



Economic Analysis Kiwifruit Vine Health Pathways Management Plan

Final report prepared for KVH

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Prepared By:

Simon Harris

For any information regarding this report please contact:

Simon Harris

Phone: 0274 356 754

Email: simon@landwaterpeople.co.nz

LWP Ltd

PO Box 70

Lyttelton 8841

New Zealand

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October 2020 update

A draft of this document was made publicly available on the KVH website Wednesday 2 September 2020 at the beginning of the Pathway Plan consultation period. However, based on feedback from the Ministry for Primary Industries (MPI) changes have been made to this original draft, which can be summarised as follows:

1. Inclusion of an executive summary.
2. The CBA now uses the Voluntary Action (VA) scenario as the baseline scenario (the previous draft used the Do Nothing option as the baseline scenario). Voluntary action is a more realistic scenario should the Pathway Plan not be adopted (as KVH would still exist and encourage voluntary uptake of biosecurity practice). Therefore this option is a more appropriate baseline for comparison. The Net Present Value (NPV) of the Pathway Plan relative to the baseline scenario is still overwhelmingly positive, and in the order of \$2B saved.
3. Other minor changes were made, including:
 - a. Slight changes to the structure of the document; namely the additions of a stand-alone method and assumption section to make it clearer to the reader how the CBA was conducted and what assumptions were used.
 - b. Other minor changes throughout the document to provide more explanation on how the assumptions were formed.

1 Executive Summary

This report describes an analysis of the benefits and costs of the Kiwifruit Vine Health (KVH) Pathway Plan proposal. It follows the requirements of the National Policy Direction for Pest Management (2015) (NPD) based on the Guidance Document (V 1.0, September 2015) for a Medium level analysis. It assesses three scenarios:

1. Pathways Management Plan (PMP) which is the proposed option.
2. Voluntary action (VA), in which KVH would continue operation and attempt voluntary compliance. This has been used as the status quo scenario.
3. Do Nothing (DN), which is the scenario that describes the course of events if KVH were to cease operation following expiry of the National Psa-V Pest Management Plan (Psa-V NPMP).

The impacts of each scenario are estimated for a range of costs supplied by KVH (administration, education, pathway management costs, control costs and lost production). The results are incorporated into a discounted cashflow analysis over 30 years at a discount rate of 6%. Risks were assessed categorically according to the Guidance and incorporated into the analysis as probabilities for achievement of the outcomes described in the scenarios. The sensitivity of the results to the assumptions used was tested using a Monte Carlo analysis.

The results are aggregated into a Net Present Value analysis, which allows the costs in the future to be adjusted to a common present-day value and compared. The results are shown in three ways: non risk adjusted base case, risk adjusted base case, and the Monte Carlo sensitivity test.

The base case analysis shows that the PMP and VA scenarios incur higher costs for all categories apart from lost production, but that the lost production under the VA and DN scenarios are more than an order of magnitude higher than the PMP. As a result on non-risk adjusted basis the net benefit of the PMP scenario relative to the VA scenario is \$1.2 billion NPV, while the DN Scenario relative to the VA scenario has a non-risk adjusted net benefit of -\$5.4 billion NPV.

When the adjustment for risk of non-achievement is taken into account, the net benefit of the PMP increases, with a net benefit of \$2.0 billion NPV. This suggests that the PMP strategy is highly worthwhile, and its net benefit exceeds the VA scenario by \$2 billion on a risk adjusted basis. The sensitivity analysis mean outcome is a net benefit for the PMP of \$2.1 billion NPV, and -\$2.5 billion NPV for the DN scenario. There is a very small probability (<1%) that the PMP scenario would have a negative outcome relative to the VA scenario, and therefore we conclude that the net benefit result shows low sensitivity and is very resilient to changes in the input assumptions.

The quantitative results provided here do not take into account the wider economic costs to employees, suppliers, and processors that will arise from an incursion, and the social costs that would occur from the disruption to the industry. The prevention or reduction of these unquantified wider costs will increase the net benefit associated with the PMP.

It is considered reasonable therefore to conclude that the PMP shows the highest net benefit of the options considered here, and it is appropriate to proceed with the proposal.

2 Background

This report describes an analysis of the benefits and costs of the Kiwifruit Vine Health (KVH) Pathway Plan proposal. It follows the requirements of the National Policy Direction for Pest Management (2015) (NPD) based on the Guidance Document (V 1.0, September 2015).

Under this guidance the requirement for analysis is required to be ranked. Using the flow chart in Figure 1 of the Guidance, the National Pathway Management Plan would be on the boundary between a low and medium level of analysis, and a “medium” level of analysis has been selected. The assessments against the NPD criteria are shown in Table 1.

Table 1: Assessment of analysis requirements

Assessment Criteria 1: The likely significance of the pest or the proposed measures	Medium – Potential for moderate interest, opposing viewpoints in some groups within community, or moderate total costs.
Assessment Criteria 2: Likely costs relative to likely benefits	Medium – Costs for the programme are likely to be lower than the benefits of the programme in most scenarios.
Assessment Criteria 3: Uncertainty of the impacts of the pest and effectiveness of measures	Medium uncertainty – Known to have impacts elsewhere in similar situations. Similar measures have been effective in other areas, or measures have only been somewhat effective.
Assessment Criteria 4: Level and quality of data available	Medium – Some historical information or data from other sources (outside of the region or NZ). No specific targeted monitoring data. Costs and impacts capable of being estimated from case studies.

Medium analysis requires the following steps:

- Describe the costs (including effects on values) of each option and quantify / value as many as practicable;
- Describe the benefits of each option and quantify / value as many as practicable;
- Apply cost/benefit analysis techniques for each option;
- Take into account the risks to being successful - as required by clause 6(2)(g) of the NPD; and
- Conclude by choosing the most appropriate option.

3 Method

The analysis adopts three scenarios of action associated with the management of new kiwifruit pest incursions into New Zealand.

1. Pathways Management Plan (PMP) which is the proposed option. This includes:
 - KVH management and operational structures including strategy development, governance, advice and education, and personnel.
 - Action to limit pathways of spread by growers, contractors, nurseries, budwood suppliers and pollen mill operators.
 - Ability to limit or minimise potential impacts of any response to incursions through early detection and established risk mitigations that prevent establishment or limit spread.
2. Voluntary action (VA), in which KVH would continue operation and attempt voluntary compliance with limitations on pathway management, including focus on education and guidance. This has been used as the status quo scenarios because at this stage KVH is intended to continue operation. It is assumed that under this scenario complacency is likely to set in and industry action to limit or minimise pathways of spread is likely to diminish and result in later detection of incursions and greater spread of pests prior to their detection. This assumption was based on an independent report looking into the Psa response which highlighted the growing complacency within the industry to abide by Psa rules and regulations under the NPMP, even in the light of ongoing Psa impacts to growers¹. Under these assumptions' responses are likely to be less effective and cost more, and production impacts are likely to be higher, compared to the PMP scenario.
3. Do Nothing (DN), which is the scenario that describes the course of events if KVH were to cease following expiry of the National Psa-V Pest Management Plan (Psa-V NPMP) and there is no coordinated pathway management. The likelihood of early detection and successful response to incursions under this scenario is very low, with consequential higher production impacts of new pests.

