Analysis of benefits (updated benefits)

A Lighter Touch: Agroecological crop protection to meet future consumer demands

NZIER report to Market Access Solutionz Ltd and Horticulture New Zealand

February 2020

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Authorship

This paper was prepared at NZIER by Chris Nixon.

It was quality approved by Mike Hensen.

The assistance of Sarah Spring is gratefully acknowledged.

L13 Grant Thornton House, 215 Lambton Quay | PO Box 3479, Wellington 6140
Tel +64 4 472 1880 | econ@nzier.org.nz

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Key points

Objective

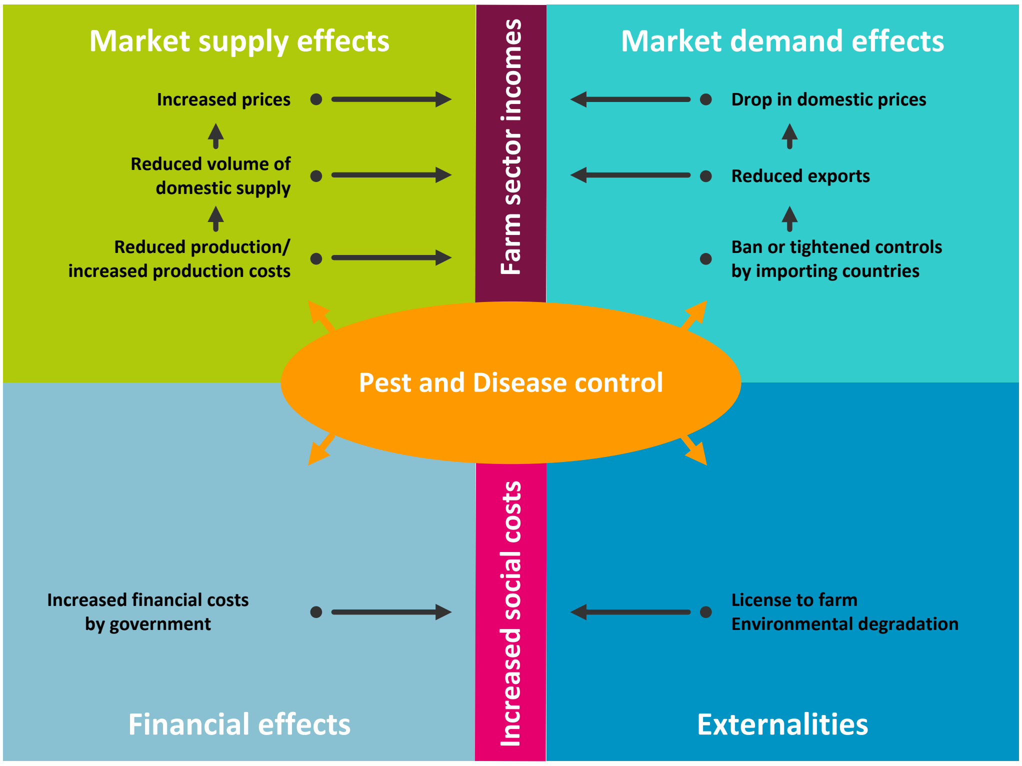
This report provides updated estimates of the benefits of the proposed Primary Growth Partnership (PGP) project: A Lighter Touch: Agroecological crop protection to meet future consumer demands.

The project's purpose is to provide the right pest and disease management tools for farmers and orchardists to maximise productivity, increase diversity of crops, increase value and quality of horticultural and arable crops, and maximise market prospects.

There are benefits across the marketing chain

Sustainable pest and disease management provides a key foundation for the development of a diverse and flourishing horticultural and arable sector. The approach is set out in the following diagram.

Benefits framework



Source: Adapted from FAO: http://www.fao.org/docrep/003/x9800e/x9800e16.htm

The proposed PGP project potentially has multiple benefits:

- **Supply management gains**. The most direct economic gain is to reduce the impact of pests and disease that reduce sector incomes
- **Demand management gains**. An increase in pest and disease incursions can have a dramatic impact on exports. Importing nations tend to react rapidly to negative changes in pest or disease status in exporting nations. Improved on-farm pest and disease management can have a positive impact on on-going market access arrangements

- **Externalities**. Horticulture and arable farming tend to be intensive. Reductions in chemical use and a shift to natural chemicals will improve environmental outcomes and reinforce and underpin the "licence to farm"
- **Reduction in government costs**. A more benign chemical regime is likely to require less regulation, monitoring and enforcement by government.

The analysis takes into account that benefits will occur over a number of years, since benefits will not be captured immediately.

