

Final Report

**Industry-specific impact assessment
program: Berries**

**Impact assessment report for project *National
strawberry varietal improvement program –
southern node (BS11013)***

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Executive Summary

What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *BS11013: National Strawberry Varietal Improvement Program – Southern Node*. The project was completed over the period June 2013 to June 2017.

Methodology

The investment was analysed qualitatively within a logical framework that included activities and outputs, outcomes and impacts. Impacts were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation. Past and future cash flows were expressed in 2020/21 dollar terms and were discounted to the year 2020/21 using a discount rate of 5% to estimate the investment criteria.

Results/key findings

The investment in BS11013 over the 2013-2017 period has continued to provide the southern node of the Australian strawberry industry with improved varieties of strawberries. Beneficiaries from the investment include strawberry growers and their supply chains including consumers.

Investment Criteria

Total funding from all sources for the project was \$4.78 million (present value terms). The investment produced estimated total expected benefits of \$12.59 million (present value terms). This gave a net present value of \$7.81 million, an estimated benefit-cost ratio of 2.63 to 1, an internal rate of return of 11.5% and a modified internal rate of return of 8.4%.

Conclusions

Project BS11013 was successful in that the investment provided improvements to the range of strawberry varieties available to southern node growers. Some of the new varieties will provide benefits to the southern Australian strawberry industry. Based on the assumptions made in the economic analysis, the investment criteria estimated show a positive return to the investment.

Keywords

Impact assessment, cost-benefit analysis, strawberry, BS11013, varietal improvement, southern node, breeding

Introduction

All research, development, and extension (RD&E) and marketing levy investments undertaken by Horticulture Innovation Australia Limited (Hort Innovation) are guided and aligned to specific investment outcomes, defined through a Strategic Investment Plan (SIP). The SIP guides investment of the levy to achieve each industry's vision. The relevant industry SIPs apply for the financial years 2016/17 – 2020/21.

In accordance with the Organisational Evaluation Framework, Hort innovation has the obligation to evaluate the performance of its investment undertaken on behalf of industry.

This impact assessment program addresses this requirement through conducting a series of industry-specific ex-post independent impact assessments of the berry (Rubus (RB) + Strawberry (BS)), mango (MG), turf (TU) and nursery (NY) RD&E investment funds.

Fourteen RD&E investments (projects) were selected through a stratified, random sampling process. The industry samples were as follows:

- Four RB + BS projects were chosen worth \$1.44 million (nominal Hort Innovation investment) from an overall population of 16 projects worth an estimated \$8.59 million,
- Three MG projects worth \$1.77 million (nominal Hort Innovation investment) from an overall population of 16 projects worth approximately \$7.9 million,
- Four TU projects worth \$0.66 million (nominal Hort Innovation investment) from a total population of 15 projects worth \$4.81 million, and
- Three NY projects worth \$0.96 million (nominal Hort Innovation investment) from an overall population of 19 projects worth \$7.32 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2015 to 30 June 2020.

The projects for each industry sample were chosen such that the investments represented (1) at least 10% of the total Hort Innovation RD&E investment expenditure for each industry, and (2) the SIP outcomes (proportionally) for each industry where possible given the small sample sizes.

Project BS11013: *National Strawberry Varietal Improvement Program – Southern Node* was randomly selected as one of four unique RB + BS investments under MT20008 and was analysed in this report.

General Method

The impact assessment follows general evaluation guidelines that are now well entrenched within the Australian primary industry research sector including Research and Development Corporations, Cooperative Research Centres, State Departments of Agriculture, and some universities. The approach includes both qualitative and quantitative descriptions that are in accord with the impact assessment guidelines of the CRRDC (CRRDC, 2018).

The evaluation process involved identifying and briefly describing project objectives, activities and outputs, outcomes, and impacts. The principal economic, environmental and social impacts were then summarised in a triple bottom line framework.

Some, but not all, of the impacts identified were then valued in monetary terms. Where impact valuation was exercised, the impact assessment uses cost-benefit analysis as its principal tool. The decision not to value certain impacts was due either to a shortage of necessary evidence/data, a high degree of uncertainty surrounding the potential impact, or the likely low relative significance of the impact compared to those that were valued. The impacts valued are therefore deemed to represent the principal benefits delivered by the project. However, as not all impacts were valued, the investment criteria reported for individual investments potentially represent an underestimate of the performance of that investment.

