AN ECONOMIC ANALYSIS OF SIX EASY STEPS® TOOLBOX DEVELOPMENT FOR REFINED ON FARM NUTRIENT MANAGEMENT

Project 2018/013

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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) (CRRDC, 2018).

2 Background

Fertiliser inputs in the Australian sugarcane industry had traditionally been based on a set of general recommendations which did not adequately account for the different impacts of growing region and soil types on nutrient requirements. Growers had often followed their own approaches to nutrient management, which due to the complexity of determining optimum rates, had the potential to lead to rates of fertiliser usage beyond what was economically or environmentally ideal.

In the past 20 years a more focused approach to understanding and managing the complexity of nutrient management on individual sugarcane soils and farming systems has evolved that has benefitted the Australian sugarcane industry. This new approach recognises the impact that different soils, growing conditions and farming systems have on nutrient requirements. Soil/site-specific fertiliser recommendations were identified as a means of achieving sustainable nutrient management outcomes in in an industry that is affected by fluctuating sugar prices and variable weather conditions.

Development of the approach has been driven by a number of key projects in nutrient management between the years 1999-2017. This investment resulted in the SIX EASY STEPS program.

At the same time (since the early 2000s) increasing attention was being given to the impacts of climate change and water quality on the sustainability of the Great Barrier Reef (GBR). Sugarcane production has been identified as contributing to a decline in water quality in the GBR catchment area through nutrient and pesticide runoff. This posed a threat to the industry as it was faced with the prospect of reduced access to key fertiliser inputs and loss of social licence to operate. It was thus recognised that sustainable nutrient management required profitable sugarcane production to be achieved in combination with the maintenance of soil fertility and minimisation of off-site effects. This supported the need for updated nutrient management practices.

A range of extension activities, governance programs and smaller Research, Development and Adoption (RD&A) projects have also contributed to the development and use of the SIX EASY STEPS program. These activities were funded from numerous sources including Canegrowers, the Australian Cane Farmers Association and the NSW Sugar Milling Cooperative Ltd and were aimed at encouraging industry acceptance and increasing the levels of adoption of nutrient guidelines.

As of 2017, the level of adoption of SIX EASY STEPS ranged from 50-70% of the Queensland area of sugarcane. Moreover, A scoping study in 2017 reported a significant opportunity to refine management of

nitrogen (N) and other nutrients by developing tools that would assist growers with such refinements in particular circumstances such as following legume rotation crops, late-harvested crops, older ratoons, sodic soils, water-logged soils, high performing sites, and where mill-mud had been applied. This opportunity was addressed by the funding of Project 2018/013.

3 Project Objectives

The overall aim of the project was to develop guidelines to enhance the use of the SIX EASY STEPS program used by growers by adjusting N fertiliser inputs in particular situations.

The specific objectives of the project were:

1) Package trial data, case studies and develop decision support tools for the refinement of nutrient rates for specific production system issues.
2) Create web platform for these tools with associated evidence to support decisions.
3) Consult with advisors on the utility of the decision support tools.
4) Integrate use of the tools into relevant adoption programs and grower services.

4 Cost of Investment for Project 2018/013

Estimates of the total investment by Sugar Research Australia (SRA), the Department of Environment and Science (DES) and others for the two-year project are provided in Table E1.

TABLE E1: THE COSTS OF THE INVESTMENT IN PROJECT 2018/013 (NOMINAL $)

YEAR ENDED JUNE	DES	SRA	CANEGROWERS	OTHER	TOTAL
2019	93,785	103,385	9,600	5,000	211,770
2020	52,757	58,158	5,400	5,000	121,315
Total	146,542	161,543	15,000	10,000	333,085

Sources: (1) Contract between SRA and SRA Technology Unit (2) Deed effected between DES and SRA (2015-2020) (3) 'Other' includes estimates of in-kind contributions for review of tools by regional industry personnel, the project working group and the SIX EASY STEPS Advisory Committee.

4.1 Real Investment and Extension Costs

For purposes of the investment analysis, the investment costs of all parties were expressed in 2019/20-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2020). There were expected to be some additional communication and extension costs associated with the adoption of the new tools produced by the project. These costs were recognised via an attribution factor as reported later in Table 7 of the quantitative analysis.

