Industry-specific impact assessment program: apple and pear

Impact assessment report for project *Development of mass-trapping methods for codling moth females in disrupted orchards* (MT12000)

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What the report is about

This report presents the results of an impact assessment of a Horticulture Innovation Australia Limited (Hort Innovation) investment in *MT12000: Development of mass-trapping methods for codling moth females in disrupted orchards.* The project was funded by Hort Innovation over the period June 2013 to May 2016.

Methodology

The investment was first analysed qualitatively within a logical framework that included activities and outputs, outcomes and impacts. Actual and/or potential impacts then were categorised into a triple bottom line framework. Principal impacts identified were then considered for valuation in monetary terms (quantitative assessment). Past and future cash flows were expressed in 2017/18 dollar terms and were discounted to the year 2018/19 using a discount rate of 5% to estimate the investment.

Results/key findings

The investment in MT12000 provided proof of concept for female codling moth (CM) mass-trapping methods and improved knowledge and scientific capacity.

Investment Criteria

Total funding from all sources for project MT12000 was $1.59 million (present value terms). No impacts were valued as part of the project evaluation.

Conclusions

Though the project produced no direct, quantifiable impacts, MT12000 is likely to contribute to future potential impacts for the Australian apple and pear industry, including reduced production losses from CM, improved environmental outcomes through reduced chemical use, and enhanced regional community wellbeing as a spill-over benefit from a more productive Australian apple and pear industry. Any such future benefits may be partially attributable to the investment in project MT12000.

Keywords

Impact assessment, cost-benefit analysis, MT12000, codling moth, trapping, mating disruption, pome, apple and pear, proof of concept

Introduction

All research and development (R&D) 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 current 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 apple & pear (AP), avocado (AV), mushroom (MU) and table grape (TG) RD&E investment funds.

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

- Nine AP projects were chosen worth $15.46 million (nominal Hort Innovation investment) from an overall population of 19 projects worth an estimated $33.31 million,
- Seven AV projects worth $1.91 million (nominal Hort Innovation investment) from an overall population of 27 projects worth approximately $9.97 million,
- Five MU projects worth $1.75 million (nominal Hort Innovation investment) from a total population of 20 projects worth $7.94 million, and
- Six TG projects worth $2.84 million (nominal Hort Innovation investment) from an overall population of 11 projects worth $5.0 million.

The project population for each industry included projects where a final deliverable had been submitted in the five-year period from 1 July 2013 to 30 June 2018.

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.

Project MT12000*: Development of mass-trapping methods for codling moth females in disrupted orchards* was randomly selected as one of the 22 unique MT18009 investments 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 (RDCs), Cooperative Research Centres (CRCs), 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 actual and/or potential 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 used 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

Apples and pears are two of the main horticulture crops produced in Australia. Combined, the apple and pear industries produce more fresh fruit than any other fruit industry in Australia (APAL, 2019). The main production of apples and pears occurs in Victoria (at 45% and 88% of national production respectively), with major apple producers also located in all other states. Most Australian apples and pears are for fresh supply, but both also have significant production sent for processing (for juices and other value-added products). Apples and pears are known as pome fruits and are members of the plant family *Rosaceae*. They are fruits that have a "core" of several small seeds, surrounded by a tough membrane. The membrane is encased in an edible layer of flesh (NSW DPI, n.d.).

In 2017/18, Australian apples had a farm gate value (FGV) of $418.3 million and production of 269,355 tonnes, while pears (including Nashi) had an FGV of $80.2 million and production of 103,748 tonnes (ABS, 2019). Domestic apple consumption has remained relatively stable over time, but per capita consumption has been falling (Hort Innovation, 2016). Fresh pear (excluding Nashi) per capita consumption has remained stable since 2002/03 (Hort Innovation, 2016).

Exports, while relatively small compared to domestic consumption, represent an important growth area for apples and pears. A total of 2,134 tonnes (or 1% of fresh production) of apples was exported in 2014/15 (Hort Innovation, 2016) with major markets being Papua New Guinea, United Kingdom, Sri Lanka, and Hong Kong S.A.R.

For pears, a total of 7,647 tonnes (7% of fresh production) was exported the same year (Hort Innovation, 2016), with major export markets being New Zealand, Indonesia, Canada, Singapore, and more recently India. Australia does allow imports of both apples and pears, but quantities are relatively small compared to domestic production.