Background & Rationale

Background

The Australian strawberry industry is one of Australia's 'traditional' horticultural industries. Strawberries Australia Inc. is the strawberry industry's peak national agri-political organisation representing strawberry growers. All States have a Strawberry Growers Association affiliated with the national body. Table 1 shows recent industry production and value statistics.

Table 1: Australian Strawberry Production and Value for Years Ending June 2018 to 2020

Year ended June	Total Australian Production (tonnes)	Fresh Supply (tonnes)	Fresh Supply Wholesale Value (\$m)	Fresh Supply Wholesale Value (\$/tonne)
2018	93,545	76,514	486.8	6,362
2019	76,605	67,577	434.2	6,425
2020	82,310	68,166	472.6	6,933
Average	84,153	70,752	464.5	6,573

Source: Australian Horticultural Statistics Handbook, 2019/20

In the year 2019/20, Queensland (QLD) produced 42% of the total strawberry volume or 34,570 tonnes (Queensland Strawberries, 2020). This volume was produced by about 80 strawberry growers from about 300 ha of planted area. By subtraction, the southern states are estimated to have produced about 47,740 tonnes of strawberries in the year ended June 2020 from about 414 ha of planted area.

The research and development activities of the strawberry industry are guided by the industry's Strategic Investment Plan (SIP). The activities are funded by levies payable on strawberry runners planted in Australia, as well as by matching government funds.

The process of preparing the latest SIP was managed by Hort Innovation in consultation with Strawberries Australia and the Strategic Investment Advisory Panel. The current SIP has been driven by levy payers and addresses the Australian strawberry industry's research and development (R&D) needs from 2017 to 2021.

Project Rationale and Subsequent Changes

Australian strawberry breeding traditionally has been focused on two zones: the northern node (servicing QLD) and the southern node servicing New South Wales (NSW), Tasmania, Victoria, South Australia and Western Australia.

Breeding for the northern node traditionally has been carried out by the Queensland Department of Agriculture and Fisheries (DAF). In the past, breeding for the southern node has been carried out by the Victorian Department of Primary Industries at Knoxfield. However, from 2012, the breeding program for the southern node was carried out by Strawberries Australia located at Wandin near Melbourne.

In 2012 it was decided that the breeding for both northern and southern nodes should be extended to 2017 and that a five year program was needed due to the long time frame required for evaluation of new varieties. For the southern node, this resulted in a new five year project being funded in June 2012. The new southern node project (BS11013) was to build on the former project (BS09009) that concluded in May 2012.

In another change, in 2015 the southern node project (BS11013) became integrated as part of a National Strawberry Breeding Program, and the southern node project based at Wandin in Victoria then became part of the national program that was led by Mark Herrington and Jodi Neal, both from Queensland DAF.

Project Details

Summary

Project Code: BS11013

Title: *National Strawberry Varietal Improvement Program – Southern Node*

Research Organisations: Strawberries Australia Inc (to 2015), Department of Agriculture and Fisheries QLD (from 2015-2017).

Project Leader: Hinga Marsh, Strawberries Australia and then Mark Herrington and Jodi Neal, Department of Agriculture and Fisheries QLD.

Period of Funding: June 2012 to June 2017

Objectives

The original project aimed to develop a range of high-quality, high value varieties suited to southern growing areas. These objectives did not change when the project was later managed by Queensland DAF.

Specific objectives included:

1. To commercialise 2-3 short day (high chill) varieties including a series of elite varieties that display high consumer appeal and outstanding agronomic characteristics and were aimed at capturing 15% of the southern Australian short day market by 2017.
2. To commercialise 1-2 day neutral varieties with high consumer appeal and outstanding agronomic characteristics from the series of Elite varieties; and were aimed capturing 15% of the southern Australia day neutral market by 2017.

Logical Framework

Table 2 provides a description of Project BS11013 in a logical framework format, organised by project activities, outputs, outcomes and impacts.