4.2 Program Management and Administration Costs

The cost of managing the investment varied according to the source of funds. Estimates of the cost of administration and management of the investment by SRA and DES were added to the total project costs currently appearing in Table E1. The management cost multipliers used were as follows:

- SRA: 1.10
- DES: 1.10

The multipliers are to accommodate the allocation of indirect Research and Development (R&D) expenditure (management and administrative resources) for each organisation across individual projects. This is to ensure the full costs of R&D funding are included as per the CRRDC Guidelines (CRRDC, 2018). The use of multipliers is an accountability item only and does not mean that any of the DES resources granted to SRA are used by SRA

to fund project administration or management costs. The DES multiplier applied is to accommodate the resources DES expends in managing the Deed.

The management and administration costs for Canegrowers and others were assumed to be included already in the contributions appearing in Table E1.

5 Activities

5.1 Project Working Group

- A project working group was established to review the development of the decision support tools that were to be developed.
- The working group participants were drawn from diverse sugarcane interest groups including researchers, advisors, representative industry bodies and government.
- The working group held a series of meetings during the project; the first meeting provided a strategy for tool development.
- The initial strategy was further developed away from complex decision support tools and towards potential changes to nutrient rates in particular circumstances to assist growers and their advisors in developing nutrient management plans.
- During calendar 2019 and early 2020, the project working group received and reviewed drafts of the decision support tools.

5.2 Development of Decision Support Tools

The decision support tools were developed for particular sugarcane cropping system situations identified in previous projects and included those in relation to:

- Legume break crops
- Late harvest
- Older (final) ratoons
- Sodic soils
- Water-logged soils
- High-performance sites
- Accounting for mill by products (e.g. mill mud)

Supporting information, including case studies, was assembled from various sources including Reef Catchments, published information and various websites.

5.3 Industry Consultation

- During the second half of calendar 2019, drafts of the decision support tools were presented at three sugarcane growing locations (Meringa, the Herbert, and the Burdekin).
- These presentations were attended by a cross-section of interested parties including sugarcane growers, industry representatives, factory representatives, productivity services, private advisors, government representatives, and the Wet Tropics Sugar Industry Partnership.
- Feedback from these consultations was received and incorporated into the decision support tools.

5.4 Input from the SIX EASY STEPS Advisory Committee (SESAC)

- SESAC were involved in the development of the decision support tools, including a review of the final drafts.

5.5 Web Availability

- Nutrient management information on the web was redesigned as part of the project.

6 Outputs

6.1 Information and Products

- Decision support tools have been developed to assist growers and advisors in the development of improved nutrient management plans.
- The tools relate to further guidance in use of SIX EASY STEPS (steps 5 and 6).
- Guidance has been developed for adjusting N applications with respect to:
  - Following legume break crops
  - Late season ratoons
  - Final ratoons
  - Sodic soils
  - Fine tuning N rates on blocks that experience waterlogging
  - High performing sites, and
  - Accounting for mill by products
- Additional information produced by the project includes:
  - Case studies, trial results and other supporting information for each decision support tool.
  - Guidance for biomass sampling and determining the N content of legume fallow crops.
  - Guidance on how to conduct on-farm trials to assess changes to management practices.
- It was recommended that any change in management is tested on-farm. This will build confidence in both the new nutrient rates but also the process of fine tuning a nutrient management program as part of steps 5 & 6 in the SIX EASY STEPS program.
- Decision support tools have been made available on the SRA website in the newly redeveloped nutrient management section.

6.2 Other Recommendations

Other recommendations in the final report of Project 2018/013 included:

- Communication activities to promote the tools should be conducted; these should include both media releases to notify growers and advisors of the tools and how they can be accessed on the SRA website, and potentially printed versions of the tools to be sent to growers and advisors, possibly through a special edition of *CaneConnection.*
- Where possible, adoption officers, productivity services and other advisors should be encouraged to further develop the tools and promote adoption by conducting demonstration trials on growers' farms.
- Further development of advice for high yielding blocks is required. There is concern amongst growers that in addressing the achievement of high yields, the SIX EASY STEPS N recommendation is not sufficient and limits productivity. While there is very limited evidence of this being the case, a research/demonstration project working with these growers would be beneficial.
- The use of nitrate test strips, or other N sensors, requires further development and validation. This would include demonstration in the field by adoption officers, productivity service officers and private advisors. This work should also include testing the use of nitrate test strips following the application of mill by-products.