Table 1 summarises the estimated impacts of the PGP programme. The analysis assumes that the PGP programme starts in late 2019 with the first benefits occurring in 2022. Full benefits only occur in 2027. While not measured, benefits are likely to continue with further industry investment after 2027.

Under our central scenario, the benefits are substantial. The quantified benefits (supply and demand management) are mainly driven by productivity gains, and maintenance/improved market access.

We produced a low and high scenario which indicate that the benefit ranges from $546.0 million to $1,528.8 million. We have also estimated GDP contribution.

Table 1 Summary estimates of the PGP project

Present value 6%, $ millions

	Low	High	Comments
Quantifiable benefits	$546.0 million	$1,528.8 million	Benefits arise all along the marketing chain from increased effectiveness of disease and pest techniques through to improved market access
Estimated GDP contribution	$245.7 million	$688.0 million	
Non quantifiable benefits			
Externalities	A successful PGP project will have a substantial environmental impact and also underpin its licence to farm		
Government costs	A more environmentally friendly industry will reduce government regulatory, monitoring, and enforcement costs		

Source: NZIER

Caveats

Most of the assumptions used to estimate the benefits are derived from discussions with industry, and New Zealand and overseas studies. These sources are characterised by major differences in definitions and measurement issues.

New Zealand data draws on a limited number of local studies and information from industry.

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1. Introduction

Horticulture New Zealand is proposing a Primary Growth Partnership (PGP) project that will assist in future proofing the horticultural industry and sustaining export growth.

To do this the horticultural industry needs to develop the right tools to boost exports and at the same time transparently show that it takes seriously its land custodial role.

Agroecological crop protection[1] provides the tools and direction required to meet this challenge. Agroecology is the study of agricultural ecosystems and can have a broad interpretation. According to FAO, Agroecology is "*a scientific discipline, a set of practices and a social movement*".

The objective of the PGP proposal approach is to shift the focus of crop protection and integrate biological and ecological processes into food production by achieving a lighter touch on the environment and meet consumer demands.[2]

Sustainable pest and disease management strategies underpinning this approach are crucial for the development of horticultural industries within New Zealand. The ability to stay on top of chemical resistance has the potential to:

- Reduce costs and sustain competitiveness
- Improve the diversity and quality of the horticultural export offering
- Develop new markets, maintain current markets, and further improve market perception of New Zealand horticulture
- Maintain the licence to farm for New Zealand horticulture.

Since premium horticultural produce remains "whole" and "unprocessed", the impact of this proposed PGP will be felt all along the marketing chain: before the orchard gate, through packing and wholesaling, and in domestic and export markets.

The purpose of this report is to demonstrate the likely impacts – given the horticultural industry's best estimate of outcomes under a successful PGP programme. In this way we can provide an estimate of the likely benefits of the proposed programme.

We have drawn on domestic studies, case studies, information from industry, perceptions of experts, international studies and other sources.

There remain a number of important questions about costs, impacts, and practical implementation issues that cannot be answered without the programme. Most importantly, the likelihood of success of the programme i.e. the potential benefit of the programme outcomes. As such, the depth of the benefit analysis reflects the initial scoping nature of the assessment, in line with good policy practice.

[1] http://www.fao.org/family-farming/themes/agroecology/en/

[2] Pretty, Jules. 2008. Agricultural sustainability: concepts, principles and evidence. Philosophical Transactions of the Royal Society, 363, 447-465.

2. The current situation

2.1. The problem

Charles Darwin could have predicted that the continued use of herbicides, pesticides or fungicides would eventually result in the evolution of resistant biological threats (weeds, insects, funguses and other organisms).

There are many real-world examples that show his theory of evolution in action. But resistance does not make biological threats insurmountable. Some industries in New Zealand, such as passionfruit and tamarillos, have been decimated by pests and diseases. While these crops are small, the impact of new biological threats should not be underestimated; and it is a constant battle to ward off new threats but also to contain current pests, funguses, and weeds.

The news is not all bad since typically it is only one mutated gene that confers resistance to the herbicide, pesticide or fungicide. This has meant that scientists have been very successful in developing new approaches to mitigate biological threats in a variety of orchards/crops and growing situations.

However, relying solely upon one approach to biological threat management is not a panacea:

- The pipeline of 'chemistries' is not inexhaustible. Registrations of effective remedies have declined substantially over the past 20 years due to regulatory constraints, the cost of product development, and the genuine scarcity of novel chemistries
- Fewer and fewer modes of action (effective physiological mechanisms) have been found, with the most recent discoveries made some time ago
- Excessive reliance upon a single mode of action can cause resistance, heavily reducing effectiveness.

In many situations in New Zealand horticultural and arable sectors, farmers are engaged in a continuing battle to maintain and improve crop quality as resistance grows and the number of chemicals that are able to be used declines.