The impacts of each scenario are estimated for a range of costs (administration, education, pathway management costs, control costs and lost production). These costs were supplied by KVH. The results are incorporated into a discounted cashflow analysis over 30 years as per the Guidance document. The discount rate of 6% is adopted, based on Treasury guidance².

All impacts are assessed as costs (i.e. additional spending or losses in production), while the estimate of cost or benefit is determined by comparing the PMP and VA scenarios with the DN scenario. The Net Present Value (NPV) generated by the discounted cash flow is presented for each category of costs and benefit, and an estimate of the potential impact of different levels of success in preventing pest incursion and spread is calculated. The analysis assesses the risk associated with the proposed approach through an estimate of the risk of non-achievement and assesses the sensitivity of the analysis to different assumptions through a Monte Carlo analysis.

¹ Sapere research group (2014) Lessons learned from the Response to Psa-V. www.kvh.org.nz/vdb/document/100538

² <https://treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates>

4 Assumptions

4.1 Estimated costs of each scenario

The input costs that have been estimated for each affected party and by category is shown in Table 2 and discussed below. These costs are shown as initial costs and ongoing costs to illustrate the changing nature of these costs over time, which is largely to reflect the decline in practice under the voluntary scenario. Under the Pathway Plan and Do Nothing scenarios there is no decline in practice over time, so these times are fixed at 1 year. The exception being operations costs under DN which we expect to increase over time to manage the increasing pest burden in the industry.

4.1.1 KVH Administration and Governance

- Education and Awareness includes costs to undertake communications on risks and required activities, and to raise awareness of risks to the industry. These costs increase significantly under Voluntary Industry Action, as the lack of regulation and certification schemes increase the importance of this activity to achieve any sort of biosecurity practice.
- Operations includes surveillance and monitoring, risk management programmes, quarantine measures, targeted movement controls, applying treatments, and NI/SI border measures. The PMP figure would be constant over time, however the VA and DN scenarios start from a lower base but see a more significant increase to manage an increasing pest burden.

Table 2: Initial and ongoing costs associated with scenarios (\$/year)

Category	Item	Pathway Plan (\$/year)			Voluntary Industry Action (\$/year)			Do Nothing Cost (\$/year)		
		Initial	Ongoing	Time between initial and Ongoing spend	Initial	Ongoing	Time between initial and Ongoing spend	Initial	Ongoing	Time between initial and Ongoing spend
KVH Administration and governance	Education and awareness	\$31,000	\$31,000	1	\$31,000	\$100,000	5	\$0	\$0	1
	Governance	\$70,200	\$70,200	1	\$70,200	\$70,200	1	\$70,200	\$70,200	1
	Office expenses	\$71,390	\$71,390	1	\$71,390	\$71,390	1	\$71,390	\$71,390	1
	Operations	\$222,250	\$222,250	1	\$50,000	\$161,290	5	\$0	\$161,290	10
	Personnel and professional services	\$524,808	\$524,808	1	\$420,000	\$84,000	5	\$0	\$0	1
	Strategy projects	\$50,000	\$50,000	1	\$100,000	\$100,000	1	\$0	\$0	1
Kiwifruit Grower	On-orchard guidelines	\$1,000,000	\$100,000	1	\$2,000,000	\$200,000	5	\$0	\$0	1
Kiwifruit industry contractors	Verification cost	\$41,000	\$41,000	1	\$0			\$0	\$0	1
	Implementation cost:	\$423,000	\$423,000	1	\$200,000	\$10,000	5	\$0	\$0	1
Nurseries	Existing KPCS nurseries	\$120,000	\$120,000	1	\$120,000	\$6,000	5	\$0	\$0	1
	Shelter belt plants	\$15,000	\$15,000	1	\$0	\$0		\$0	\$0	1
	Non kiwifruit nurseries	\$20,400	\$8,500	1	\$0	\$0		\$0	\$0	1
Budwood suppliers	Audit	\$3,500	\$3,500	1	\$0	\$0		\$0	\$0	1
	Testing	\$23,710	\$23,710	1	\$6,000	\$300	5	\$0	\$0	1
Pollen mill operators and pollen suppliers	Audit	\$10,000	\$10,000	1	\$0	\$0		\$0	\$0	1

- Personnel and professional services include management, planning and reporting, standard setting, compliance and audit, technical transfer. Spend for PMP is budgeted at \$500k which would be constant, VA would see an immediate reduction in participants reducing this cost and would gradually decrease over time. DN would have no costs under this line item. The need to increase these costs under VA and DN in response to an incursion is included in the capability component of incursion response.
- Governance, and office expenses would be relatively constant between the scenarios and over time.

4.1.2 Kiwifruit Growers

Under the PMP the current requirement for growers to have and implement an orchard management plan would continue beyond 2023, but would be altered slightly to accommodate a wider range of risks outside PSA. Currently the new kiwifruit orchard management plan is aligned with existing “Kiwifruit Growers Biosecurity Guidelines” which KVH introduced in 2019 on a voluntary basis and is a Zespri GAP requirement to begin transitioning to broader biosecurity management. Reporting from the Zespri GAP audits highlighted that at least 15% of growers have already completed their on-orchard biosecurity guidelines under the Psa-V NPMP and this number is expected to increase next year with transition to the Pathway Plan. As these requirements become regulated, we expect growers may need to take more time to complete and operate within their orchard biosecurity management plan. This cost will vary depending on current state, but it is expected this will require most of one day per year to update paperwork and implement systems to manage risk on-orchard. These systems will be incorporated into on orchard BAU and will be on-going. Such systems/activities may include signage, visitor logs, property access changes, training/biosecurity awareness among staff to name a few. Once established, many of these activities will be unlikely to have on-going costs. As such, associated costs to growers has been calculated as 8 hours x \$50/hr x 2600 (number of growers) = \$1M. This will be mitigated to some degree by education and provision of templates and grower assistance where required. Ease of compliance with the orchard biosecurity management plan is also expected to improve for growers with the planned introduction of an expanded Kiwifruit Plant Certification Scheme (KPCS) and contractor certification.

Under VA KVH invests in a concerted ‘campaign’, but the costs will diminish as complacency sets in to 10% of current levels by year 5. No costs are included for DN as it is assumed there would be no grower programme.