Table 2: Logical Framework for Project BS11013

Activities	<p>Development of a strawberry ideotype</p> <ul style="list-style-type: none"> • The southern node breeding program developed an ideotype for the ‘ideal strawberry’; this was achieved in association with key stakeholders including the Victorian Strawberry Growers Association and the National Strawberry Varietal Improvement Steering Committee (NSVISC). <p>Definition of traits to be targeted</p> <ul style="list-style-type: none"> • The traits to be targeted in the breeding program took into account the defined ideotype as well as productivity traits (e.g. yield, consistency, uniformity, season period), fruit quality traits (e.g. size, colour, shelf-life), and production cost traits (e.g. pest and disease tolerance, ease of picking). <p>Choice of breeding and selection methods</p> <ul style="list-style-type: none"> • Various mating designs (selection of parents) were considered so that genetic information could be best developed to address the desired traits. • The breeding population was characterised to better understand the best opportunities for future crossing and increase the probability of developing new and improved cultivars.
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	<ul style="list-style-type: none"> The introgression of new sources of material that could provide novel traits was recognised and accommodated. <p>Population improvement and selection</p> <ul style="list-style-type: none"> The population improvement part of the program was to ensure that the currently available germplasm was used to its maximum potential and was gradually improved for future use. The selection-only part of the program used recurrent phenotypic selection and then hybridisation of elite lines. <p>Selection trials</p> <p>Selection trials included:</p> <ul style="list-style-type: none"> intermediate selections, advanced selections, and elite selections. <p>Collaborations and linkages</p> <ul style="list-style-type: none"> A Southern Regional Reference Group was involved in local breeding issues and facilitated a nationally consistent strategy. Linkages with other overseas breeding initiatives were developed (e.g. Italy, Netherlands). <p>Pathogen testing and commercialisation</p> <ul style="list-style-type: none"> Crop Health Services was contracted to provide pathogen tested material for the project. The Victorian Strawberry Industry Certification Authority was contracted to provide nucleus and foundation plant material for supply to licensees. Plant Breeders Rights applications were prepared for elite lines to be commercialised following consultation with NSVISC.
Outputs	<ul style="list-style-type: none"> Several new commercially available short day (high chill) strawberry varieties with high consumer appeal and favourable agronomic characteristics were produced. Several commercially available 1-2 day neutral varieties with high consumer appeal and favourable agronomic characteristics were produced. Seed from both short day and 1-2 day neutral varieties was supplied to Western Australia (the Mediterranean environment). Three varieties have been released from the southern node breeding program since 2013. The first of these is '14-051-151' which is the intellectual property of Strawberries Australia Incorporated (SAI) and Hort Innovation; this variety was developed within project BS11013 and selected by DAF under Project BS12021. This variety is being commercialised by SAI and the Queensland Strawberry Growers Association. The other two variety releases are 'Tahli-ASBP' and 'Tamara-ASBP', which were crossed in the first year that DAF led the southern node program. These were commercialised in 2021. Early feedback on the performance of these varieties, especially 'Tahli-ASBP' is very positive (Jodi Neal, pers. comm., 2021). When DAF initially took leadership of project BS11013 there were also three short day selections and one day neutral selection ready for commercial release ('05-027-1', '05-028-55', '05-069-63', and '08-022-042'). These were the intellectual property of SAI and Hort Innovation, and DAF positioned these so that these organisations had the opportunity to release them. In the end SAI