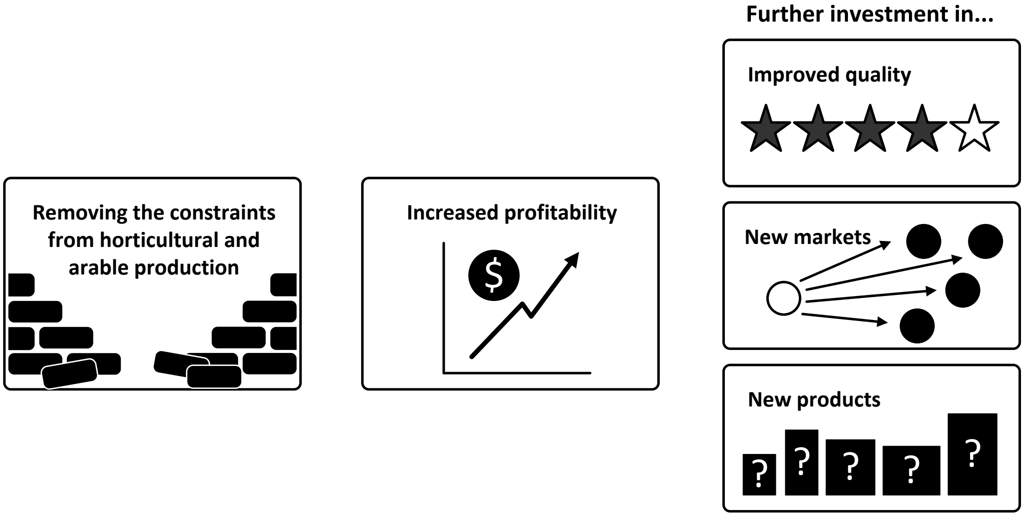
2.2. Addressing the problem

The aim of the programme is to underpin a growing vibrant horticultural industry by improving the market offering (improved products, new markets, and new products) and increasing profitability by removing constraints to further production. To do this requires:

- Developing a virtuous circle of benefits that reinforce industry sustainability
- Improving industry performance all along the production chain
- Improving incrementally to create a step change in performance.

The following diagram sets out the approach.

Figure 1 Addressing the the problem



Source: NZIER

This involves:

- Removing some of the constraints and increasing on-orchard flexibility

A successful PGP project will increase volumes of product per hectare and improve quality. Typically, this would reduce price (particularly on the domestic market) however the size of the international market means that prices are likely to remain firm in most cases.

There is also likely to be an allocative efficiency gain where less time is spent on crop protection (freeing up valuable labour) and more time spent on experimenting with new crops and improving existing crops.

Increased diversification of crops also reduces risks since each crop has different economic drivers. Improved orchard and crop flexibility increases the sustainability and viability of production.

- Generating increased profitability

Less spending on crop protection will improve profitability. Increased profitability will attract new entrants and add further vibrancy to the industry.

Profitability increases economies of scale and scope. Increased profitability will also allow for an increase in scale and scope of operations – improving profitability further. Larger operations will give operators the potential to increase skilled labour to support crop diversification. This also assists in the ability to retain staff.

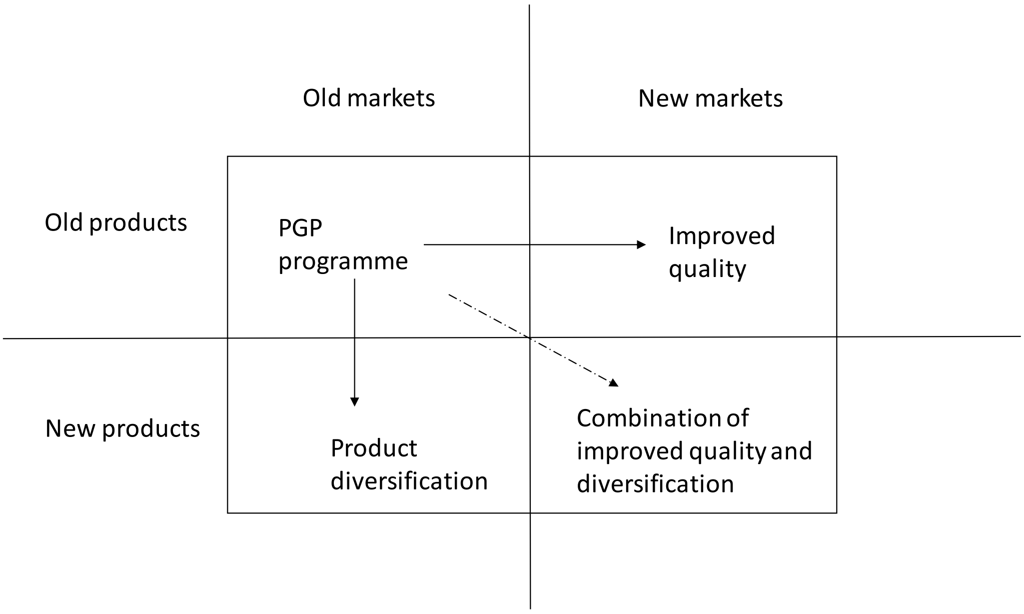
- Further investment can create a step change in performance