4.1.3 Kiwifruit industry contractors

Kiwifruit contractors are currently required to implement Psa-V risk management measures under the Psa-V NPMP, and in accordance with industry protocols that cover wider biosecurity matters. These are in addition to existing compulsory health and safety and food safety requirements. Under the PMP the proposed requirement for contractors to have and implement a ‘Kiwifruit Contractor Biosecurity Plan’ is a new requirement. The planned integration of biosecurity within existing contractor assurance and verification processes and

tools (Zespri Compliance Assessment Verification – CAV - for contractors, and the OnSide app) is designed to minimise costs of compliance for contractors³.

Contractors currently pay \$1500 for their organisation to become CAV, and then \$700 per year to maintain this. This process is 1.5 days in duration and therefore the requirements we propose to embed into this audit are not expected to change the overall time taken or cost of these audits. Based on the additional time required by the CAV auditor (i.e. 1 hour) to assess those additional requirements under the plan, we estimate an additional audit cost of \$41,000 per annum based on \$100 per audit and 410 contractors.

While the requirements under the Pathway Plan are not significantly different to the status quo, compliance with current requirements is low and there would be a cost associated with achieving a higher level of implementation compliance, which is mainly a time cost to clean equipment. We have estimated this at \$10 per orchard visit averaged across the various equipment types. Based on our experiences with Psa we know that some equipment is too difficult to clean between all orchard visits and an acceptable plan for these contractors will be more based around cleaning logs and traceability records of orchards visited between cleaning. The highest risk is tools that create wounds in plants, such as pruning and girdling tools, and this is where our efforts will be focused.

The cost associated with people and their tools and equipment, which is focussed around the cleaning when entering/leaving an orchard and while interacting with the vine (i.e. pruning), was estimated to be \$0.1 per orchard visit. This assumes that a bottle of disinfectant (i.e. Janola) at the dilution rate required for cleaning of tools and equipment would cover around 100 orchards. These costs were then multiplied by number of orchard visits per year for each contracting type across the industry for a total of \$423,000 per annum.

4.1.4 Nurseries

The kiwifruit industry currently has 60 Kiwifruit Plant Certification Scheme (KPCS) certified nurseries who supply kiwifruit plants. Under the PMP these nurseries current costs of \$120,000 per annum will continue (\$2000 / yr x 60 nurseries). Of these certified nurseries a small portion (around six) also supply shelter belt plants and would need to extend biosecurity requirements to include these where destined for kiwifruit orchards. This would only result in a small administrative cost (\$3,000 per annum) to implement systems.

For shelter nurseries not part of the KPCS, they will need to upgrade their systems to meet Plant Production Biosecurity Scheme (PPBS) certification requirements. The cost will depend on current state of the nursery operation but New Zealand Plant Producers Incorporated (NZPPI) estimate this to be on average \$3500 for time to become certification ready, \$2500 for infrastructure upgrades and ongoing costs of \$2500 per year to maintain certification. However, for these nurseries the costs and benefits of PPBS certification would apply to their entire operation, of which shelter plants may only be 5% or less. Only a small proportion (estimated ~5%) of the 68 potential nurseries are expected to engage with this scheme, resulting in a cost initially of \$20,000 per annum, and \$8,500 ongoing for maintenance of certification.

No costs for nurseries are expected under the VA and DN scenarios.

³ This is likely to also make it easier for growers to ensure contractors working in their orchard(s) implement effective biosecurity measures.

4.1.5 Budwood suppliers

The PMP sets higher biosecurity requirements for budwood suppliers (over and above current Psa-V protocol). An expanded KPCS certification will provide avenues for compliance with this higher level of requirement. For the seven commercial distributors of budwood audit costs will apply estimated at \$500 each per year based on previous KPCS experience, for a total audit cost of \$3500.

Distributors may also be responsible for the testing costs of their supplying orchards, although Psa non-detected orchards such as the entire South Island, where the majority of budwood is sourced, already test for Psa, and no additional costs are proposed. For Psa positive orchards the additional testing costs would be up to \$385 per block. Budwood suppliers are currently required to register with KVH and our records suggest that there are only 46 orchards to whom the additional testing requirements would apply. The analysis allows \$23,710, based on the current \$6,000 plus an additional \$17,710 (\$385 x 46) for new orchards.

Under the VA current suppliers are expected to continue initially, but this will decrease over time to only 10% of suppliers after 5 years. No costs are included for the DN scenario. This assumption is based on our previous experience with the Kiwifruit Plant Certification Scheme (KPCS) which KVH introduced on a voluntary basis in 2013 before becoming mandatory in 2016. Of the 50 kiwifruit nurseries at the time, only 5 became certified during the first two years (10%) which later increased to 11 (22%) in 2016. These figures would be higher than a true voluntary action, as they reflect early adoption of a standard that they knew would soon be mandatory and there were commercial incentives for doing so. 2013 was only three years after the initial Psa incursion and many regions outside of the Bay of Plenty were still in the early stages of infection and biosecurity was front of mind for the industry. Yet voluntary compliance to this particular scheme remained low.

4.1.6 Pollen mill operators

Under the PMP there is limited change in requirements for pollen mill operators from the status quo, but the current risk and audit process will be aligned with KPCS certification. The mill will be responsible for ensuring that all flowers have been sourced from compliant suppliers and will likely manage the certification process on their behalf. Mills will be audited to ensure this compliance is met at a cost of \$500 per mill (currently there are 20 pollen mills) for a total of \$10,000 per annum ongoing.

No costs for pollen mill operators are expected under the VA and DN scenarios.

4.1.7 Other parties

We consider there will be no differences among the scenarios for kiwifruit post-harvest processors and marketers, compost and soil suppliers, beekeepers, transporters, landholders with wild kiwifruit or abandoned orchards, research industry or consultants, or regional councils. There will be no additional costs for MPI in the management of the PMP, but there may be additional costs for response to incursions, which are included in the gross estimates of response costs below.

4.2 Incursion response costs, production losses and other costs

Under each scenario there is the potential for new incursions, for which there is likely to be a response cost and a cost associated with lost production. In addition there are pathogens currently present which could expand in the absence of management of pathways. The analysis estimates all these as costs to growers and the industry which will occur at different levels across the three scenarios. We are then able to calculate the benefits of the PMP as 'avoided costs' by comparing the lower costs in the PMP with the higher costs of the DN scenarios.

The analysis assesses three types of incursion – Major incursion, minor incursion and existing pathogens. The impacts of a major incursion are based on the *Ceratocystis fimbriata* (Cf) which has caused major problems for growers in Brazil (Table 9). The impacts of a minor incursion are based on *Pelargonium zonate* spot virus (Pz) (Table 10), and the existing pest is modelled based on *Neonectria microcondia* (Nm) which is currently present in the country (Table 11).