	<p>and Hort Innovation decided not to commercialise these selections (Jodi Neal, pers. comm., 2021).</p> <ul style="list-style-type: none"> • All other promising selections from the subsequent '09' to '13' breeding generations produced under BS11013 were found by DAF to be virus-infected, and these selections would have taken several years to make clean for commercial release. The decision was made to use these elite selections as parents only and instead move forward with new virus-free material (the '14' generation onwards), which includes 'Tahli' and 'Tamara' (Jodi Neal, pers. comm., 2021).
Outcomes	<ul style="list-style-type: none"> • A potential increase in yield of Australian bred strawberry varieties suitable for southern states and Western Australia. • A potential improvement in sensory characteristics of both short day and day neutral varieties used in southern Australia. • An increase in price of Australian bred strawberry varieties suited to southern areas due to an increase in consumer appeal. • An increase in sales of Australian bred varieties of strawberries in southern states vis a vis imported varieties. • Tahli-ASBP has significantly higher yield and average fruit size than 'Albion', the current leading temperate variety, while still having excellent flavour (Jodi Neal, pers. comm., 2021). • Tamara-ASBP is a premium berry with outstanding flavour, and is targeted for consumer markets that would garner a higher price. These varieties were only released in 2021 and are being grown in moderate commercial numbers for the first time this season (Jodi Neal, pers. comm., 2021). • All three of the varieties released under the southern node are newly released, and are still in the process of being produced in larger numbers by plant propagators. For this reason they have not yet had the opportunity to impact on the larger southern industry. This coming season will be the first time that they will have been planted in moderate numbers commercially. • The varieties released have been selected for a balance of traits that will make them valued by consumers (excellent flavour, appearance and shelf life), productive to grow (e.g. high yields and good disease resistances), and cost-effective to produce (e.g. large fruit size, more consistent fruit shape and size, good bruise resistance, quick to pick and pack) (Jodi Neal, pers. comm., 2021). • The generations following these are looking even more promising, with ongoing gains in several key traits including consistency of fruit size (Jodi Neal, pers. comm., 2021).
Impacts	<ul style="list-style-type: none"> • A potentially increased demand for strawberries due to the past and future releases of new varieties with characteristics valued by consumers. • A potential contribution to improved profitability of strawberry growing for southern regions due to, for example: increased productivity, price, and/or growing-cost reductions compared with varieties replaced. • An increase in capital value of unreleased strawberry germplasm in the program between 2013 and the end of the investment in 2018. • Increased disease resistance of some new varieties may have resulted in reduced chemical use and hence a reduction in chemical export to the off-farm environment. • Increased regional community spillovers from a more productive southern strawberry industry. • Enhanced capability and capacity of strawberry breeders.

Project Investment

Nominal investment

Table 3 shows the total investment made in Project BS11013 by Hort Innovation and Queensland DAF. Hort Innovation continued to fund the project as originally planned, but Queensland DAF provided additional resources to the project when it was merged with BS12021 in the final four years.

Table 3: Annual Investment in Project BS11013 (nominal \$)

Year ended 30 June	Hort Innovation (\$)	Queensland DAF (\$)	TOTAL (\$)
2012	180,000	0	180,000
2013	140,000	0	140,000
2014	346,160	0	346,160
2015	181,186	264,269	445,455
2016	330,014	284,432	614,446
2017	331,544	355,753	687,297
2018	76,231	271,841	348,072
Totals	1,585,135	1,176,295	2,761,430

Sources: Project Research Agreement and Assessment Summary by Alok Kumar; investment from 2015 onwards (when Queensland DAF took over the project) was provided by Jodi Neal.

Program management costs

For the Hort Innovation investment the cost of managing its funding was added to the Hort Innovation contribution in Table 3 via a management cost multiplier (1.162). This multiplier was estimated based on the share of 'payments to suppliers and employees' in total Hort Innovation expenditure (3-year average) reported in the Hort Innovation's Statement of Cash Flows (Hort Innovation Annual Report, various years). This multiplier was then applied to the nominal investment by Hort Innovation shown in Table 3. For the Queensland DAF investment, it was assumed the management cost was already included in the DAF contribution in Table 3.

Real investment and extension costs

For purposes of the investment analysis, the investment costs of all parties were expressed in 2020/21 dollar terms using the Implicit Price Deflator for Gross Domestic Product (ABS, 2021). No additional costs of extension were included as the project itself was closely involved with industry.

Impacts

Table 4 provides a summary of the principal types of impacts delivered by the project, based on the logical framework. Impacts have been categorised into economic, environmental and social impacts.