7 Outcomes

There is no information currently available about the extent of usage of the new decision support tools from surveys of advisors or productivity officers, and /or web hits. However, potentially such information could be sought in future SRA grower surveys (Barry Salter, pers. comm., 2020).

As the tools were released only in May 2020, it will take time for growers and advisors to become comfortable with them and incorporate the concepts into nutrient management plans.

In response to the other recommendations listed in the above outputs, information on their associated outcomes follows (Barry Salter, pers. comm., 2020):

- Communication activities: Communication of the tool's development and availability on the website was conducted. There is a plan to include tools content in *CaneConnection* (2 at a time) in future editions, but this is yet to commence. There has been recent discussion, following feedback from Tully, of including PDFs of the tools on the website so that advisors and growers can print content.
- Further tool development: Various tools are being tested in a number of reef related projects across the industry. This includes Great Barrier Reef Foundation (GBRF) projects in the Wet tropics and Central regions (Cane2Creek). Testing the tools is also likely to be proposed in GBRF project proposals in the Tully and South Johnstone regions.
- High Yielding Blocks: This issue has not been addressed directly by SRA. However, a grower in Mackay is investigating this issue working with Farmacist as part of Project Catalyst, a partnership between more than 130 innovative Queensland cane growers, Catchment Solutions, and the Australian Government.
- Nitrate test strips: Some advisors like Farmacist promote and assist growers with the use of nitrate test strips.

8 Impacts

The potential impact from this project is expected to be an improved efficiency of N fertiliser application by some growers with assistance from advisors, through improved future efficiency of N use for sugarcane in various locations, soil types, and previous environmental conditions and paddock histories. This was expected to result in:

- N fertiliser cost savings for some farm areas,
- Reduced export of unused N to off-farm locations and, potentially, an associated improvement in water quality export to the GBR, and
- A reduced probability of a future loss in the social licence for sugarcane growing.

If further development of advice for high yielding blocks eventuates, an additional potential impact may be:

- Increased sugarcane yields for some farm areas in some years.

As indicated under the earlier Outcomes section, there is continued trialling of tools with growers in some reef projects. There are also some growers that have been exposed to the tool's ideas through advisors like Farmacist; some growers have already adopted the tool concepts. Therefore, it is likely small gains in nitrogen use efficiency (NUE) have already been delivered, but these are not likely to have come from the project itself (Barry Salter, pers. comm., 2020).

A summary of the principal types of likely impacts associated with the outcomes of the project is shown in Table E2.

TABLE E2: CATEGORIES OF PRINCIPAL IMPACTS AND POTENTIAL IMPACTS FROM THE INVESTMENT

ECONOMIC

- Contribution to higher profits for some sugarcane growers from more accurate estimation of N requirements leading to:
  - Cost savings and increased profits from reduced N application rates on some farm areas under specific conditions.
  - Future potential for increased sugarcane yields and increased net profits from increased and more efficient N applications on some high yielding sites.

ENVIRONMENTAL • Potential reduction in export of fertiliser N to off-farm environments, including the GBR.
SOCIAL • Spillover impacts to regional communities from increased sugarcane industry net incomes. • A reduced probability of a future loss in the social licence for sugarcane growing.

8.1 Public versus Private Impacts

The key potential impacts will be private, initially delivered to some sugarcane growers directly or via advisors. Some additional private impacts could be delivered to sugarcane processors via increased cane production.

Public impacts are likely to be in the form of environmental benefits from a reduced level of nitrogen entering public waterways and from regional spillovers from increased grower incomes.