4.2.1 Response costs

The aim of the response is to minimise the damage to the industry and identify a pathway for recovery. Response costs are dependent on the organism type, scenario surrounding the incursion, and response option that has been decided upon.

Response measures can include (but not limited to):

- Establishment of systems of disease surveillance and the management of an infection database
- Organisation and funding of the disposal of infected plant material that is cut out of orchards
- Funding of research and development of new tests
- The implementation and funding of testing
- The establishment and notification of biosecurity zones that determine the limits on plant material and machinery movement
- Potential subsidies for testing and spraying
- The implementation of on-orchard border controls including wash-down facilities for machinery and vehicles
- Public signage (i.e. road signs) advising motorists of the risks of spreading the organism
- The implementation of controls on plant material movements.
- Compensation for growers who are financially impacted i.e. those required to cut out infected orchards to reduce the inoculum burden and control disease spread in the early stages of disease management, or spray chemicals rendering fruit unsaleable.

For the PMP the estimated response cost to a major incursion was based on the Psa response cost, with the cost of \$50M adopted. Of this \$17M was spent on compensation for vine removal. An allowance of \$20 million has been included for the VA scenario, and \$10m for the DN scenario. These allowances are smaller than the PMP scenario because it is assumed

that the response will be abandoned earlier as spread will be more extensive, so the costs incurred will be significantly less. There will however be correspondingly higher production losses.

Minor incursion costs were estimated at \$1million under the PMP scenario and \$500k for each of the VA and DN scenarios. These costs are indicative of the costs associated with tracing, surveillance and diagnostic testing. Under the PMP scenario the costs are higher as it is more likely that eradication would be pursued making the response more protracted and more likely to also include compensation for removal of infected vines.

4.2.2 Lost production

Under all scenarios there is the potential for lost production as a result of a new incursion or the spread of an existing incursion. The modelling of the spread of any new disease is difficult, and this analysis adopts an indicative approach where the spread of area infected is assumed to occur quasi-linearly over a 10 year period from minimum to maximum area, and the maximum area infested is maintained from year 10 to year 30 (i.e. the period of the analysis). The exception to this is the major incursion under the PMP, where the incursion is assumed to be caught earlier, and spread halted by year 5. Under all scenarios the maximum area affected is assumed to be impacted by the policies adopted, with the maximum area affected greatest under DN and least under PMP. The key modelling parameters are shown in Table 3 below, and the detailed annual losses are shown under Table 9 to Table 11 in Appendix D.

The cost of lost production is estimated from reductions in orchard gate returns, less any reductions in the cost of production. For the major incursion it was assumed that vines would die, and neither pruning, thinning nor harvest costs would be required for those parts of the orchard. For the minor incursion and established pests' vines would not die but would experience reduced production, resulting in lower harvest costs. The losses in revenue were estimated from reduction in production times the average orchard gate returns (OGR) of \$114,000 per ha. The production area affected and severity of impact are shown in summary in Table 3 and in more detail in Table 9 to Table 11 in the appendices. The reductions in costs were estimated from a total labour cost of \$21700 (ANZ 2019)⁴, with the harvest (24%), thinning (10%) and pruning (60%) split based on figures from MPI (2012).

Table 3: Modelling parameters for lost production

Incursion type	Initial area (ha)			Max area (ha)			Time to Max area (years)		
	Pathway Plan	Voluntary Action	Do Nothing	Pathway Plan	Voluntary Action	Do Nothing	Pathway Plan	Voluntary Action	Do Nothing
Major incursion	5	5	5	5	4000	13500	1	10	10
Minor incursion	20	20	20	130	4000	13500	10	10	10
Existing pest	300	300	300	300	4000	13500	0	10	10

4.2.3 Other costs

Only the costs directly to the industry have been quantified in this analysis. However because of the significance of the kiwifruit industry in the economy, there will be a range of other costs

⁴ The labour cost of 20,600/ha from 2018 plus the additional 1,100/ha of inflation increases noted as likely to occur for the coming season.

that are not included in the analysis but should be considered by decision makers. The impact of an incursion on the kiwifruit industry will have impacts beyond growers and those directly affected. The kiwifruit industry is New Zealand's largest horticultural export industry, generating export returns of \$2.3B (based on 2019 export value). The kiwiberry industry generates export returns of \$3.6M (New Zealand KiwiBerry Growers).

There are 10,000 permanent employees in the kiwifruit industry and 22,000 seasonal workers forecast to pick and pack the 2020 season. Typically, this consists of 50% New Zealanders, 20% recognised seasonal employees, and 30% backpackers/international students etc (although COVID-19 has disrupted this balance in the current season). NZKGI projects seasonal worker numbers to increase from 19,500 FTE in 2019 (148mTE) to 27,880 FTE in 2027 (190mTE) (NZKGI pers. comms 24 June 2020).

It is estimated that Māori have investments in the industry totalling more than \$300m. It is also estimated there are at least 2,475 FTE of Māori employed in the industry.

The losses incurred by the kiwifruit growers will extend to other parts of the economy. Packhouse operators and processors will be immediately affected, and there will be a reduction in profits, GDP, employment and household income for these parties. The loss of wages and profits in the orchard, their staff, suppliers and processors reduce consumption and investment in the surrounding communities, and will have ongoing flow on impacts for the region and country.

A report released by Lincoln University in May 2012 conservatively estimated that Psa-V would cost the kiwifruit industry between \$310 and \$410M over the next five years, and between \$740 and \$885M over the next 15 years. Multiplier effects were not included in these estimates. However, average loss of employment within the Bay of Plenty region alone was estimated at between 360 to 470 full-time-equivalent jobs per year between 2012 and 2016.

Social impacts will occur at the individual level, household level and community level. Anyone involved in the kiwifruit supply chain, from pickers and packers, to truck drivers and contractors will likely be impacted by an incursion. Many social impacts are generated through the loss of income (productivity impacts) which can affect mental health or reduce welfare. These social impacts will occur within the industry and in their surrounding communities.

4.2.4 Estimating scenario impacts

In order to calculate the response and production costs, the modelling allows for a 1 in 10 annual chance of a major incursion, and a 4 in 10 annual chance of a minor incursion. These probabilities are estimated based on experience over the past decade, and steady trend that risk is increasing. The same probabilities are applied to all three scenarios, which is likely slightly conservative because the PMP approach may reduce the probability of incursions through control of sources of infection before they reach an orchard.

The analysis uses the profile of costs after an incursion to estimate an NPV of the incursion over 30 years, then multiplies the NPV of the incursion response for each scenario with the probability of each incursion type, with the result included for the first ten years of the analysis⁵.