Table 4: Triple Bottom Line Categories of Principal Impacts from Project BS11013

Economic	<ul style="list-style-type: none"> • A potentially increased demand for strawberries due to the past and future releases of new varieties with characteristics valued by consumers. • A potential contribution to improved profitability of strawberry growing for southern regions due to, for example: increased productivity, price, and/or growing-cost reductions compared with varieties replaced. • An increase in capital value of unreleased strawberry germplasm in the program between 2013 and the end of the investment in 2018.
Environmental	<ul style="list-style-type: none"> • Increased disease resistance of some new varieties may have resulted in reduced chemical use and hence a reduction in chemical export to the off-farm environment.
Social	<ul style="list-style-type: none"> • Increased regional community spillovers from a more productive southern strawberry industry. • Enhanced capability and capacity of strawberry breeders.

Public versus private impacts

The impacts identified from the investment are predominantly private impacts accruing to the strawberry industry (including consumers) through the availability of improved varieties. Some public and community impacts also will be delivered by the spillover effects on regional communities as well as via the enhanced breeding capability and capacity of strawberry breeders.

Distribution of private impacts

The private impacts will be largely focused on strawberry growers in the southern states including businesses involved in the strawberry supply chains.

Impacts on other Australian industries

It is likely that most impacts will be mostly confined to the Australian strawberry industry.

Impacts overseas

It is unlikely that there will be any significant spillover impacts from the project to overseas interests.

Match with national priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 5. The project outcomes and related impacts will contribute primarily to Rural RD&E Priority 4, and to Science and Research Priority 1.

Table 5: Australian Government Research Priorities

Australian Government	
Rural RD&E Priorities (est. 2015)	Science and Research Priorities (est. 2015)
<ol style="list-style-type: none"> 1. Advanced technology 2. Biosecurity 3. Soil, water and managing natural resources 4. Adoption of R&D 	<ol style="list-style-type: none"> 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)

Alignment with the Strawberry Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the Australian strawberry industry are outlined in the Strawberry Industry’s Strategic Investment Plan 2017-2021¹ (Hort Innovation, 2017). Project BS11013 addressed Outcome 3 through Strategy 3.1 (Ensure that superior strawberry varieties that match consumer expectations are available to growers) with some contribution to Outcome 1 (‘By 2021, per capita domestic consumption of fresh Australian strawberries will increase by 10 per cent, underpinned by consistent supply of premium quality fruit that matches consumer desires’) through delivery of new varieties suitable to the southern growing areas and that are preferred by growers and consumers.

¹ For further information, see: <https://www.horticulture.com.au/hort-innovation/funding-consultation-and-investing/investment-documents/strategic-investment-plans/>

Valuation of Impacts

Valuation Framework

The valuation framework for Project BS11013 was based on an earlier evaluation of a project (BS12021) that addressed both southern and northern nodes of the national strawberry breeding program. However, this earlier valuation focused on the valuation of impacts only in the northern zone. While using the earlier valuation framework, the evaluation of Project BS11013 considered only the southern zone impacts and the southern zone investment costs. Hence, there is no duplication of any benefits and costs in the assessments of the impacts of Projects BS12021 and BS11013.

Impacts Valued

A number of new varieties suitable for the southern growing areas were released during Project BS11013. In addition, the project has potentially made significant contributions to new varieties that have been/will be released after the completion of the project.

The impact that was valued was the gross margin increase associated with the three varieties released from the project that replaced older varieties. The new varieties provided one or more benefits via contributions from increased yield and price and lowered costs.

Plantings of these new varieties required a royalty payment being made by the grower. The royalty payment was used by the industry to offset some of the costs incurred in the development of future varieties, that is the royalty payments by growers were returned to levy payers. Hence, the royalty payments were incurred by Australian growers and received by the program/levy payers. In that regard, they were considered a transfer payment only and did not represent a net benefit to Australia.

Valuation of impacts produced estimates of benefits that included future expected benefits. A degree of conservatism was used when finalising assumptions, particularly as there was some uncertainty involved in assumptions. Sensitivity analysis was undertaken for some of those variables where there was greatest uncertainty.

The assumptions that have driven gross margin increases due to the new southern region varieties are provided later in Table 6. The table shows the increase in proportion of southern strawberry growing area that was assumed populated by the released project-bred varieties, together with an increase in the gross margin. The increase in the gross margin was assumed to include both yield and price increases as well as any potential variable cost reductions.

