AN ECONOMIC ANALYSIS OF: SUGAR INDUSTRY PRODUCTIVITY AND DATA RECORDING SPATIAL DATA HUB FOR RESEARCH AND EXTENSION

Project 2015/045

Chief Investigator
Robert Crossley, Agtrix

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

The Australian sugarcane industry has been collecting spatial information using Geographic Information Systems (GIS) over a long period. This data resource has already been used in research and extension for various purposes and could potentially be used for various other purposes including productivity analysis and bio-security response management.

However, the data are fragmented as different data sets are held by different milling organisation databases/archived files, are stored in different formats and use different codes to indicate crop varieties and classes. This has made it difficult for researchers to access and interpret quickly, and in some cases can lead to the data being used inappropriately due to a lack of understanding about its limitations (e.g. poor consignment accuracy)

Individual mill GIS data can be used together with satellite imagery to produce yield maps for individual farms, regions and mill areas. Such information can assist with such decisions as:

- nitrogen fertilisation decisions and other input decisions via precision agriculture technology,
- forthcoming mill throughput predictions, including associated decisions on the timing of sugarcane crushing commencement, and private forward selling decisions.

Further, the capacity for the industry to provide an integrated data recording capacity in the event of a disease or weed outbreak is already available in most regions through systems provided by Agtrix, but currently lacks a coordinated industry approach and is not available to bio-security personnel centrally.

A more integrated and coordinated approach to data format and availability could improve access and lower costs, as well as increase frequency of use, and increase value in a range of farm and industry decision making.

3 Project objectives

The overall aim of Project SRA 2015/045 was to enable quicker access for research and extension purposes to more highly standardised industry datasets currently held by individual sugarcane mills.

The original specific objectives were:

1) Engage the main data providers and stakeholders of the industry to establish the Privacy and Intellectual Property conditions required to enable participation for the major data providers, and establish the acceptable protocols and mechanisms needed to allow data to be provided when requested.

2) Communicate with the industry what data may be stored in this data hub, and who may access that data, the types of data stored and the frequency and mechanism of updating the data repository.
3) Build on the existing infrastructure and systems to provide the data repository, data verification and quality assessment, and data migration pathways to be able to store the industry data and provide access to the stakeholders that the industry agrees to.
4) Capture historical data of the spatial data representing paddocks where sugar was grown and production that is accessible to the industry for research purposes.
5) Implement data update processes that the industry can keep the data up to date into the future.
6) Implement data request protocols to facilitate the provision of data to the various data users, ensuring the rights of the original data owners are protected in the same manner that is done currently when data is provided electronically now.

It is noted that there was a change in approach once the project commenced. This was a move away from a centralised data storage hub from which data users could draw after agreement with the individual owners of the data. Privacy concerns by the data owners precluded this model of data storage and access. Instead, the new model was for the standardised data to be provided back to the individual data owners for storage and then made available as appropriate for research and extension purposes.

4 Cost of investment for project 2015/045

Estimates of the total investment by year and by the project funders including Sugar Research Australia (SRA), as well as the in-kind resources provided by Agtrix, are provided in Table 1.

TABLE 1: THE COSTS OF THE INVESTMENT IN PROJECT 2015/045 (NOMINAL $)

YEAR ENDED JUNE	SRA	AGTRIX	TOTAL
2016	56,820	25,000	81,820
2017	63,400	25,000	88,400
2018	14,500	15,000	29,500
Total	134,720	65,000	199,720

4.1 Program management and extension costs

The costs of administration and management of the investment from all parties are assumed to be included in the figures appearing in Table 1.

5 Activities

1) A Consultative/Steering Committee was formed consisting of representatives from:

- Sugar Research Australia
- Australian Sugar Milling Council
- Canegrowers
- Australian Cane Farmers Association
- Agtrix

The functions of the Committee were to establish the conditions that would enable participation of the major data providers and develop acceptable protocols required to allow data to be provided when required.

2) Five regional workshops were held to discuss and develop how the storage and retrieval system might operate. Locations included Gordonvale, Burdekin. Mackay, Isis, and one workshop in NSW. Attendees were from both data providers and users, and included personnel from productivity boards, extension groups including agronomists, grower and milling organisations, and from research organisations.