There are both opportunities and challenges for the Australian apple and pear industry to improve in areas such as biosecurity, inconsistency of eating quality, export competition and market access, and an oversupply leading to lower prices (Hort Innovation, 2016).

The collective goal of the two industries is to increase the growth in domestic consumption of apples and pears, and to see growth in exports. The apple and pear industries have funded a number of projects, through Hort Innovation and industry RD&E investments, around improving access to the Asian export market, improved marketing of apples and pears, and improving industry productivity and quality (APAL, 2013).

Statutory levies are in place for both industries for Emergency Plant Pest Response, National Residue Testing, Plant Health Australia, Marketing and Research and Development (R&D). Marketing and R&D levies are managed by Hort Innovation. APAL is the apple and pear industries' representative body and non-profit membership organisation.

Rationale

Codling moth (CM) is the most serious pest of pome fruit worldwide and is noted as a key pest issue for the Australian apple and pear, nashi and quince industries in the Hort Innovation Apple and Pear Strategic Investment Plan 2017-2021 (Hort Innovation, 2017). CM is widely distributed in all Australian states except Western Australia and the Northern Territory. In the past, CM was controlled by multiple applications of organophosphate insecticides until the pest developed resistance to the pesticides. Newer pesticides with lower human toxicity are more specific but often more expensive than the organophosphate pesticides they replaced, but also require more attention to timing of spray applications and adherence to resistance management strategies (Williams, 2018).

Control of CM is the key to almost all other pest programs in pome fruit orchards since the chemicals commonly used to control codling moth have adverse effects on beneficial insect species, which contribute to biological control of other pests (Williams, 2000). Current control methods for CM include (Michaels, 2019):

- Biological control with the *Trichogramma* micro wasp and other natural codling moth enemies (such as entomopathogenic nematodes, CM granulosis virus, etc.),
- Orchard maintenance including tree monitoring, destruction of affected fruit, and removal of loose bark and debris,
- Chemical control using appropriate pesticides,
- Conventional insect trapping devices, and
- Pheromone-mediated mating distruption (MD)/trapping.

MD in particular has been a key, non-chemical tool for the implementation of integrated pest management (IPM) for pome fruit in Australia. However, where female CM population density is medium to high, MD becomes less effective. Project MT12000 (*Development of mass-trapping methods for codling moth females in distrupted orchards*) was funded as a 'proof of concept' project to develop mass-trapping methods for female CM to complement existing MD practices.

Project Details

Summary

Project Code: MT12000

Title: *Development of mass-trapping methods for codling moth females in disrupted orchards*

Research Organisation: Victorian Department of Primary Industries (VIC DPI[1])

Principal Investigator: David Williams

Period of Funding: June 2013 to May 2016

Objectives

The objectives of the project were to:

1. Assess the effectiveness of putative synergist in mixtures with pear ester and/or codlemone for attracting codling moths.
2. Investigate the active space of traps containing the best performing combination lure identified from objective 1 above.
3. Determine the optimal spatial density of the traps for use in mass-trapping of codling moths in pear orchards.

Logical Framework

Table 1 provides a description of MT12000 in a logical framework.

Table 1: Logical Framework for Project MT12000

Activities and Outputs	*Activities:* • In 2013/14, two field sites were established in the Goulburn Valley, Victoria, to assess the relative attractiveness of various combinations of pheromones and host plant volatiles in lures for male and female codling moths. • For the first field site at Bunbartha, a block of CM infested Corella pears surrounded by Nashi was used to assess 6 lure types (combinations) replicated 4 times in a Randomized Complete Block Design (RCBD). • Delta traps baited with individual lures were placed in the top meter of the tree canopy in October 2013. • For the second trial site, a large orchard in Ardmona containing Packham pears with a history of CM infestation was selected for a larger experiment using 24 lure types (combinations) replicated 4 times in a Randomised Incomplete Block Design (RIBD). • At both experimental sites, all traps were monitored weekly and all captured moths were counted before being removed for sexing by examining genitalia under the dissecting microscope. • For identification of female mating status, the abdomen of CM females was dissected and bursa copulatrix inspected for presence of spermatophores. • In 2014/15, a separate block of pears (cv. Packham's Triumph) in an orchard at Ardmona, Victoria, with a history of damage by CM and treatment with pheromone