Improving quality all along the marketing chain enhances the chance of developing new markets (see the following Figure). Moving existing products can extend the industry's profitability in the short term by breaking into new markets.

Over time improved flexibility on-orchard and on-farm also contributes to the develop of new product offerings which are the life blood of any industry. Extending the product range in existing markets also adds to the exporting resilience.

Expanding into new markets with existing products and new products is the final aim of this process. It increases the potential sales of existing products, entry of new products, and the development of new markets. In this way the industry can maximise the profitability of New Zealand's orchards and cropping farms.

Figure 2 Improved returns through extending its existing product range, introducing new products, and developing new markets



Source: NZIER

2.3. Size of the problem

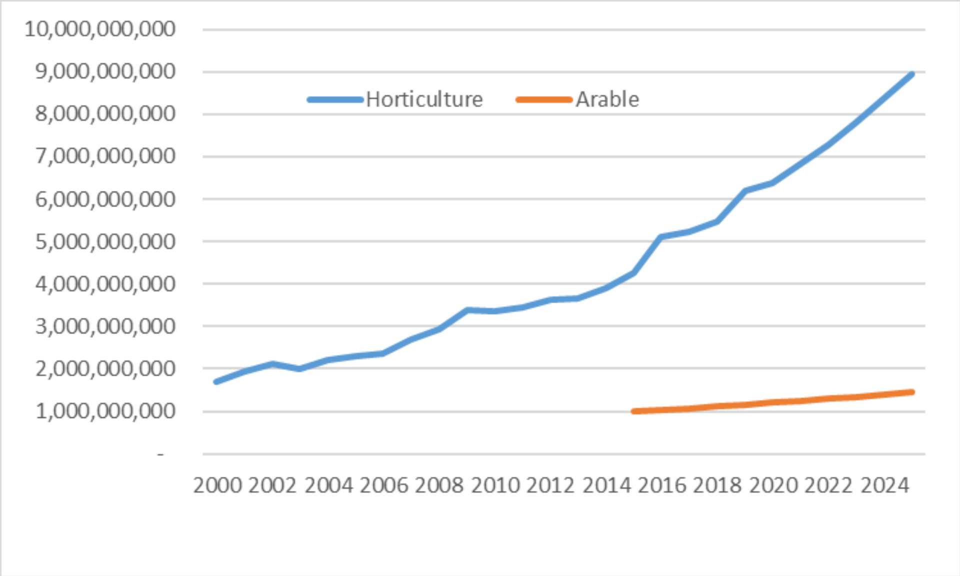
The Ministry for Primary Industries (MPI) report that horticultural exports increased 13.7% in the year ended June 2019. Further growth is expected in the year ending June 2020 albeit at a much lower rate (3.8%). Given that the average growth rate between 2000 and 2018 has been 7%, projecting a similar growth rate until 2027 seems realistic.

According to Plant and Food Research, arable production is growing at 2.75% per annum. We have used this growth rate to project total arable production out to 2027.

Figure 3 sets out the baseline project "without" the PGP programme. By 2027, the expected export value of the horticultural export industry is forecast to be $10,252 million and arable production to be at $1,555 million.

Figure 3 Projected horticultural export and arable production growth

2016-2027



Source: Fresh Facts and http://www.plantandfood.co.nz/growingfutures/cropping

2.3.1. Damage estimates

Published literature on the economics of resistance to disease and pest control is relatively scarce. A certain amount of unpublished literature exists, but it tends to be specific to the commodities that are most important for individual countries. Data from developing countries on crop losses from pests are not very reliable and have generally been derived from site-specific tests rather than from systematic research sponsored by governments.

Analyses in economic impact studies are often limited to effects on production, with relatively little regarding subsequent impacts on prices, trade or secondary and tertiary market effects. NZIER's Apple Futures project is an exception to this comment since it focuses on the trade impacts of on-farm pest and disease management.

The literature rarely includes externality costs, control efforts, or infrastructure costs. Longer-term impacts, the dynamics of responses to outbreaks and farmer or community adaptation are also universally lacking.