3) A report detailing the findings of the workshops was produced, including the data and its attributes to be stored, a request process and protocols to be observed for data provision. A key conclusion, based on privacy concerns, was the that the Hub concept was to be revised to one of decentralised storage by individual data owners who would also retain control of data access by potential data users.
4) The technology and systems facilitating data storage, security, and access and data provision protocols were constructed; much of this process had already been implemented commercially.
5) After written agreements from a number of Mill Data entities were delivered, the Consultative Committee recommended the project should proceed.
6) Thirteen Mill Data entities provided data for standardisation into a common data format; data were subject to processes of verification, cleansing and quality rating.

Mill data assembled and standardised included:

- Spatial extents of paddocks by season in GIS format
- Paddock identifier (block, sub block)
- Sugarcane variety, plant or ratoon crop (age of crop)
- Tonnes sugarcane harvested
- Tonnes sugar

Other data assembled included:

- Soil type (from Department of Agriculture and Fisheries)
- Closest weather station (from Bureau of Meteorology)

7) For each Mill Data entity, at least ten years of historical data were cleaned and standardised. Spatial and productivity data for 2015 and 2016 were also included.
8) The data for each Mill Data entity were provided back to the individual data owners who were then to have control over user access to such data.

6 Outputs

A summary of the principal outputs from the project follows:

- The project has transformed historical and current sugarcane data for Mill Data entities that are now available in a standardised form to a substantial part of the Australian sugarcane industry.
- There is now a common industry format for any data provided to external research or extension persons or groups.
- The information can now be used by the individual Mill Data entity, and/or extension and research entities, subject to permission from the Mill Data entity who hold the data.
- The information will allow extension and research personnel to analyse productivity data more meaningfully for management purposes than hitherto as well as relate performance data to soils and weather data.
- The management of the data will be in the hands of the data owners rather than stored in a centralised Hub as originally planned, so avoiding security issues.

6.1 Communication

All relevant industry interests including Mill Data entities were aware of the project and its activities and outputs due to the original regional workshops conducted as well as the continuing interactions with Agtrix personnel throughout the project. In addition, Agtrix was in direct contact with potential future users of the data such as extension personnel and precision agriculture researchers.

Other communication outputs included a poster submitted for the 2018 ASSCT conference and the Agtrix FarmMap conference (an annual conference with 6 of the 8 milling companies).

7 Outcomes and potential outcomes

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

- Increased control by data owners of their data compared to the centralise Hub approach.
- External compilation of data sets by consultants and researchers will become easier as all data will be in the same format.
- The standardisation of the data sets will enable more efficient and wider use of the data itself; for example, combining data between Mill Data entities and regions where required, compared to the pre-project situation.
- The cleaning and standardisation of data also will provide greater confidence data validity and hence use.
- The inclusion of spatial data, soil type and weather data will allow productivity data (sugarcane and sugar yields) from the Global Positioning Systems to be analysed more meaningfully and efficiently than hitherto.
- As an example of the above (availability of spatial data, productivity data, soil type and weather data), developing precision agriculture and climate forecasting tools can be facilitated and validated and hence may become more reliable and their adoption may be increased.
- The use of the data held by individual Mill Data entities and across multiple Mill Data entities may increase.
- New uses for the standardised data sets may be developed such as pest and disease incident and response recording over time. The data recording system in place can be quickly adapted to meet new requirements as required and used to efficiently and quickly record incident or damage data for a bio-security incident or natural disaster damage assessment (e.g. cyclone damage).

8 Impacts

Many of the outcomes and potential outcomes listed earlier could have been delivered without the data extension and standardisation delivered by this project. However, the project has reduced the data assembly effort involved that was required from the previous data storage structure and extended it to include soil and climate data. The standardisation and extension of the data has increased the efficiency and reduced the costs of data assembly. The changes also have provided a spatial component to the data that would not be accessible to most researchers (Robert Crossley, pers. comm., 2019),

The extension to soil and climate data will be able to provide relationships and data that can be used to inform more effective strategies for input management such as the timing and rate of nitrogen fertiliser applications and use of enhanced efficiency fertilisers in sugarcane. The data are being used by Jo Stringer (SRA) to perform statistical analysis that includes these factors, as well as the influence of harvester speed on productivity in the next year (Robert Crossley, pers. comm., 2019).