Impacts Not Valued

Several other impacts were identified but not valued; they included:

- Any Increase in the capital value of southern zone strawberry germplasm available but unexploited at the end of the project.
- Potential for reduced chemical use and hence a reduction in chemical export to the off-farm environment. This impact was not valued due to the difficulty of making assumptions regarding chemical export quantities and the damage they might do to the environment.
- Increased regional community spillovers from a more productive and profitable strawberry industry captured by local families and businesses along the supply chain. This impact was not valued due to the difficulty of making sound linkage assumptions between the project and the impact and the diversity of geographic locations involved, as well as a lack of time and resources.
- Enhanced capability and capacity of scientists associated with strawberry breeding; this impact was not valued due to insufficient resources/time and the difficulty in assembling appropriate data. Moreover, this impact was already valued, at least in part, via the contribution to the improved varieties produced and released.

Summary of Assumptions

The specific assumptions used to value the likely improved profitability of southern strawberry growing due to BS11013 are provided in Table 6.

Table 6: Summary of Assumptions for Valuation of Impact for Project BS11013

Variable	Assumption	Source/Comment
Impact valued: Improvement in yield and price due to new varieties		
Proportion of production in Queensland	42%	QLD Strawberries (2020)
Average annual area of strawberry production in Queensland	Agtrans estimate of 450 ha	Based on average of Queensland Strawberries (2020) 300 ha and Qld Govt (2019) 600 ha
Estimated Australian area of strawberries	1,071 ha per annum	450 x 100/42
Estimated total southern area of strawberries	621 ha	(1071-450) ha
Proportion of total southern area growing the three new varieties from the southern node breeding program	15%	Analyst assumption based on project outputs and outcomes
Average annual gross margin for Australian strawberry production	\$81,179 per ha per annum	Department of Primary Industries, Parks, Water and Environment, Tasmania (2018) https://dpiuwe.tas.gov.au/
Maximum increase in gross margin due to planting of the three new varieties released	15%	Analyst assumption based on a combination of an increase in consumer value reflected in price, and increased yield and reduced costs captured by growers
First year of impact	Year ended June 2022 (one third of maximum impact)	Analyst assumptions
Year of maximum impact	Year ended June 2024	
Risk, attribution and counterfactual factors		
Probability of outcome (the assumed proportion of southern industry experiencing productivity gains from the project)	90%	Estimates by Analyst
Probability of increase in gross margin due to project (probability of impact)	90%	
Attribution	100%	
Counterfactual	It was assumed that without the investment in BS11013, the impact valued would not have occurred	

Results

All costs and benefits were discounted to 2020/21 using a discount rate of 5%. A reinvestment rate of 5% was used for estimating the modified internal rate of return (MIRR). The base analysis used the best available estimates for each variable, notwithstanding a level of uncertainty for many of the estimates. All analyses ran for the length of the project investment period plus 30 years from the last year of investment (2016/17) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Tables 7 and 8 show the investment criteria estimated for different periods of benefits for the total investment and the Hort Innovation investment alone.