[1] Now known as the Department of Jobs, Precincts and Regions (DJPR). Also formerly known as the Department of Economic Development, Jobs, Transport and Resources (DEDJTR).

	mediated MD, was selected as a study site. • The experimental plot was approximately 2.6 ha in size. Tree rows were 5.9 m apart and trees within the rows were spaced approximately 5.1 m apart. • One delta trap baited with the test lure (codlemone + pear ester + a confidential host plant volatile) was placed on a branch within the top meter in the outer edge of the canopy in every 2nd tree (starting 3 trees in from the western end of the row) in every 2nd row (starting 3 rows in from the northern side of the block) until 14 traps had been placed in each of 8 trapped rows. • This resulted in a grid of 112 traps in which each trap was approximately 11.8 m away from its nearest neighbour across a row or 10.2 m within rows. • Then, another block of the same pear variety, located about 145 m to the south of the first block with a similar history of CM damage and with trees the same age and laid out the same way as in the first block, was used to compare the active space of the traps when MD pheromone was not present. • Traps were established using the same protocol as per the first block. • The location of all traps was recorded as GPS coordinates. Lures in the traps were not periodically changed (normal practice would be to change lures every 6-8 weeks) because the project team were interested in testing longevity of the lures as well as the attractive radius. • Traps were inspected each week for the presence of moths. All trapped CMs were counted, collected into vials and transported to the laboratory for determination of gender, and mating status of females. • The cumulative catch in each trap and the GPS referenced location of each trap, was then used in Vesper 1.6[2] (Australian Centre for Precision Agriculture, The University of Sydney, NSW) to produce a spatial prediction of the CM population density in the trial orchard at each sampling date. This enabled estimation of the active radius. • Fruit damage assessments on 100 trees (100 fruits per tree) within each block with and without MD (i.e. 200 trees and 20,000 fruits in total) were conducted close to the end of the growing season, but just before commercial harvest. • In 2015/16, work was conducted to assess the field life of the lures and to determine potential impacts on efficacy of mass trapping. • The same pear blocks at Ardmona, used in previous seasons, were selected as study sites. • One delta trap baited with the test lure (codlemone + pear ester + a confidential host plant volatile) was placed on a branch within the top meter in the outer edge of the canopy of each of 4 trees per plot, with 3 plots (treatments) per experimental block, and 10 blocks in total. • Treatments allocated to plots were based on frequency of changing the lures. • Treatments were: (1) no change of lure; (2) lure changed every 6 weeks; and (3) lure changed every 3 weeks. • The location of all traps was recorded as GPS coordinates so that spatial analysis could be used to confirm the active radius calculations from the previous season. • Traps were inspected each week for presence of moths. All trapped CMs were counted and then collected into vials and transported to a laboratory to determine

[2] VESPER: Variogram Estimation and Spatial Prediction Plus Error. VESPER is a PC-Windows program developed by the Australian Centre for Precision Agriculture (ACPA) for spatial prediction that is capable of performing kriging with local variograms (Haas, 1990). Kriging with local variograms involves searching for the closest neighbourhood for each prediction site, estimating the variogram from the neighbourhood, fitting a variogram model to the data and predicting the value and its uncertainty (The University of Sydney, 2012).