In addition, the reduced assembly costs and confidence in the standardised data sets (e.g. via consignment accuracy and standardisation of locational references) will most likely increase the use of currently possible data applications by research and extension organisations.

Broader data applications that may require analysis of data across regions or across different mills in the one region will also be facilitated. Such new forms of analyses are likely to result in information for extension programs that would not otherwise be available.

Further, new applications will be easier to develop. For example, tracking and responding to pest and disease outbreaks in sugarcane and severe weather events will be possible and potentially more effective than hitherto.

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 • Cost saving for applications of data applications that still would have occurred without the data standardisation project. • Increased use of the data for extension and research purposes for development of more tailored extension information leading to productivity and profitability impacts.

• New uses for the standardised data framework such as pest and disease monitoring leading to improved management and control.
ENVIRONMENTAL • Potential reduction in export of fertiliser nutrients and potentially chemicals to off-farm environments.
SOCIAL • Spillover impacts to regional communities from increased sugar industry net incomes.

8.1 Public versus private impacts

The key potential impacts will include both private and public. The future private impacts potentially will accrue primarily to sugarcane growers and potentially factories. Public impacts will potentially include the environmental impacts and spillover regional impacts from the sugar industry profitability gains.

8.2 Distribution of impacts along the supply chain

Potential future impacts associated with this project will most likely accrue to sugarcane growers and factories and some associated service industries.

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 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 Priority 1, 3 and 4, (and to some extent in the future to Priority 2). The investment will contribute predominantly to Science and Research Priority 1 and 2

TABLE 3: 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)

8.5 SRA Key Focus Areas

SRA's key focus areas are presented in Table 4. Project 2015/045 addressed KFAs 2,3, 4, and 5, 7 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)

9 Valuation of impacts

9.1 Impacts valued

9.1.1 Saved data extraction costs

It was estimated in the final report for the project that $5,000 to $30,000 may be spent on data collation for each project that involves retrieval and collation of data from the milling sector sugar industry. It is assumed that this required standardising and checking data validity and would have been even more time consuming if more than one mill data set had to be accessed.

There are no credible past data available on the number of projects per annuum that would have required access and data compilation and how many mill data sets were required to be accessed per project (Robert Crossley, pers. comm., 2019).

Specific assumptions on the number of projects per annum in the past that required data access, and the average cost savings with the standardised data now available due to the investment are provided in Table 5.

9.1.2 Increased use of the data resource

It is assumed that the improved data quality and access to standardised data across all Mill Data Sets also will marginally increase the use of the data by extension and research personnel.

One difference due to the project is that the data now have been spatialised with the spatial extent of the paddocks now included. This has allowed current projects to include additional analyses such as:

- time between harvest one year to the next,
- assessment of speed of harvesters and influence on yield,
- integration of more localised weather data to production,
- integration of soils data for production analysis
- linking pest and disease records where data records were not recorded spatially to understand disease spread.

Such analyses were not possible previously from mill production data unless the researcher could source the corresponding spatial data of the relevant paddocks and had the skills to use a GIS to include such data (Robert Crossley, pers. comm., 2019).

However, as most usage will continue as before the standardisation and has been assigned benefits of a data extraction cost reduction, it is assumed usage driven by the standardisation would increase by one additional usage every two years. Specific assumptions on the extent and value of this additional usage are provided in Table 5.

