.28	0.28
Net present value ($m)	0.06	0.40	0.74
Benefit-cost ratio	1.21	2.41	3.62

10 Conclusions

The principal finding from this project investment was that the existing fibre quality measurements used in the varietal improvement program are the best available and should continue. However, consideration should be given to implementing a test for short fibre at the Final Assessment Trial Repeats stage in the breeding program.

Given the assumptions made on the impact pathway and extent of impacts, the investment criteria estimated for total investment in the project of $0.28 million (present value of costs) were positive with an expected present value of benefits of $0.68 million, an expected net present value estimated at $0.40 million and an expected benefit-cost ratio of 2.41 to 1. All investment criteria were estimated using a discount rate of 5% and with benefits estimated over 30 years from the final year of investment. The internal rate of return was estimated at 8.2% and the modified internal rate of return at 7.2%.

As several impacts identified were not valued, the magnitude of the investment criteria estimated and reported could be an underestimate.

11 Acknowledgments

Geoff Kent, Principal Research Fellow, Queensland University of Technology

Roy Parfitt, Sugar Research Australia

12 References

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