⁵ In effect the analysis estimates the expected annual value of the incursion (NPV * annual probability) for the first ten years only. These costs could continue on for the full period of the analysis, because the annual probability of incursion is not limited to the first ten years. However because both the cost of an incursion and the rate of spread would be affected by previous incursions, the analysis would become overly complex. This simpler approach underestimates the costs of lost production and incursion response, but is adequate for the level of analysis required.

4.3 Assessment of Risk

4.3.1 NPD assessment of risk

The risks associated with the PMP are included in the main strategy document. The extent to which the proposed option for the Pathway Plan is likely to be affected by risks is assessed in accordance with Section 6(3) of the NPD as follows:

Technical and operational risks of the programme

The technical and operational risks of the programme are low. KVH, and the wider kiwifruit industry, have considerable experience with practical implementation of pathway management operations through the Psa-V Response and National Psa-V Pest Management Plan over the past decade. The Pathway Plan builds on this experience and wider systems already implemented by the kiwifruit industry (e.g., the Contractor Assurance Verification scheme operated by Zespri, and the Kiwifruit Plant Certification Scheme and Post-harvest audit programme already operated by KVH, which can be further leveraged to strengthen pathway management).

Extent to which the Pathways Management Plan will be implemented and complied with

The extent to which the Pathways Management Plan will be implemented and complied with is expected to be high. Again, both kiwifruit growers, associated industries and other audiences that will need to comply with the plan requirements already have a decade of experience and systems and capabilities in place to achieve biosecurity compliance. Where these are expanded under the Pathway Plan KVH will be providing supporting tools and guidance to remove barriers to compliance (refer to explanation and examples in section 22 of the Pathway Plan proposal).

Risks that compliance with other legislation will adversely affect implementation of the plan

KVH is not aware of any other legislation that will adversely affect implementation of the plan. Potential legislation considered includes the Resource Management Act 1991, the Health and Safety at Work Act 2015 and the Food Act 2014.

Application of plant protection products under the Pathway Plan proposal would be subject to requirements of regulatory framework governing use of such products, including the Hazardous Substances and New Organisms Act 1996. This framework could limit use of potential plant protection products, however, this is not likely to adversely affect the kiwifruit industry as the regulatory framework and the strict standards and quality assurance programme operated by the kiwifruit industry are essential to maintain consumer and customer confidence and market access for New Zealand's kiwifruit products.

Risks that public or political concerns will adversely affect implementation of the plan

There is a low risk that public or political concerns will adversely affect implementation of the plan. Effective kiwifruit industry pathway management is beneficial to New Zealand as it strengthens the role of the kiwifruit industry in the "biosecurity team of 4.7m New Zealanders". Those that must comply with the plan are also typically beneficiaries of the plan to a greater or lesser extent, as their businesses rely to that extent on biosecurity resilience of the kiwifruit industry.

Also refer to the “results of consultation” in section 31 of the Plan Proposal, which demonstrates there a good level of support for the proposal.

Other material risks

KVH is not aware of any other material risks likely to affect the proposed Pathway Plan.

4.3.2 Inclusion of risk in the analysis

In order to adjust of risk of non-achievement of the strategy the outcomes were adjusted by the probability of their occurrence. For example, with the PMP it may not be completely successful or not successful at all in containing a major incursion. There is no objective way of assessing what the risk of non-achievement would be, so some subjective expert assessments have been made to allow for this risk. The analysis allows a probability of 75% of achieving the specified results of the PMP, 20% chance of achieving only the same results as have been specified for the VA scenario, and a 5% chance of achieving the same outcomes as the DN scenario. The base case assessment of risks is shown in Table 4. Note that these assumed probabilities are sensitivity tested as discussed in Section 4.4.

Table 4: Assessment of outcome probability for base case

Intended outcome	Outcome actually achieved		
	Pathway Plan	Voluntary Action	Do Nothing
Pathway Plan	0.75	0.20	0.05
Voluntary Action	0.20	0.50	0.30
Do Nothing	-	0.30	0.70

4.4 Sensitivity Testing

A Monte Carlo analysis was undertaken on the results to test the sensitivity of the analysis to different values for the multiple assumptions used. This involves randomly varying the inputs to determine what impact this may have on the outcome. The variability was included by selecting randomly from different distributions for each main parameter as shown in Table 5. For the assessment of outcome risk the Monte Carlo analysis varies the probabilities as shown in Table 6.

Table 5: Sampling distributions for main parameters in sensitivity analysis

Parameter	Distribution type	Mean or multiplier	Coefficient of variation or range
Discount rate	Normal	6%	20%
Response cost sensitivity	Normal	1	20%
Lost production	Normal	1	40%
Other costs	Normal	1	20%
Probability of major incursion	Uniform	0.1	0.05 – 0.15
Probability of minor incursion	Uniform	0.4	0.2 – 0.6

Table 6: Sampling ranges for uniform distribution of risk of non achievement of scenario outcomes

Intended outcome	Outcome actually achieved		
	Pathway Plan	Voluntary Action	Do Nothing
Pathway Plan	0.6 – 0.9	80% of the residual	20% of the residual
Voluntary Action	0.1 – 0.3	62.5% of the residual	37.5% of the residual
Do Nothing	0%	0.1 – 0.3	Residual probability

5 Results

The results are aggregated into a Net Present Value analysis, which allows the costs in the future to be adjusted to a common present day value and compared. This allows scenarios with different timing of impacts to be compared on the same basis. As with any analysis the outcomes are dependent on the input assumptions used and the range of possible costs and outcomes under an incursion are very large. Some care should be taken to ensure that these assumptions are reasonable and caution associated with the results. Nevertheless, we consider they are based on the best available information and appropriate for an analysis of this type.

The results are shown in three ways: non risk adjusted base case, risk adjusted base case, and a sensitivity test of the assumptions using Monte Carlo analysis on the risk adjusted results. In the non-risk adjusted base case the results are presented for all three scenarios, and in comparison with the VA (status quo) scenario to show the net benefit. The cashflows associated with the base case are shown in Appendix A, Appendix B and Appendix C. In the other sets of results the analysis shows only the net benefit.

5.1 Base case results

The base case analysis uses the primary set of assumptions as outlined above. The NPV of results, using a 6% discount rate, is shown in Table 7.

They show that the PMP and VA scenarios incur higher costs for all categories apart from lost production, but that the lost production under the VA and DN scenarios are more than an order

of magnitude higher. As a result on non-risk adjusted basis the net benefit of the PMP scenario relative to the VA scenario is \$1.2 billion NPV, while the DN Scenario relative to the VA scenario has a non risk adjusted net benefit of -\$5.4 billion NPV.