We have used tentative estimates based on information from United States and the Apple Futures project that suggests that crop/orchard production is reduced by biological threats by as much as 15% (Grafius (1990), Norton et al (1989), NZIER (2012), Pimental (2005) and Shufran et al (1990)).

Assuming that biological threat costs in New Zealand are similar to those in the United States, the size of the loss that the PGP programme is attempting to avoid is over $1,800 million by 2027 e.g. approximately $1,500 million (horticulture) and $233 million (arable).

2.4. Sources of mitigation

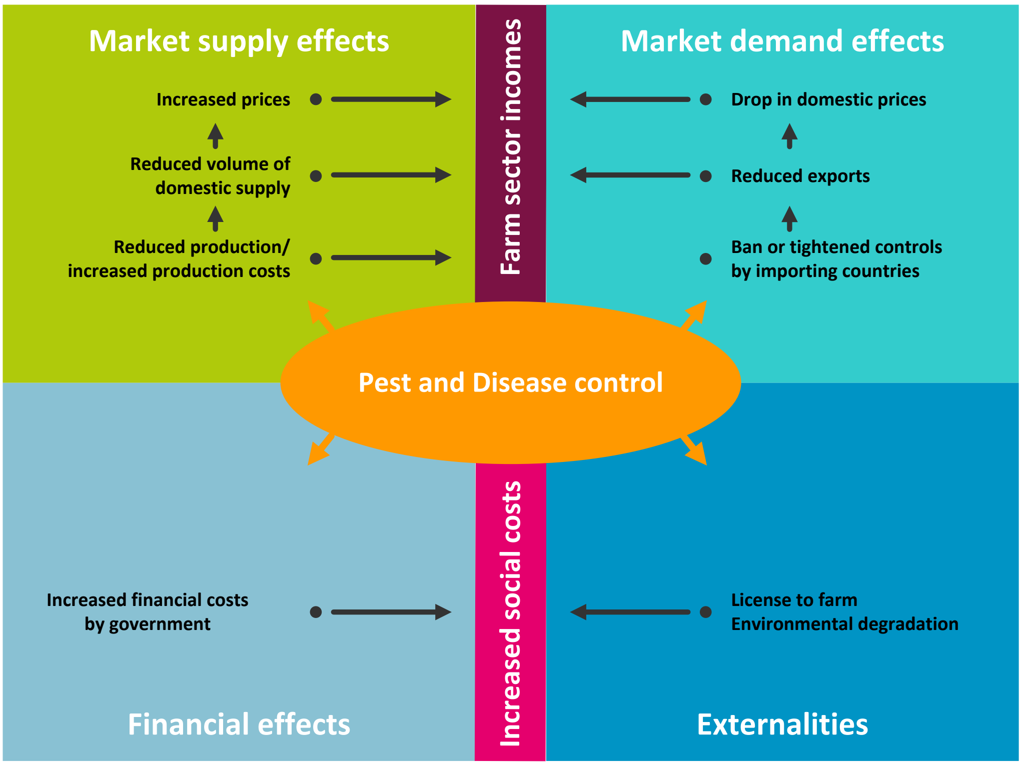
It is not surprising that estimating the damage impacts is difficult. The economic impacts of pests and diseases can be complex and go beyond the immediate impact on the directly affected agricultural producers. Some of the possible effects are illustrated in Figure 4. However, the actual economic impact will vary case by case and depend on factors such as the type of pest or disease, but the complexity of the effects often makes precise measurement of the economic impacts very difficult.

Despite good knowledge of past impacts of pests and disease predicting how new threats can be mitigated is difficult because:

- The specific nature of the threat determines the scope and size of the impact. For example, a threat to rye grass has much wider impacts than just to rye grass. This is because roughly 75% of energy intake from livestock comes directly from rye grass
- Market entry tends to switch off if importing countries perceive a threat to their own domestic production. Losses can be much higher for unprocessed produce exports than for industries where the crop is used as an input – particularly in the short term
- There is a dynamic at play where substitutes can be found or resistance is developed for affected crops (and where the mix of biological threats varies from country to country). This tends to mitigate against prolonged or permanent losses e.g. the recovery from PSA in kiwifruit has been dramatic. Despite large initial losses associated with PSA the use of a new cultivar has (along with the presence of PSA in other countries) limited the damage.

All of these factors must be further understood when considering the benefits of the industry wide programme.

Figure 4 Benefits framework



Source: Adapted from FAO: http://www.fao.org/docrep/003/x9800e/x9800e16.htm

2.4.1. Supply side management effects

The most direct economic impact of a pest or disease is the loss or reduced efficiency of arable or horticultural production – which reduces farm income. The severity of the economic effect will depend on the specific circumstances. If the horticultural/arable economy is relatively diversified and other income opportunities exist, the burden will be reduced. Conversely, if the local economy is heavily dependent on one or a few vulnerable crops, the burden may be severe.