	gender by examining genitalia under the dissecting microscope. • Data were analysed using RCBD-based repeated measures ANOVA[3]. Variograms were also used to determine active space, as in 2014/15. • Fruit damage was assessed by inspecting 200 fruit from the central tree in each plot. *Outputs:* • The project demonstrated that, in pear orchards treated with pheromone-mediated MD: o A combination of codlemone plus pear ester and another, confidential plant volatile outperformed 23 other combinations of volatiles, including codlemone plus pear ester and acetic acid, in trapping male and female CM. o The active space of delta traps baited with the best performing lure was between 35 – 43 meters for trapping male, and 32 – 33 meters for trapping female CM. o Delta traps baited with the best performing lure could be used at 8 traps per hectare to produce reliable estimates of CM population density. o Damage levels attributed to CM were reduced from 0.57%, at the end of the first year of mass-trapping, to 0.083% at the end of the second year. This was in line with a forecast outcome of less than 0.1% crop damage provided in the original project proposal. • A final report was produced that documents the proof of concept. • A second report also was produced that discussed issues associated with the integration of CM female mass-trapping and improved monitoring in pheromone MD orchards into pome fruit orchard IPM programs. • A number of articles were prepared and published in the apple and pear industry magazine to increase awareness of the project findings. • Project results also have been included in several workshops and industry presentations. • A number of scientific papers and conference presentations were produced.
Outcomes	• The project was designed as a proof of concept investment only. • The Department of Jobs, Precincts and Regions (DJPR)[4], Victoria has since developed a proposal for a second stage of work to be discussed with Hort Innovation, industry and potential commercial partners. However, no specific information on these investments or their likely outputs was available at the time of the current impact assessment. • If proof of concept and the DJPR proposal are accepted, the second phase will progress development of female CM mass-trapping options through to registration, commercialisation and adoption by pome growers in Australia. • Three commercial partners have been identified to date: a trap manufacturer in China, a lure manufacturer in Costa Rica, and another manufacturer/pest management equipment supplier in the United States of America.
Impacts	As the project was specifically a proof of concept investment, the following impacts are considered potential, future impacts that may be, in part, attributable to the investment in MT12000: • Contribution to reduced production losses from CM for the Australian apple and pear industry through the development of female CM mass-trapping devices/methods. • Contribution to prolonged life of existing narrow-spectrum pesticides through reduced reliance on chemical control of CM. • Contribution to improved environmental outcomes, including enhanced survival of biocontrol agents and reduced chemical export off-farm, from reduced pesticide use. • Increased knowledge and research capacity. • Some contribution to improved regional community wellbeing as a spill-over benefit from more productive apple and pear growing regions.

[3] Analysis of Variance (ANOVA) is a collection of statistical models and their associated estimation procedures used to analyse the differences among group means in a sample.

[4] Formerly known as the Department of Economic Development, Jobs, Transport and Resources (DEDJTR) and VIC DPI.

Project Investment

Nominal Investment

Table 2 shows the annual investment (cash and in-kind) in project MT12000 by Hort Innovation and DJPR. The project was also funded by voluntary contributions from industry through Turnbull Bros Orchards Pty Ltd.

Table 2: Annual Investment in the Project MT12000 (nominal $)

Year ended 30 June	Hort Innovation[(a)] ($)	DJPR ($)	Industry	Total ($)
2013	100,000	145,171	0	245,171
2014	120,000	145,171	51,404	316,575
2015	100,000	145,171	51,404	296,575
2016	100,000	145,171	51,404	296,575
Totals	420,000	580,684	154,212	1,154,896

Source: MT12000 Project Agreement and Variation documents supplied by Hort Innovation 2019

(a) Note: $200,000 contributed by the Apple and Pear R&D levy and $10,000 contributed by the Nashi R&D levy (with matching Government funds)

Program Management Costs

For the Hort Innovation investment the cost of managing and administrating the Hort Innovation funding was added to the Hort Innovation contribution for the project 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 2.

For the DJPR and industry investments, it was assumed that the management and administration costs were already included in the nominal values reported in Table 2.

Real Investment and Extension Costs

For the purposes of the investment analysis, investment costs of all parties were expressed in 2017/18 dollar terms using the Gross Domestic Product deflator index (ABS, 2018). No additional costs associated with project extension were incorporated as the project included a high level of industry participation and a number of extension activities.

Impacts

Table 3 provides a summary of the principal types of impacts delivered by the project. Impacts have been categorised into economic, environmental and social impacts.

Table 3: Triple Bottom Line Categories of Principal Impacts from Project MT12000

Economic	• Potential future contribution to reduced production losses from CM for the Australian apple and pear industry through the development of female CM mass-trapping devices/methods. • Potential future contribution to prolonged life of existing narrow-spectrum pesticides through reduced reliance on chemical control of CM.
Environmental	• Potential future contribution to improved environmental outcomes, including enhanced survival of biocontrol agents and reduced chemical export off-farm, from reduced pesticide use.
Social	• Increased knowledge and research capacity. • Some potential future contribution to improved regional community wellbeing as a spill-over benefit from more productive apple and pear growing regions

Public versus Private Impacts

Impacts identified in this evaluation are predominantly private in nature. Private benefits are likely to be realised by Australian apple and pear producers in the future through reduced production losses from CM because of adoption of new and improved female CM mass-trapping methods. Some public benefits may occur and include improved environmental outcomes through reduced pesticide use, increased scientific capacity as well as potentially increased incomes in apple and pear growing communities/regions associated with a more productive industry.