TABLE 5: SUMMARY OF ASSUMPTIONS

VARIABLE	ASSUMPTION	SOURCE
IMPACT 1: SAVED DATA EXTRACTION COSTS		
Estimated number of projects in the past accessing mill data sets, before data standardisation	10 per annum	Agtrans Research
Estimated average cost of data extraction before standardised data sets	$15,000 per project (one off)	Based on the range estimate in the Final Report for Project 2015/045
Expected average cost of data extraction with standardised data sets	$5,000 per project (one off)	Agtrans Research
Average cost saving due to standardised data sets	$10,000 per project (one off)	$15,000 - $5,000
Total cost savings per annum due to the project	$100,000 per annum	10 projects x $10,000
Period over which cost savings assumed	10 years	Agtrans Research
RISK FACTORS FOR IMPACT 1		
Probability of outcome	100% that number of projects per annum in the past without data standardisation will at least continue into the future with data standardisation	Agtrans Research
Probability of cost saving assumed of $10,000 per project will occur with data standardisation	75%	
IMPACT 2: NET PRODUCTIVITY BENEFITS FROM INCREASED FUTURE USAGE FROM CLEANED AND STANDARDISED DATA		
Increase in new usages	1 additional usage every two years for the improved Mill Data Sets	Agtrans Research
Timing of new future usage commencements	Years ending 30th June 2020, 2022, 2024, 2026, and 2028	Agtrans Research
Average net productivity benefit delivered by each project	Average of $27 per ha	Based on net benefit assumed delivered by SRA Project CSE002 of approximately $30 per ha (via Precision Agriculture) as well as from SRA project 2015/070 of approximately $24 per ha (seasonal climate forecasting influencing nitrogen management)
Area of Australian sugarcane	386,000 ha	Average over past 15 years (2003-2017); ABARES, 2017
Average area of sugarcane per mill area	16,000 ha	386,000 ha/24 mills (ASMC, 2018)
Average proportion of a mill area assumed to gain the benefit	5%	Agtrans Research
Period over which benefit applies	10 years	Agtrans Research
RISK FACTORS FOR IMPACT 2		

Probability of average productivity impact of $27 per ha being delivered	50%	Agtrans Research
Probability of 5% mill area adopting	50%	

9.2 Impacts identified but not valued

Impacts identified but not valued for Project SRA 2015/045 included:

- New uses for the standardised data framework such as pest and disease monitoring leading to improved management and control (Final Report for Project 2015/045)
- Potential reduction in export of fertiliser nutrients and potentially chemicals to off-farm environments.
- Spillover impacts to regional communities from increased sugar industry net incomes.

The principal reasons these impacts were not valued were a lack information on which credible quantitative assumptions could be developed.

10 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 Tables 6 and 7.

TABLE 6: INVESTMENT CRITERIA FOR TOTAL INVESTMENT AND TOTAL BENEFITS (DISCOUNT RATE 5%)

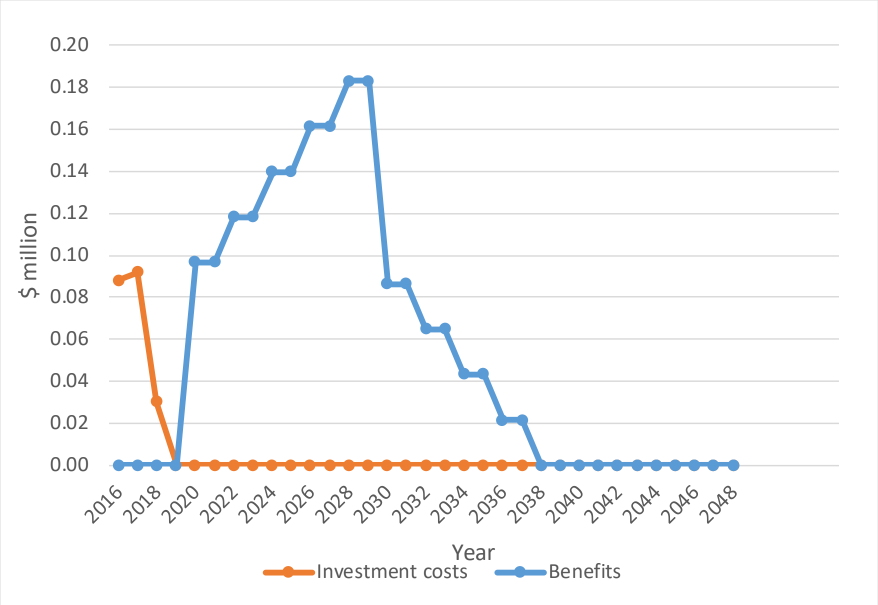
INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.38	0.93	1.21	1.27	1.27	1.27
Present value of costs ($m)	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Net present value ($m)	-0.23	0.14	0.70	0.98	1.04	1.04	1.04
Benefit–cost ratio	0.00	1.61	3.98	5.16	5.41	5.41	5.41
Internal rate of return (%)	negative	16.0	28.2	29.6	29.7	29.7	29.7
Modified internal rate of return (%)	negative	18.3	22.4	18.0	14.8	12.7	11.3