Table 7: Investment Criteria for Total Investment in Project BS11013

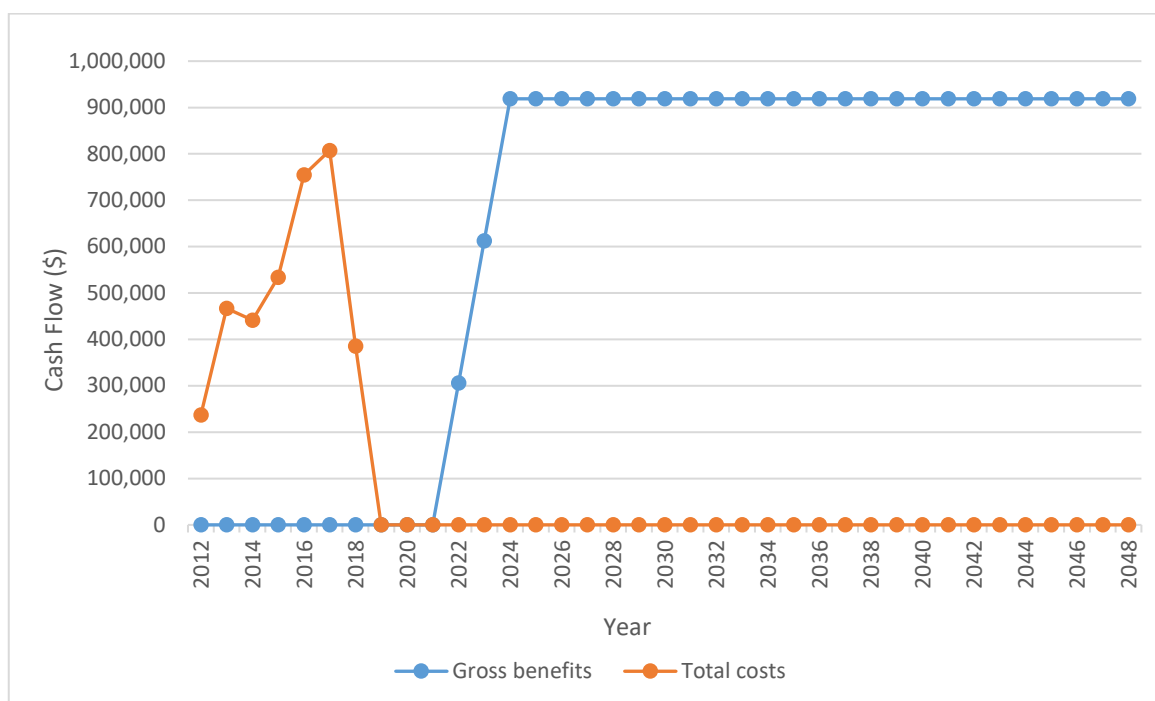
Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	0.00	0.85	4.46	7.28	9.50	11.23	12.59
Present Value of Costs (\$m)	4.78	4.78	4.78	4.78	4.78	4.78	4.78
Net Present Value (\$m)	-4.78	-3.94	-0.33	2.50	4.71	6.45	7.81
Benefit-Cost Ratio	0.00	0.18	0.93	1.52	1.98	2.35	2.63
Internal Rate of Return (%)	negative	negative	4.26	8.71	10.36	11.10	11.47
MIRR (%)	negative	negative	5.07	8.04	8.63	8.62	8.44

Table 8: Investment Criteria for Hort Innovation Investment in Project BS11013

Investment Criteria	Years after Last Year of Investment						
	0	5	10	15	20	25	30
Present Value of Benefits (\$m)	0.00	0.54	2.86	4.68	6.10	7.22	8.09
Present Value of Costs (\$m)	3.17	3.17	3.17	3.17	3.17	3.17	3.17
Net Present Value (\$m)	-3.17	-2.62	-0.31	1.51	2.93	4.05	4.92
Benefit-Cost Ratio	0.00	0.17	0.90	1.48	1.93	2.28	2.55
Internal Rate of Return (%)	negative	negative	4.00	8.26	9.88	10.62	10.99
MIRR (%)	negative	negative	9.79	12.28	11.82	11.08	10.39

The annual undiscounted benefit and cost cash flows for the total investment for the duration of the BS11013 investment plus 30 years from the last year of investment are shown in Figure 1.

Figure 1: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs



Sensitivity Analyses

A sensitivity analysis was carried out on the discount rate. The analysis was performed for the total investment and with benefits taken over the life of the investment plus 30 years from the last year of investment. All other parameters were held at their base values. Table 9 presents the results that show a moderate sensitivity to the discount rate.

Table 9: Sensitivity to Discount Rate
(Total investment, 30 years)

Investment Criteria	Discount rate		
	0%	5%	10%
Present Value of Benefits (\$m)	23.89	12.59	7.68
Present Value of Costs (\$m)	3.63	4.78	6.28
Net Present Value (\$m)	20.26	7.81	1.40
Benefit-cost ratio	6.59	2.63	1.22

A sensitivity analysis was then undertaken for the average increase in the gross margin for the proportion of southern strawberry area impacted. Results are provided in Table 10.