8.2 Distribution of Impacts along the Supply Chain

The project is likely to have contributed to direct private productivity/profitability impacts for Australian sugarcane producers through improved NUE driven largely by reduced N fertiliser use/N savings. Secondary productivity/profitability impacts may accrue to the Australian sugarcane milling sector if, in the future, improved NUE on-farm results in increased sugarcane yields and therefore increased cane processing.

8.3 Impacts on other Primary Industries

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

8.4 Impacts Overseas

There are no overseas impacts expected.

8.5 Match with National, State and SRA Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table E3. The Project 2018/013 investment could potentially contribute primarily to Rural RD&E Priority 1, 3, and 4 and to Science and Research Priorities 1 and 2.

TABLE E3: AUSTRALIAN GOVERNMENT RESEARCH PRIORITIES

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

Sources: DAWR (2015) and OCS (2016)

9 SRA Research Priorities

SRA's key focus areas are presented in Table E4. Project 2018/013 addressed KFAs 2, 4 and 7.

TABLE E4: 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 u4lisa4on 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)

10 Valuation of Impacts

10.1 Impacts Valued

Of the four major impacts identified in Table E2, only part of the first impact has been valued in this assessment, namely the contribution to higher profits for some sugarcane growers from more accurate estimation of N requirements.

10.2 Other Potential Impacts Identified but not Valued

The other four impacts of the five identified in Table E2 were not valued for the following reasons:

- The future potential for increased sugarcane yields from increased N applications on some high yielding sites was not valued due to the difficulty of defining the extent of high yielding sites, the proportion of these that may receive increased N due to use of the tool and the net value of yield response that may be obtained.
- The potential reduction in export of fertiliser N to off-farm environments, including the GBR, was not valued due to the difficulty of quantifying the reduction and its value on improving GBR health.
- Spillover impacts to regional communities from increased sugarcane industry net incomes was not valued due to the range and diversity of geographic locations involved.
- A reduced probability of a future loss in the social licence for sugarcane growing was not valued due to the difficulty of identifying any clear linkages between the likely project outcomes and community views and/or government policy.

10.3 Attribution

The counterfactual assumed is that the industry changes that are anticipated would not have taken place without the funding of this project. However, an attribution factor of 40% is applied to the valued impacts due to the contribution of the significant additional communication and extension costs required to assist growers capture the benefits assumed.

10.4 Summary of Assumptions for Impact Valuation

The outputs from the project were directed at a number of specific components of sugarcane farming systems for assisting with N management decisions, namely:

- Following legume break crops
- Late season ratoons
- Final ratoons
- Sodic soils
- Fine tuning nitrogen rates on blocks that experience waterlogging
- High performing sites, and
- Accounting for mill by products

The framework for the monetary assessment is built around:

- Estimates of the prevalence of these components by area in Australian sugarcane farming systems,
- Estimates of the likelihood of tool usage by component area, and
- Estimates of the N saved if the tool is used for each system component.

The specific assumptions used to populate the framework are provided in Table E5. The estimates are only indicative estimates made by the analyst with some input from Barry Salter (project Principal Investigator).

TABLE E5: SIMPLIFIED FRAMEWORK FOR ESTIMATING N SAVINGS MADE BY USE OF THE NEW DECISION SUPPORT TOOLS

BEST ESTIMATES	FARMING SYSTEM COMPONENT					
	LEGUME BREAK CROP	LATE SEASON RATOON (A)	FINAL RATOON (A)	SODIC SOILS	WATER-LOGGED SITES	ACCOUNTING FOR MILL BY PRODUCTS
Estimate of proportion of QLD sugarcane area that is relevant to each farming system component	3.5% (b)	15%	15%	10%	10%	10%
Relative usage of decision support tool by relevant population in next five years (c)	50%	20%	20%	10%	10%	25%
Indicative kg N saved if relevant decision tool used	40% (d)	20%	20%	12.5% (10-5%)	10%	22.5 % (15-30%)

a) *Very often these are the same crops as final ratoons are harvested late in the season (Barry Salter, pers. comm., 2020); hence, only one of these two farming system components has been included in the valuation of benefits.*