When the adjustment for risk of non-achievement is taken into account, the net benefit of the PMP is still large at \$2.0 billion NPV. This suggests that the PMP strategy is highly worthwhile, and its net benefit exceeds the VA scenario by \$2 billion on a risk adjusted basis.

Table 7: Base case results (\$ million NPV, 6%)

Category	Total NPV of costs (\$million)			Net Benefit (\$ million)	
	Pathway plan	Voluntary Action	Do Nothing	Pathway plan	Do Nothing
Administration and governance	\$13.35	\$8.43	\$3.51	-\$4.92	\$4.91
Kiwifruit Grower	\$2.23	\$6.76	\$0.00	\$4.54	\$6.76
Kiwifruit industry contractors	\$6.39	\$0.56	\$0.00	-\$5.83	\$0.56
Nurseries	\$1.82	\$0.34	\$0.00	-\$1.48	\$0.34
Budwood suppliers	\$0.37	\$0.02	\$0.00	-\$0.36	\$0.02
Pollen mill operators and pollen suppliers	\$0.14	\$0.00	\$0.00	-\$0.14	\$0.00
Response costs	\$39.74	\$16.19	\$8.83	-\$23.55	\$7.36
Lost production	\$28	\$1,297	\$6,743	\$1,269	-\$5,446
Total	\$100	\$1,300	\$6,800	\$1,200	-\$5,400
Risk Adjusted Total	\$700	\$2,700	\$5,100	\$2,000	-\$2,400

5.2 Sensitivity testing

The sensitivity testing uses Monte Carlo analysis to show how the net benefit result would vary given simultaneous variations in all the input parameters. The results are an aggregation of 2000 simulations with different input values and are shown in Table 8 below. They show that the mean outcome of the simulations is a net benefit for the PMP of \$2.1 billion NPV, and -\$2.5 billion NPV for the DN scenario. There is a small probability (<1%) of a negative outcome (*i.e.* the scenario is not worthwhile relative to the VA scenario) for the PMP and VA scenarios. The standard deviations of the results are high relative to the mean – a coefficient of variation of ~55% - 60%, indicating the results have considerable uncertainty around them. The high variation is not surprising given that a number of parameters are being varied simultaneously.

The histogram of the sensitivity testing suggests that the results are right skewed, with a long tail of highly positive outcomes.

Table 8: Monte Carlo results based on 2000 simulations (\$million NPV, probability)

Item	Net Benefit (\$million NPV, probability)	
	Pathway Management Plan	Do Nothing
Mean	\$2,150	-\$2,463
Maximum	\$7,490	\$616
Minimum	-\$907	-\$9,894
Probability of negative outcome	0.9%	99.6%
Standard deviation	1202	1514

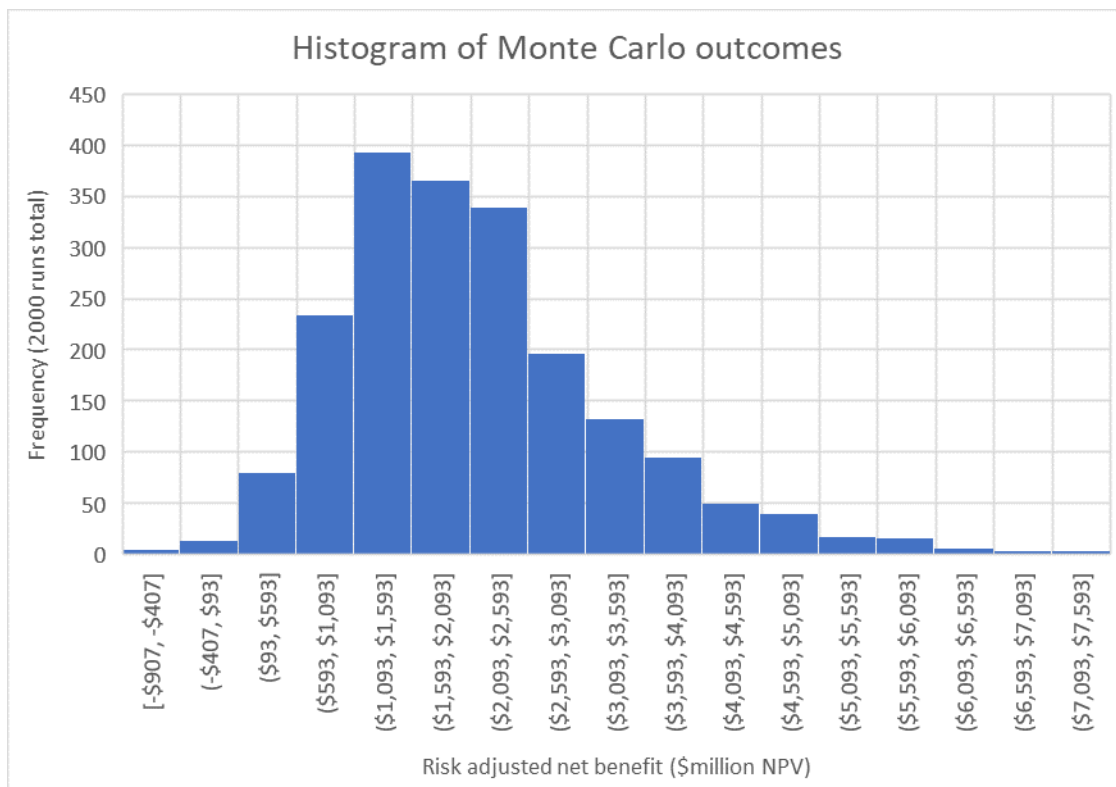


Figure 1: Sensitivity test - histogram of PMP Monte Carlo simulation results (\$ million NPV net benefit based on 2000 iterations)

5.3 Conclusion

The analysis shows that there are significant potential costs associated with the PMP, the largest of which is to growers and for management of the plan. However, because of the scale of the potential damages in the event of an incursion, it is worthwhile spending that money in advance to ensure readiness for any incursion.

While the results have considerable uncertainty around them given the range of possible input assumptions, even when testing the sensitivity of the assumptions used with a wide possible range of inputs there is only a very small probability that the benefits of the PMP do not exceed the costs. The quantitative results provided here do not take into account the wider economic

costs to employees, suppliers, and processors that will arise from an incursion, and the social costs that would occur from the disruption to the industry. The prevention or reduction of these unquantified wider costs will increase the net benefit associated with the PMP.

It is considered reasonable therefore to conclude that the PMP shows the highest net benefit of the options considered here, and it is appropriate to proceed with the proposal.

6 References

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Acknowledgements

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Appendix A PMP Cashflow results year 1 – 10, 29 and 30.