The impacts of reduced productivity on crops can be long-lasting. Pest infestations and disease incursions can impair fertilisation rates or seed recovery, while increased chemical applications can harm soil and water fertility – not only hurting profitability but harming the environment. It could also harm public perceptions of farming (e.g. the "licence to farm" is curtailed).

Diseases and pests can have lasting effects on tree and crop production in a number of "hidden" ways (e.g. the Liberibacter carried by psyllids kills tamarillo trees. This delays production because it takes 18-20 months before a new tree bears fruit, leading to much reduced fruit volumes, which often exceed the losses associated with the direct impact).

Although the loss of output from a pest or disease may appear easy to identify, it can nevertheless be difficult to measure in precise economic terms. Indeed, such an economic evaluation should not simply measure the value of lost output by multiplying estimated physical loss by the market price. This may exaggerate the likely economic impacts of damage. Actual economic impacts also depend on adaptation (or dynamics) by farmers as well as possible market adjustments. Farm communities can respond to reduced productivity in various ways including; replanting; or selling assets and engaging in non-farm income earning activities. In these situations, and for these reasons, the welfare loss may be less than the value of lost output.

However, if the farmer livelihood responses are very restricted, or the community economy is heavily dependent on the commodity affected by the pest or disease, the welfare losses likely to exceed the value of lost output.

Furthermore, the difficulty of distinguishing the production impacts of pests from other changes – such as climate – has not been effectively overcome. Often, pest infestations and disease epidemics coincide with changes in climatic conditions, such as drought, early rains and other output-reducing events.

2.4.2. Demand side management effects

Prices and market effects

Variations in prices can occur, which are determined by the supply and demand effects induced by pests or disease. Market effects can similarly induce variations in wages for farm, processing, packing and wholesaling employment and can also spread through to upstream and downstream activities.

Depending on the market for the affected arable or horticultural products, an infestation or outbreak can lead suddenly to higher prices (if most production is domestically consumed), or to lower prices (if most production is exported and quarantine prevents such exports but allows domestic consumption).

The relative effects of the production shortfall on producers and consumers depend on the responsiveness of demand and supply to price changes. Negative price effects can also occur where consumer health concerns lead to reductions in demand.

Trade effects

Through the demand channel, pests and disease can have major implications for farmers and countries that either produce for export or plan to export. This is particularly so for New Zealand since it is one of the few industrialised nations that earn significant revenue from land-based and sea-based exports.

Outbreaks of pests and diseases in New Zealand therefore have major immediate ramifications. Importing countries tend to shut down trade quickly by totally excluding the importation of products from areas affected by pests and disease or by making importation conditional on a series of precautionary (sometimes costly) measures.

Conversely, the benefits of eliminating or staying on top of the problems associated with pests and disease can be very large. The desire to gain and maintain access to high-value export markets is the driving force behind many plant and disease eradication efforts and this PGP project.

2.4.3. Externalities

There is increasing concern over threats to the environment, either from pests and disease themselves or from the control measures used against them. Control measures have become a matter of serious concern since attention has focused on the dangers associated with chemicals used. There is also growing concern about invasive species, brought in by trade or movements of people, which dominate or otherwise harm the native ecology.

Externalities are also linked with the licence to farm. These decisions are influenced by public perceptions of the methods used to farm and sustain the land.

The concept of a social licence to operate is the complex mix of philanthropic, ethical, legal and economic expectations that a community and stakeholders may have, which enables an operation, in this case farming, to continue in a local community.

If mistrust between communities and farmers develops based on community concerns about farmers' management of biological threats, then farmers may face inefficient restrictions on farming practices constraining their ability to produce at competitive costs and ultimately the viability of their farming business.

Further, a lack of understanding between farmers and regulators can also lead to badly designed policies that do not assist in efficient or effective improvement of environmental outcomes.

2.4.4. Costs to government

There are also government budgetary implications for pests and disease. Control measures generally involve budgetary outlays, including for inspection, monitoring, prevention, regulatory, and response costs.

Demands are also often put on governments to extend financial assistance to the affected producers. The costs of some of these measures are not always proportionate to the size of the agriculture sector being protected.

The benefits of prevention and emergency preparedness are generally not directly apparent, as they depend on assumptions about avoided costs of infestations and outbreaks.

We have not quantified the benefits of avoided government costs in this report but they can be substantial.