Distribution of Private Impacts

Any future impacts on the Australian apple and pear industry from investment in project MT12000 will be shared along the apple and pear supply chains with input suppliers, growers, processors, transporters, wholesalers, retailers and consumers all sharing impacts produced by the project according to relevant supply and demand elasticities.

Impacts on Other Australian Industries

Impacts on industries other than the Australian apple and pear industry may include potential gains to other fruit tree industries (e.g. quince) via potential future spill-overs from the increase in knowledge and scientific capacity.

Impacts Overseas

No significant or direct overseas impacts were identified. However, the knowledge created by the project and shared through international scientific and industry networks may results in some positive impacts for pome industries overseas where CM are endemic.

Match with National Priorities

The Australian Government's Science and Research Priorities and Rural RD&E priorities are reproduced in Table 4. The project findings and related impacts will contribute to Rural RD&E Priority 1, and potential some contribution to Priority 3, and to Science and Research Priority 1.

Table 4: 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 6. Resources 7. Advanced Manufacturing 8. Environmental Change 9. Health

Sources: (Commonwealth of Australia, 2015) and (Australian Government, 2015)

Alignment with the Apple and Pear Strategic Investment Plan 2017-2021

The strategic outcomes and strategies of the apple and pear industry are outlined the Apple and Pear Strategic Investment Plan 2017-2021[5] (Hort Innovation, 2017). Project MT12000 addressed Outcome 2 (Strategy 2.1).

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

Valuation of Impacts

Impacts Valued

The investment in MT12000 was a proof of concept investment and did not produce and direct, quantifiable impacts, therefore no quantitative evaluation processes were applied.

Impacts Not Valued

Project MT12000 contributed increased knowledge and scientific capacity as well as to a number of potential future impacts including reduced production losses associated with CM, improved environmental outcomes from reduced chemical use, and improved regional community wellbeing as a spill-over benefit from a potentially more productive Australian apple and pear industry.

Any future benefits from the adoption of female CM mass-trapping devices developed based on the proof of concept provided by MT12000 will be partially attributable to the investment in MT12000. Further CM R&D investments are being pursued by DJPR but no specific information on these investments or their likely outputs was available at the time of the current impact assessment.

Results

All past costs were discounted to 2017/18 using a discount rate of 5%. No impacts were valued; thus, the investment criteria reported were limited to the Present Value of Costs (PVC). To ensure consistency with other Hort Innovation project analyses and reporting, the PVC was reported for the length of the project investment period plus 30 years from the last year of investment (2015/16) as per the CRRDC Impact Assessment Guidelines (CRRDC, 2018).

Investment Criteria

Table 5 shows the investment criteria estimated for different periods of benefit for the total investment. Table 6 shows the investment criteria estimated for different periods for the Hort Innovation only. Hort Innovation investment in project MT12000 was approximately 39.9% of the total investment.

Table 5: Investment Criteria for Total Investment in Project MT12000

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Costs ($m)	1.59	1.59	1.59	1.59	1.59	1.59	1.59

Table 6: Investment Criteria for Hort Innovation Investment in Project MT12000

Investment Criteria	**Years after Last Year of Investment**						
	0	**5**	**10**	**15**	**20**	**25**	**30**
Present Value of Costs ($m)	0.64	0.64	0.64	0.64	0.64	0.64	0.64

The annual undiscounted cost cash flows for the total investment for the duration of MT12000 investment plus 30 years from the last year of investment are shown in Figure 1.