Category	Item	NPV	Start	Max	Time	1	2	3	4	5	6	7	8	9	10	29	30
Administration and governance	Education and awareness	\$426,710	\$31,000	\$31,000	1	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000	\$31,000
Administration and governance	Governance	\$966,291	\$70,200	\$70,200	1	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200
Administration and governance	Office expenses	\$982,671	\$71,390	\$71,390	1	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390
Administration and governance	Operations	\$3,059,234	\$222,250	\$222,250	1	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250	\$222,250
Administration and governance	Personnel and professional services	\$7,223,894	\$524,808	\$524,808	1	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808	\$524,808
Administration and governance	Strategy projects	\$688,242	\$50,000	\$50,000	1	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000	\$50,000
Kiwifruit Grower	On-orchard guidelines	\$13,764,831	\$1,000,000	\$1,000,000	1	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000
Kiwifruit industry contractors	Verification cost	\$564,358	\$41,000	\$41,000	1	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000	\$41,000
Kiwifruit industry contractors	Implementation cost:	\$5,822,524	\$423,000	\$423,000	1	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000	\$423,000
Nurseries	Existing KPCS nurseries	\$1,651,780	\$120,000	\$120,000	1	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000	\$120,000
Nurseries	Shelter belt plants	\$206,472	\$15,000	\$15,000	1	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
Nurseries	Non kiwifruit nurseries	\$128,227	\$20,400	\$8,500	1	\$20,400	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500	\$8,500
Budwood suppliers	Audit	\$48,177	\$3,500	\$3,500	1	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500	\$3,500
Budwood suppliers	Testing	\$326,364	\$23,710	\$23,710	1	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710	\$23,710
Pollen mill operators and pollen suppliers	Audit	\$137,648	\$10,000	\$10,000	1	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000
Response costs	Major incursion	\$36,800,435	\$50,000,000	\$50,000,000	0.1	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000	\$5,000,000
Response costs	Minor incursion	\$2,944,035	\$1,000,000	\$1,000,000	0.4	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000	\$400,000
Lost production	Major incursion	\$1,331,714	\$1,809,373		0.1	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937	\$180,937
Lost production	Minor incursion	\$22,425,835	\$7,617,381		0.4	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952	\$3,046,952
Lost production	Established pest	\$4,508,871	\$4,508,871		1	\$144,031,846											

Appendix B Voluntary Action Cashflow results year 1 – 10, 29 and 30.

Category	Item	NPV	Start	Max	Time	1	2	3	4	5	6	7	8	9	10	29	30
Administration and governance	Education and awareness	\$1,222,701	\$31,000	\$100,000	5	\$31,000	\$48,250	\$65,500	\$82,750	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000
Administration and governance	Governance	\$966,291	\$70,200	\$70,200	1	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200
Administration and governance	Office expenses	\$982,671	\$71,390	\$71,390	1	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390
Administration and governance	Operations	\$1,972,098	\$50,000	\$161,290	5	\$50,000	\$77,823	\$105,645	\$133,468	\$161,290	\$161,290	\$161,290	\$161,290	\$161,290	\$161,290	\$161,290	\$161,290
Administration and governance	Personnel and professional services	\$1,905,098	\$420,000	\$84,000	5	\$420,000	\$336,000	\$252,000	\$168,000	\$84,000	\$84,000	\$84,000	\$84,000	\$84,000	\$84,000	\$84,000	\$84,000
Administration and governance	Strategy projects	\$1,376,483	\$100,000	\$100,000	1	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000	\$100,000
Kiwifruit Grower	On-orchard guidelines	\$6,764,674	\$2,000,000	\$200,000	5	\$2,000,000	\$1,550,000	\$1,100,000	\$650,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000
Kiwifruit industry contractors	Verification cost	\$0	\$0	\$0	0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Kiwifruit industry contractors	Implementation cost:	\$561,106	\$200,000	\$10,000	5	\$200,000	\$152,500	\$105,000	\$57,500	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000
Nurseries	Existing KPCS nurseries	\$336,664	\$120,000	\$6,000	5	\$120,000	\$91,500	\$63,000	\$34,500	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000	\$6,000
Nurseries	Shelter belt plants	\$0	\$0	\$0	0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Nurseries	Non kiwifruit nurseries	\$0	\$0	\$0	0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Budwood suppliers	Audit	\$0	\$0	\$0	0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Budwood suppliers	Testing	\$16,833	\$6,000	\$300	5	\$6,000	\$4,575	\$3,150	\$1,725	\$300	\$300	\$300	\$300	\$300	\$300	\$300	\$300
Pollen mill operators and suppliers	Audit	\$0	\$0	\$0	0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Response costs	Major incursion	\$14,720,174	\$20,000,000	\$0	0.1	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$2,000,000	\$100,000	\$100,000
Response costs	Minor incursion	\$1,472,017	\$500,000	\$0	0.4	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$200,000	\$70,200	\$70,200
Lost production	Major incursion	\$664,757,882	\$903,192,962		0.1	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$90,319,296	\$71,390	\$71,390
Lost production	Minor incursion	\$594,223,998	\$201,840,003		0.4	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$80,736,001	\$161,290	\$161,290
Lost production	Established pest	\$38,172,466	\$38,172,466		1	\$38,172,466											

Appendix C Do Nothing Cashflow results year 1 – 10, 29 and 30.

Category	Item	NPV	Start	Max	Time	1	2	3	4	5	6	7	8	9	10	29	30
Administration and governance	Education and awareness	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Administration and governance	Governance	\$966,291	\$70,200	\$70,200	1	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200	\$70,200
Administration and governance	Office expenses	\$982,671	\$71,390	\$71,390	1	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390	\$71,390
Administration and governance	Operations	\$1,563,531	\$0	\$161,290	10	\$0	\$17,921	\$35,842	\$53,763	\$71,685	\$89,606	\$107,527	\$125,448	\$143,369	\$161,290	\$161,290	\$161,290
Administration and governance	Personnel and professional services	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Administration and governance	Strategy projects	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Kiwifruit Grower	On-orchard guidelines	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Kiwifruit industry contractors	Verification cost	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Kiwifruit industry contractors	Implementation cost:	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Nurseries	Existing KPCS nurseries	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Nurseries	Shelter belt plants	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Nurseries	Non kiwifruit nurseries	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Budwood suppliers	Audit	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Budwood suppliers	Testing	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Pollen mill operators and pollen suppliers	Audit	\$0	\$0	\$0	1	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
Response costs**	Major incursion (000)	\$7,360	\$10,000	\$0	\$0	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000	\$7,360	\$10,000	\$1,000	\$1,000
Response costs**	Minor incursion (000)	\$1,472	\$500	\$0	\$0	\$200	\$200	\$200	\$200	\$200	\$200	\$200	\$200	\$1,472	\$500	\$200	\$200
Lost production**	Major incursion (000)	\$4,485,302	\$6,094,088	\$0	\$0	\$609,409	\$609,409	\$609,409	\$609,409	\$609,409	\$609,409	\$609,409	\$609,409	\$4,485,302	\$6,094,088	\$609,409	\$609,409
Lost production**	Minor incursion (000)	\$2,113,522	\$717,900	\$0	\$0	\$287,160	\$287,160	\$287,160	\$287,160	\$287,160	\$287,160	\$287,160	\$287,160	\$2,113,522	\$717,900	\$287,160	\$287,160
Lost production**	Established pest (000)	\$144,032	\$144,032	\$0	\$0	\$4,508,871											