Table 10: Sensitivity to Assumption of Increase in Gross Margin
(Total investment, 30 years)

Investment Criteria	Increase in Gross Margin for Area of New Varieties		
	10%	15% (Base)	20%
Present Value of Benefits (\$m)	8.39	12.59	16.79
Present Value of Costs (\$m)	4.78	4.78	4.78
Net Present Value (\$m)	3.61	7.81	12.00
Benefit-cost ratio	1.75	2.63	3.51

Confidence Rating

The results produced are highly dependent on the assumptions made, some of which are uncertain. There are two factors that warrant recognition. The first factor is the coverage of benefits. Where there are multiple types of benefits it is often not possible to quantify all the benefits that may be linked to the investment. The second factor involves uncertainty regarding the assumptions made, including the linkage between the research and the assumed outcomes.

A confidence rating based on these two factors has been given to the results of the investment analysis (Table 11). The rating categories used are High, Medium and Low, where:

- High: denotes a good coverage of benefits or reasonable confidence in the assumptions made
- Medium: denotes only a reasonable coverage of benefits or some uncertainties in assumptions made
- Low: denotes a poor coverage of benefits or many uncertainties in assumptions made

Table 11: Confidence in Analysis of Project

Coverage of Benefits	Confidence in Assumptions
Medium-Low	Low-Medium

Coverage of benefits was assessed as Medium-Low. While the most important impact from the investment was valued, there were a number of other impacts that were identified but not valued in monetary terms. As a result, the investment criteria as provided by the valued benefit are likely to be underestimated.

Confidence in assumptions for the impact valued was rated as Low-Medium, as a number of the assumptions regarding the future use of the new varieties to be released and their performance when grown commercially could not be based on actual data.

Conclusions

The investment in Project BS11013 focused on continuing the investment in the Strawberry Breeding Program -Southern node. The future release of new strawberry varieties suited to southern Australia growing regions is likely to contribute to an increase in consumer demand for these varieties as well as providing some increased profitability for strawberry growers in the southern areas of Australia.

Total funding from all sources for the project was \$4.78 million (present value terms). The investment produced estimated total expected benefits of \$12.59 million (present value terms). This gave a net present value of \$7.81 million, an estimated benefit-cost ratio of 2.63 to 1, an internal rate of return of 11.5% and a modified internal rate of return of 8.4%.

As several economic and social impacts identified were not valued, the investment criteria reported by the evaluation may be underestimates of the actual performance of the investment.

Glossary of Economic Terms

Cost-benefit analysis:	A conceptual framework for the economic evaluation of projects and programs in the public sector. It differs from a financial appraisal or evaluation in that it considers all gains (benefits) and losses (costs), regardless of to whom they accrue.
Benefit-cost ratio:	The ratio of the present value of investment benefits to the present value of investment costs.
Discounting:	The process of relating the costs and benefits of an investment to a base year using a stated discount rate.
Internal rate of return:	The discount rate at which an investment has a net present value of zero, i.e. where present value of benefits = present value of costs.
Investment criteria:	Measures of the economic worth of an investment such as Net Present Value, Benefit-Cost Ratio, and Internal Rate of Return.
Modified internal rate of return:	The internal rate of return of an investment that is modified so that the cash inflows from an investment are re-invested at the rate of the cost of capital (the re-investment rate).
Net present value:	The discounted value of the benefits of an investment less the discounted value of the costs, i.e. present value of benefits - present value of costs.
Present value of benefits:	The discounted value of benefits.
Present value of costs:	The discounted value of investment costs.

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Abbreviations

ABS	Australian Bureau of Statistics
BS	Strawberry
CRRDC	Council of Research and Development Corporations
DAF	Department Agriculture and Fisheries Queensland
DAWR	Department of Agriculture and Water Resources (Australian Government)
GDP	Gross Domestic Product
Hort Innovation	Horticulture Innovation Australia Ltd
MG	Mango
MIRR	Modified Internal Rate of Return
NSVISC	National Strawberry Varietal Improvement Steering Committee
NSW	New South Wales
NY	Nursery
OCS	Office of Chief Scientist
QLD	Queensland
R&D	Research and Development
RB	Rubus
RD&E	Research, Development and Extension
SAI	Strawberries Australia Incorporated
SIP	Strategic Investment Plan
TU	Turf
\$m	million dollars