b) *There is about 377,000 ha of sugarcane in an average year based on the 2017 and 2018 years (Canegrowers Annual Report, 2018/19). If it is assumed that 60,000 ha of plant cane exists in any one season, that 75% of plant cane comes from a fallow, and 30% of the fallow area comes from a legume break crop, the estimated annual percentage of the total sugarcane area that is planted to a legume break crop would be about13,500 ha or about 3.5% of the total area of sugarcane in any one year (13,500/377,000).*

c) *The usage estimates are based on business as usual. However, it needs to be kept in mind that growers will be required to develop nutrient management plans and use a N cap on their farm as part of new regulations. This could see significantly higher adoption rates from 2022 onwards. The tools were partly developed to assist growers and advisors with this process (Barry Salter, pers. comm., 2020).*

d) *An estimate of N saved based on an average soybean crop that is not harvested would be 75-100%; this will vary with legume crop size, species, harvested or not etc. However, growers are conservative and are likely to adopt a more cautious approach. More likely N reduction would be in the 25-50% reduction range (Barry Salter, pers. comm., 2020).*

In developing the simplified framework above, is recognised that the use of an estimate of the value of N saved is an incomplete measure of gain as it does not include the full impact of change. However, examination of a case study of N strategies for sodic soils in the Burdekin, showed that the savings in N fertiliser by using SIX EASY STEPS may provide a conservative estimate of the net gain by using SIX EASY STEPS (see Table E6 below).

TABLE E6: RP20 TRIAL RESULTS FOR SODIC SOILS IN THE BURDEKIN

METHOD	CROP	KG N/HA	N COST @$1.23 /KG
SIX EASY STEPS	Plant crop	150	
	R1	190	
	R2	190	
	R3	190	
	Average	180	$221.40 per ha
Grower	Plant crop	210	
	R1	250	
	R2	250	
	R3	250	
	Average	240	$295.20 per ha
Source for above data: https://sugarresearch.com.au/wp-content/uploads/2017/06/Nitrogen-Results-17-F.pdf			
Saved N cost by use of SIX EASY STEPS			$73.80 per ha ($295.20-$221.40)
REVENUE LESS FERTILISER, HARVESTING COST OF EXTRA CANE AND LEVIES OVER FULL CROP CYCLE			
SIX EASY STEPS	$13,859	Source: https://sugarresearch.com.au/wp-content/uploads/2017/06/Nitrogen-Results-17-F.pdf	
Grower	$13,073		
SES net advantage	$786 per ha full crop cycle		
SES net advantage	$157.20 per ha per annum		
Conclusion Any small increase in sugarcane yield from using a higher nitrogen rate than SIX EASY STEPS appears to be more than offset by: the negative impact of ccs for the higher grower N rate the marginal harvesting cost of additional cane **Hence, from this trial, it would appear that using the average saved N fertiliser cost ($73.80 per ha) would be a valid but conservative estimate of the total advantage of using SES ($157.20 per ha) over grower rates.**			

A summary of the key assumptions made is shown in Table E7.

TABLE E7: SUMMARY OF ASSUMPTIONS FOR VALUING INVESTMENT IN PROJECT 2018/013

VARIABLE	ASSUMPTION	SOURCE
GENERAL		
Total Australian sugarcane area	377,000 ha	Average of past two years (2017/18 and 2018/19) (Canegrowers Annual Report, 2018/19)
Average current N usage	160 kg/ha	Analyst assumption

BENEFIT 1: ESTIMATES OF N COST SAVINGS MADE BY USE OF THE SES DECISION SUPPORT TOOLS		
N savings made by farming system component	Relevant areas, adoption levels and N savings made	Table 5
Farm gate value of elemental N	$1.23 per kg	Based on urea price of $565 per tonne @46% N
Year of first adoption due to project	2021	Analyst assumptions
Maximum year of adoption	2030	
RISK FACTORS		
Probability of Output	100%	Analyst assumption: project outputs already exist
Probability of Outcome (Usage)	50%	Analyst assumption that refers to the probability that the adoption rates in Table 5 eventuate for each farming systems component
Probability of Impact (given usage)	50%	Analyst assumption that refers to N reduction assumptions for each component provided in Table 5
ATTRIBUTION		
Attribution to SRA Project 2018/013	40%	Analyst assumption: allows for the significant additional communication and extension costs required to assist growers capture the potential cost savings

10.5 Results

All past costs and benefits were expressed in 2019/20-dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2020). All benefits after 2019/20 were expressed in 2019/20-dollar terms. All costs and benefits were discounted to 2019/20 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 (2019/20).