** Note (000) for last 6 rows to fit on page.

Appendix D Production losses

Table 9: Lost production from major incursion (\$/year)

	Pathway Plan				Voluntary Action				Do Nothing			
	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses
NPV				\$1,809,373				\$903,192,962				\$6,094,088,299
Year 1	5	10%	\$93,950	\$46,975	5	10%	\$93,950	\$46,975	5	10%	\$93,950	\$46,975
Year 2	5	20%	\$93,950	\$93,950	50	20%	\$93,950	\$939,502	500	20%	\$93,950	\$9,395,019
Year 3	5	30%	\$93,950	\$140,925	100	30%	\$93,950	\$2,818,506	1500	30%	\$93,950	\$42,277,586
Year 4	5	30%	\$93,950	\$140,925	150	30%	\$93,950	\$4,227,759	3000	30%	\$93,950	\$84,555,172
Year 5	5	30%	\$93,950	\$140,925	300	30%	\$93,950	\$8,455,517	6000	50%	\$93,950	\$281,850,575
Year 6	5	30%	\$93,950	\$140,925	500	30%	\$93,950	\$14,092,529	9000	50%	\$93,950	\$422,775,862
Year 7	5	30%	\$93,950	\$140,925	1000	30%	\$93,950	\$28,185,057	11000	50%	\$93,950	\$516,726,054
Year 8	5	30%	\$93,950	\$140,925	1500	30%	\$93,950	\$42,277,586	12000	50%	\$93,950	\$563,701,150
Year 9	5	30%	\$93,950	\$140,925	3000	30%	\$93,950	\$84,555,172	13000	50%	\$93,950	\$610,676,246
Year 10	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 11	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 12	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 13	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 14	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 15	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 16	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 17	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 18	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 19	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 20	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 21	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 22	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 23	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 24	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 25	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 26	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 27	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 28	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 29	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794
Year 30	5	30%	\$93,950	\$140,925	4000	30%	\$93,950	\$112,740,230	13500	50%	\$93,950	\$634,163,794

Table 10: Lost production from minor incursion (\$/year)

	Pathway Plan				Voluntary Action				Do Nothing			
	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses
NPV				\$7,617,381				\$201,840,003				\$717,899,865
Year 1	20	5%	\$109,188	\$109,188	50	5%	\$109,188	\$272,970	50	5%	\$109,188	\$272,970
Year 2	40	5%	\$109,188	\$218,376	150	5%	\$109,188	\$818,911	500	5%	\$109,188	\$2,729,705
Year 3	60	5%	\$109,188	\$327,565	500	5%	\$109,188	\$2,729,705	1500	5%	\$109,188	\$8,189,115
Year 4	70	5%	\$109,188	\$382,159	1,000	5%	\$109,188	\$5,459,410	3000	5%	\$109,188	\$16,378,230
Year 5	80	5%	\$109,188	\$436,753	1,500	5%	\$109,188	\$8,189,115	6000	5%	\$109,188	\$32,756,459
Year 6	90	5%	\$109,188	\$491,347	2,000	5%	\$109,188	\$10,918,820	9000	5%	\$109,188	\$49,134,689
Year 7	100	5%	\$109,188	\$545,941	2,500	5%	\$109,188	\$13,648,525	11000	5%	\$109,188	\$60,053,509
Year 8	110	5%	\$109,188	\$600,535	2,800	5%	\$109,188	\$15,286,348	12000	5%	\$109,188	\$65,512,919
Year 9	120	5%	\$109,188	\$655,129	3,000	5%	\$109,188	\$16,378,230	13000	5%	\$109,188	\$70,972,329
Year 10	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 11	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 12	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 13	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 14	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 15	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 16	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 17	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 18	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 19	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 20	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 21	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 22	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 23	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 24	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 25	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 26	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 27	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 28	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 29	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034
Year 30	130	5%	\$109,188	\$709,723	4,000	5%	\$109,188	\$21,837,640	13500	5%	\$109,188	\$73,702,034

Table 11: Lost production from established pest (\$/year)

	Pathway Plan				Voluntary Action				Do Nothing			
	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses	Area affected (ha)	Proportion of vines impacted per hectare	Per ha returns	Production losses
NPV				\$4,508,871				\$38,172,466				\$144,031,846
Year 1	300	1%	\$109,188	\$327,565	300	1%	\$109,188	\$327,565	300	1%	\$109,188	\$327,565
Year 2	300	1%	\$109,188	\$327,565	525	1%	\$109,188	\$573,238	700	1%	\$109,188	\$764,317
Year 3	300	1%	\$109,188	\$327,565	600	1%	\$109,188	\$655,129	1,500	1%	\$109,188	\$1,637,823
Year 4	300	1%	\$109,188	\$327,565	660	1%	\$109,188	\$720,642	3,000	1%	\$109,188	\$3,275,646
Year 5	300	1%	\$109,188	\$327,565	800	1%	\$109,188	\$873,506	6,000	1%	\$109,188	\$6,551,292
Year 6	300	1%	\$109,188	\$327,565	1,000	1%	\$109,188	\$1,091,882	9,000	1%	\$109,188	\$9,826,938
Year 7	300	1%	\$109,188	\$327,565	1,500	1%	\$109,188	\$1,637,823	11,000	1%	\$109,188	\$12,010,702
Year 8	300	1%	\$109,188	\$327,565	2,000	1%	\$109,188	\$2,183,764	12,000	1%	\$109,188	\$13,102,584
Year 9	300	1%	\$109,188	\$327,565	3,000	1%	\$109,188	\$3,275,646	13,000	1%	\$109,188	\$14,194,466
Year 10	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 11	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 12	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 13	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 14	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 15	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 16	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 17	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 18	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 19	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 20	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 21	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 22	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 23	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 24	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 25	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 26	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 27	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 28	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 29	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407
Year 30	300	1%	\$109,188	\$327,565	4,000	1%	\$109,188	\$4,367,528	13,500	1%	\$109,188	\$14,740,407