3. Proposed approach

The PGP programme has four themes:

- Enduring outcomes
- Agroecological crop protection including:
  - Biopesticides path to market
  - Up-scaling biological capability
  - New technologies for crop protection
- Transition projects:
  - New age agrichemicals for crop protection
  - Resistance prevention and management
- Programme management.

Below we set out the details of each theme.

3.1. Enduring outcomes

Enduring outcomes (Theme 1) revolves around three projects that underpin the long-term transition to a less chemical dependent future beyond the life of the PGP programme.

Key to this outcome is to:

- Establish an "Institute for Agroecological Crop Protection"
- Focus the Institute on consumers by ensuring that changing consumer demands are monitored
- Build in flexibility into the PGP programme so it can respond to changing consumer demands.

The aim of Theme 1 is to ensure that there is a strong connection between market outcomes and research direction. By matching (i.e. improving allocative efficiency) trends in the market to supply constraints/barriers the focus of the research will be improved.

3.2. Agroecological crop protection

Agroecological Crop Protection (Theme 2) focuses on understanding and better managing agricultural ecosystems to enable less chemical dependent crop protection programmes to be adopted.

The aim is to further understand how to overcome the issues with scaling up biological controls, the need for investment in capacity, and infrastructure for commercialisation of biopesticides and biological control agents.

The projects of specific interest in valuing the benefits are set out below.

3.2.1. Biopesticides pathway to market

Biopesticides are certain types of pesticides derived from natural materials such as animals, plants, bacteria, and certain minerals. The advantage of biopesticides is that they are:

- Usually inherently less toxic than conventional pesticides
- Generally, affect only the target pest and closely related organisms, in contrast to the broad-spectrum effects of conventional pesticides that may extend to organisms as different as birds, insects and mammals
- Effective in very small quantities and often decompose quickly, resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides.

3.2.2. Up-scaling biological control capability and adoption

There is strong interest in the role that biological control agents (BCAs) in pest management might play, as part of a wider agroecological crop protection approach. Biological control agents are predatory, parasitic, or herbivorous invertebrates or pathogens that attack and reduce populations of pest species (in this sense many biopesticides are BCAs). Two main approaches exist (although there are hybrids of these approaches):

- In classical biological control, BCAs establish in the growing area and their population dynamic follows that of the target species
- Inundative biological control is where large numbers of BCAs are reared and released into a growing area (e.g., greenhouses) to suppress a pest population, after which both populations collapse.

This project will identify opportunities to expand the use of BCAs in the horticulture, arable and wine sectors, improving awareness and attractiveness of biological control services. It will also support the up-scaling of BCA production and biological control services in New Zealand.

The aim is to increase the adoption of all forms of biological control.

3.2.3. New organisms for biological control

This activity will identify opportunities for new BCAs to be incorporated into agroecological crop protection programmes. These may include:

- New organisms (new to New Zealand, as defined in the HSNO Act)
- Organisms present in New Zealand that are not produced commercially for use in biological control programmes.

3.2.4. Proof of concept

"Proof of concept" is required for arable, fruit, and vegetable production systems. Crops selected for this project will host a range of common pest and disease problems as identified by the co-investor group.

The combined knowledge of the agroecology of these crops and new information from all of the PGP programme projects will be used to demonstrate how a range of crop protection strategies, combined with an understanding of the crop's agroecology, can produce crops successfully and profitably, and meet stringent consumer demands.

3.2.5. A focus on extension

Extension is a key part of the project and is required to overcome barriers to use.

While agroecological crop protection can be at the forefront of pest management decision making in horticulture crop production; to-date, integrated pest management, biological control, and other non-agrichemical pest management methods have not gained mainstream traction within horticulture.

This project will coordinate the activities of horticulture industry organisations to focus on the need for change (i.e. meet consumer demands) and provide and demonstrate the tools and benefits of change.

The key outcome will be uptake by growers. This will only occur if the programme can translate agroecological approaches into increased export returns.

3.2.6. Summary

These projects will focus on understanding the barriers to facilitating improvement in the system and undertaking proof of concept to test and further refine the process. The following outcomes are expected:

- Increased investment in biopesticide development
- Early adoption of innovative new technologies
- Increased availability of pest management options for organic and conventional production
- Lower residue levels
- Improved access to export markets
- Improved ability to deal with biosecurity incursions in urban areas
- Improved export opportunities (e.g. due to lower residues, improved quality etc.)
- Reduced environmental and societal risks from the use of pest control options
- Improved uptake of IPM programmes.