TABLE 7: INVESTMENT CRITERIA FOR SRA INVESTMENT AND SRA BENEFITS (DISCOUNT RATE 5%)

INVESTMENT CRITERIA	YEARS FROM LAST YEAR OF INVESTMENT						
	0	5	10	15	20	25	30
Present value of benefits ($m)	0.00	0.26	0.63	0.82	0.86	0.86	0.86
Present value of costs ($m)	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Net present value ($m)	-0.16	0.10	0.47	0.66	0.70	0.70	0.70
Benefit–cost ratio	0.00	1.61	3.97	5.15	5.40	5.40	5.40
Internal rate of return (%)	negative	15.8	28.0	29.4	29.5	29.5	29.5
Modified internal rate of return (%)	negative	18.1	22.3	18.0	14.7	12.6	11.3

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



10.1 Source of benefits

The relative contributions of the two sources of benefits are provided in Table 8. Given the assumptions made, there was not a large difference between the contributions from each source. It needs to be recognised that where the saved data extraction cost applies, the benefit from the data usage is assumed to have been delivered with and without the standardisation. Where the standardisation is assumed to drive extra usage, the benefit would not have been delivered without the standardisation.

TABLE 8: CONTRIBUTION TO PRESENT VALUE OF BENEFITS (PVB) FROM EACH SOURCE

SOURCE OF BENEFIT	CONTRIBUTION TO PVB ($M)	CONTRIBUTION TO PVB (%)
Saved data extraction costs	0.579	45.5
Increased use of Mill Data sets	0.693	54.5

10.2 Sensitivity analyses

Sensitivity analyses were carried out for several variables and results are reported in Tables 9 to 10. All sensitivity analyses were performed on the total investment only using a 5% discount rate (with the exception of Table 9) with benefits taken over the 30-year period. All other parameters were held at their base values.

Table 9 shows there is only a moderate sensitivity to the discount rate, largely due to short period of time between the investment and when benefits commence being delivered.

TABLE 9: SENSITIVITY TO DISCOUNT RATE(TOTAL INVESTMENT, 30 YEARS)

CRITERION	DISCOUNT RATE		
	0%	BASE (5%)	10%
Present value of benefits ($m)	1.83	1.27	0.93
Present value of costs ($m)	0.21	0.23	0.26
Net present value ($m)	1.62	1.04	0.67
Benefit-cost ratio	8.71	5.41	3.56

Table 10 provides a sensitivity analysis for several key assumptions behind each impact. Results show that while the investment criteria for the pessimistic assumptions fall considerably from the base, they are still quite positive; this is partly due to the relatively small investment associated with the data standardisation project.

TABLE 10: INVESTMENT CRITERIA CHANGES FOR OPTIMISTIC AND PESSIMISTIC SCENARIOS (TOTAL INVESTMENT, 5% DISCOUNT RATE, 30 YEARS)

CRITERION	SENSITIVITY TO OPTIMISTIC AND PESSIMISTIC SCENARIOS FOR COST SAVING ASSUMPTIONS AND NUMBER OF ADDITIONAL USAGES OF THE STANDARDISED DATA		
	PESSIMISTIC $5,000 PER USAGE SAVED; 1 EXTRA USAGE EVERY FOUR YEARS	BASE $10,000 PER USAGE SAVED; 1 EXTRA USAGE EVERY TWO YEARS	OPTIMISTIC $15,000 PER USAGE SAVED; 2 EXTRA USAGES EVERY TWO YEARS
Present value of benefits ($m)	0.88	1.27	2.25
Present value of costs ($m)	0.23	0.23	0.23
Net present value ($m)	0.64	1.04	2.02
Benefit-cost ratio	3.73	5.41	9.59

11 Conclusions

Given the assumptions made on the value of impacts, the investment criteria estimated for total investment in the project of $0.23 million (present value of costs) were positive with an expected present value of benefits of $1.27 million, an expected net present value estimated at $1.04 million and an expected benefit-cost ratio of 5.41 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 29.7% and the modified internal rate of return at 11.3 %.

As several impacts identified were not valued, the magnitude of the investment criteria estimated and reported are likely to be underestimated.

12 Acknowledgments

Robert Crossley, Agtrix
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13 References

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