The investment criteria are reported for the total investment, the SRA investment, and the DES investment in Table E8, Table E9 and Table E10.

TABLE E8: INVESTMENT CRITERIA FOR TOTAL INVESTMENT (DISCOUNT RATE 5%)

INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.19	0.61	1.02	1.34	1.60	1.79
Present value of costs ($m)	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Net present value ($m	-0.38	-0.19	0.23	0.64	0.96	1.22	1.41
Benefit-cost ratio	0.00	0.51	1.61	2.69	3.54	4.20	4.72
Internal rate of return (IRR) (%)	negative	negative	12.19	17.05	18.44	18.92	19.09
Modified IRR (%)	negative	negative	10.07	12.16	11.85	11.21	10.58

TABLE E9: INVESTMENT CRITERIA FOR SRA INVESTMENT (DISCOUNT RATE 5%)

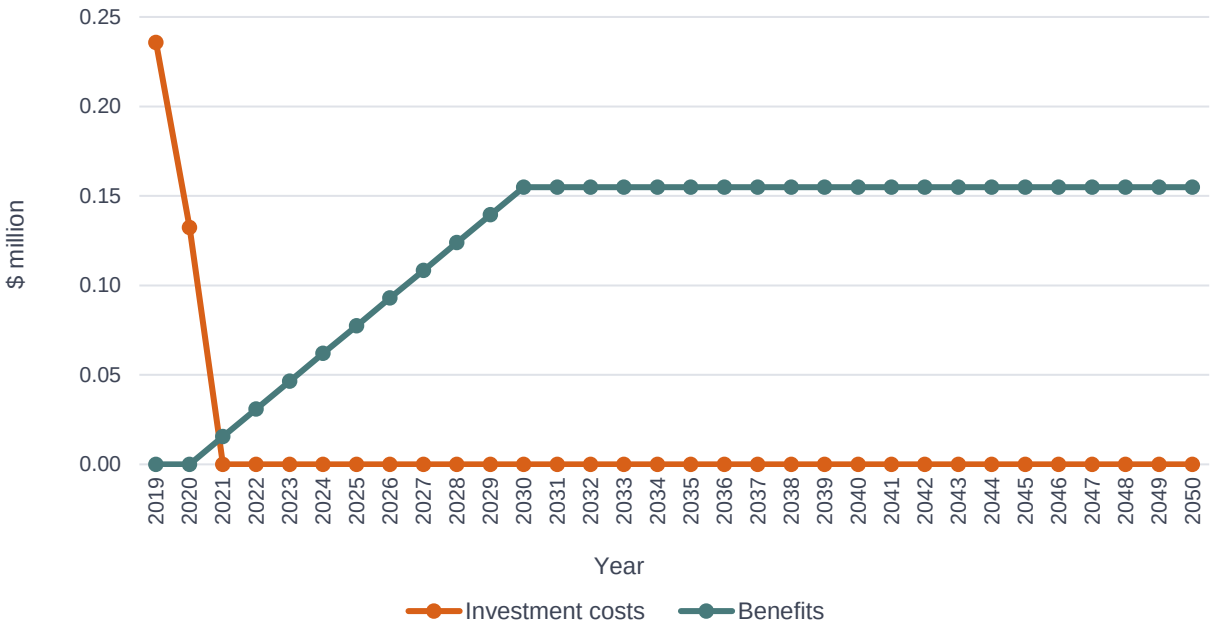
INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.10	0.30	0.50	0.66	0.78	0.88
Present value of costs ($m)	0.19	0.19	0.19	0.19	0.19	0.19	0.19
Net present value ($m)	-0.19	-0.09	0.11	0.31	0.47	0.59	0.69
Benefit-cost ratio	0.00	0.51	1.60	2.69	3.54	4.20	4.72
Internal rate of return (IRR) (%)	negative	negative	12.19	17.05	18.44	18.92	19.09
Modified IRR (%)	negative	negative	10.07	12.13	11.85	11.20	10.58