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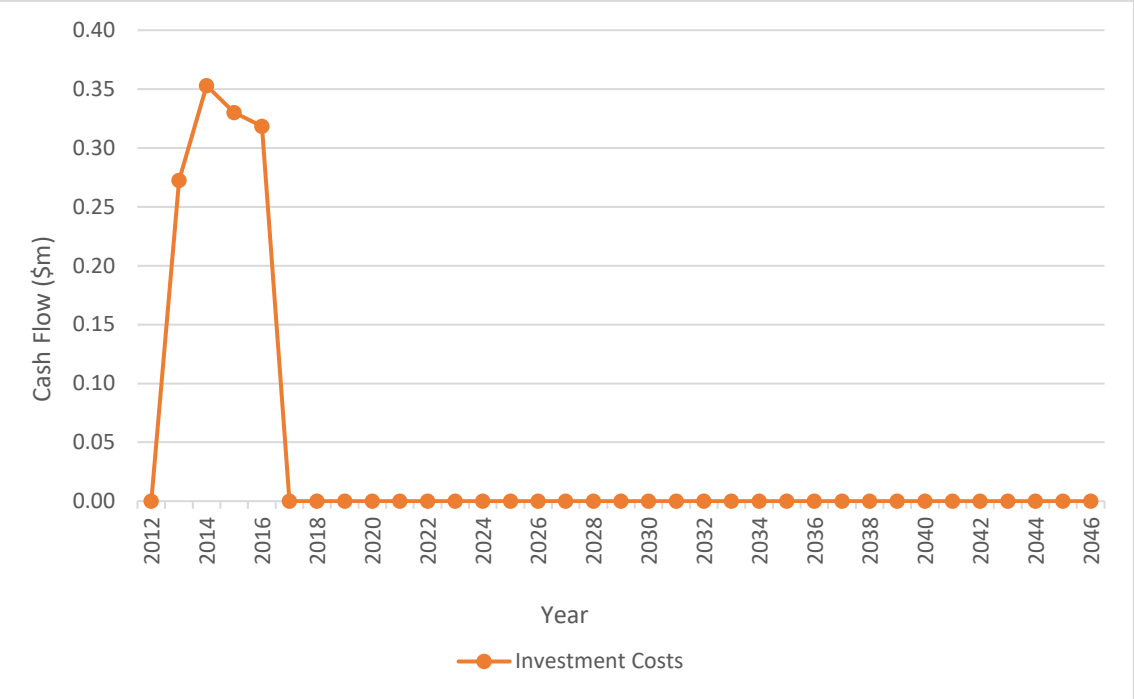
Figure 1: Annual Cash Flow of Undiscounted Total Benefits and Total Investment Costs



Conclusion

Total funding from all sources for project MT12000 was $1.59 million (present value terms). The investment in MT12000 provided proof of concept for female CM mass-trapping methods and improved knowledge and scientific capacity. Though the project produced no direct, quantifiable impacts, MT12000 is likely to contribute to future potential impacts for the Australian apple and pear industry, including reduced production losses from CM, improved environmental outcomes through reduced chemical use, and enhanced regional community wellbeing as a spill-over benefit from a more productive Australian apple and pear industry. Any such future benefits may be partially attributable to the investment in project MT12000.

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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David Williams, Principal Research Scientist, Agriculture Victoria

Abbreviations

ABS	Australian Bureau of Statistics
ANOVA	Analysis Of Variance
AP	Apple and Pear
APAL	Apple and Pear Australia Limited
AV	Avocado
CM	Codling Moth
CRC	Cooperative Research Centre
CRRDC	Council of Rural Research and Development Corporations
DEDJTR	Department of Economic Development, Jobs, Transport and Resources (Victoria)
DJPR[(a)]	Department of Jobs, Precincts and Regions (Victoria)
FGV	Farm Gate Value
GPS	Global Positioning System
Hort Innovation	Horticulture Innovation Australia Limited
IPM	Integrated Pest Management
MD	Mating Disruption
MU	Mushroom
NSW DPI	New South Wales Department of Primary Industries
PVC	Present Value of Costs
R&D	Research and Development
RCBD	Randomized Complete Block Design
RD&E	Research, Development and Extension
RDC	Research and Development Corporation
RIBD	Randomized Incomplete Block Design
SIP	Strategic Investment Plan
TG	Table Grape
VESPER	Variogram Estimation and Spatial Prediction Plus Error
VIC DPI	Department of Primary Industries (Victoria)

(a) Formerly known as DEDJTR and VIC DPI.