TABLE E10: INVESTMENT CRITERIA FOR DES INVESTMENT (DISCOUNT RATE 5%)

INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.09	0.27	0.45	0.60	0.71	0.80
Present value of costs ($m)	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Net present value ($m)	-0.17	-0.08	0.10	0.28	0.43	0.54	0.63
Benefit-cost ratio	0.00	0.51	1.60	2.69	3.54	4.20	4.72
Internal rate of return (IRR) (%)	negative	negative	12.19	17.05	18.44	18.92	19.09
Modified IRR (%)	negative	negative	10.07	12.13	11.85	11.20	10.58

The annual cash flow of undiscounted benefits and costs for the total investment are shown in Figure E1.

FIGURE E1: ANNUAL CASH FLOW OF UNDISCOUNTED BENEFITS AND COSTS



10.6 Sensitivity Analyses

Sensitivity analyses were carried out for two variables and results are reported in Table E11 and Table E12. The sensitivity analyses were performed on the total investment using a 5% discount rate (with the exception of Table E11) with benefits taken over the 30-year period. All other parameters were held at their base values.

Table E11 shows there is a moderately high sensitivity to the discount rate, partly due to the long period of benefits assumed.

TABLE E11: SENSITIVITY TO DISCOUNT RATE (TOTAL INVESTMENT, 30 YEARS)

CRITERION	DISCOUNT RATE		
	0%	BASE (5%)	10%
Present value of benefits ($m)	3.95	1.79	0.00
Present value of costs ($m)	0.37	0.38	0.39
Net present value ($m)	3.58	1.41	-0.39
Benefit-cost ratio	10.73	4.72	0.00

Table E12 provides the sensitivity of the investment criteria to the assumed average industry usage of the decision tools.

TABLE E12: SENSITIVITY TO LIKELIHOOD OF GROWER USAGE OF THE DECISION TOOLS (TOTAL INVESTMENT, 5% DISCOUNT RATE, 30 YEARS)

CRITERION	LIKELIHOOD OF GROWER USAGE FOR EACH FARMING SYSTEMS COMPONENT		
	PESSIMISTIC (50% LESS THAN TABLE 5)	BASE (SEE TABLE 5)	OPTIMISTIC (50% MORE THAN TABLE 5)
Present value of benefits ($m)	1.13	1.79	2.69
Present value of costs ($m)	0.38	0.38	0.38
Net present value ($m)	0.75	1.41	2.31
Benefit-cost ratio	2.97	4.72	7.09

11 Conclusions

The project is likely to have contributed to direct private productivity/profitability impacts for Australian sugarcane producers through improved NUE driven largely by reduced N fertiliser use/N savings. Secondary productivity/profitability impacts may accrue to the Australian sugarcane milling sector if, in the future, improved NUE on-farm results in increased sugarcane yields and therefore increased cane processing.

Given the assumptions made, the investment criteria estimated for total investment in the project of $0.38 million (present value of costs) were positive with an expected present value of benefits of $1.79 million, an expected net present value estimated at $1.41 million and an expected benefit-cost ratio of 4.72 to 1. The internal rate of return was estimated at 19.1% and the modified internal rate of return at 10.6%.

For the SRA investment, the investment of $0.19 million provided an expected net present value estimate of $0.88 million and an expected benefit-cost ratio of 4.72 to 1, with rates of return similar to those for the total investment,

For the DES investment, the investment of $0.17 million gave an expected net present value of $0.80 million and an expected benefit-cost ratio and rates of return similar to those for the total investment.

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 quantitative analysis relied on assumptions regarding future usage and impact of a number of decision support tools associated with a number of farming system components. While best bet estimates for the various component usages and impacts have been made, there has been to date no hard data assembled on usage as the tool became available only in 2020. Also, as explained earlier, four impacts of the project investment that were identified were not valued in the monetary analysis. Hence, the magnitude of the investment criteria estimated and reported are likely to be underestimated. In addition, the project has contributed to future projects that are likely to further improve grower decision making.

12 Acknowledgments

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