Table 2 Matching economic and environmental issues to agroecology crop protection

Economic and environmental issues	PGP project objectives
Supply management	Adds new ways of controlling pests and disease that are more likely to be part of a long-term solution for effective pest and disease control
Demand management	Further assists in reducing market access risks because of its benign residue impact coupled with its effective action on targeted weeds, pests, and diseases
Externalities	Reduces environmental impact since the chemical footprint is decreased through the use naturally occurring chemicals where possible
Cost to government	More benign chemical use will reduce oversight costs by government

Source: NZIER

3.3. Transitions projects

The transition to agroecological crop protection may take 20 years to achieve, although disruptive technologies such as robotics may advance these approaches. To achieve a smooth transition more focused agrichemical products (that are compatible with new crop protection programmes) are required to replace older broad-spectrum technology.

This will enable producers and exporters to keep pace with changing consumer preferences while gearing up for the transition to agroecology.

3.3.1. Resistance prevention and management

During the transition period there is a need to protect the new crop protection products from over-use and from the risk of pests and diseases developing resistance to agrichemicals.

Resistance means that chemicals no longer control the pest, disease or weed for which it was designed. For example, diamondback moth (DBM) was the first insect pest to develop resistance against DDT in the 1950s.

DBM has since developed resistance to a number of synthetic pyrethroids and organophosphates. Incorrect use of, and sole reliance on, chemicals for pests and disease problems is not a long-term solution. The DBM case was a catalyst for the integrated use of a range of management techniques as a way to avoid pesticide resistance.

This example also highlights how vital investment in resistance management is for maintaining effective crop protection options. Losing the ability to control pests, diseases or weeds due to excessive use of specific pesticides or pesticide groups may result in high crop losses and the need to use more expensive alternative control products and methods. Using integrated management strategies can reduce the development of resistance and also contribute towards the quality of the environment.

Key elements to a strategy are understanding the risks of resistance development, identifying agronomic practices to reduce pest pressure, restricting the number of applications of agrichemicals with similar modes of action, and alternating pest management options to prevent resistance development.

The PGP programme will result in:

- Further understanding of the resistance risk and the need for resistance management
- Develop a system for monitoring and reducing risk and prioritise
- Longer life of pest management options
- Develop and improved pest management strategies resulting in increased yields and quality
- Develop a cross industry collaborative approach to resistance management.

3.3.2. New Age agrichemicals for crop protection

The aim is to provide faster access to the best crop protection products. These products will be required to match the new protection products with the current and future crop protection programmes.

Factors may include compatibility with BCAs and biopesticides, use patterns and low crop residues, or specific gaps in pest control needs. The focus is on minor crops that currently use broad spectrum products off-label.

Minor use, which applies to most crops in New Zealand, applies to chemicals where the potential use is not large enough to justify its registration from an applicant's perspective. A key driver for minor use can be the lack of economic return to an applicant from the registration of those uses. In particular, the associated costs of generating the data required for obtaining and maintaining regulatory approval and potential liability after use is approved.

Typically, minor use involves crops grown on a small scale (minor crops) which are often high value specialty crops. Additionally, minor use can involve application to major crops to control minor pests and disease. This results in a situation where crop industries are either without or lack sufficient access to pest control products. The major factor hindering the regulatory approval of minor use is a lack of data that is largely attributable to a lack of funding required to generate data.

As there is no internationally accepted definition for minor use, it is quite often defined as:

- Use of pesticides on small crop areas or against infrequent pests
- Those which are too small to warrant sufficient return for manufacturers to seek approval for application of pesticides to these crops.

Many New Zealand crops are caught in the second category.

To overcome this issue, a group of horticultural sectors did the ground work to create the data needed for approval for a selected group of insecticides that are used on selected minor crops. The industry saw this investment in R&D as a highly successful pilot project.

This element of the programme will result in regulatory efficiencies and new minor crop registrations with the following benefits:

- Improved export opportunities (through lower residues and improved quality)
- Collaboration with international minor use programmes to increase availability and decrease costs
- Harmonised MRLs improving access to export markets
- Reduced impact of the Environmental Protection Agency (EPA) reassessment programme
- Increased investment in minor crops through certainty of pest management and biosecurity mitigation
- Improved compliance with residue and other regulatory requirements through label use.

4. Approach to estimating the PGP programme value

4.1. Counterfactual

Setting up the counterfactual (what would happen without the PGP) is difficult because there is:

- Limited baseline data from which to measure any change
- Uncertainty about what industries (and other parties) are likely to do in absence of the PGP approach
- Uncertainty about the impact of initiatives that would emerge without a PGP project.

Therefore, there are potentially a number of credible counterfactuals. The one we assume here is open to question, and should be treated as "work in progress". We treat the counterfactual here as a tentative "peg in the ground".

We assume that in the absence of no national strategy in place, industries will proceed with their own individual initiatives to combat pests and disease. This may include some of the initiatives planned in the PGP project. We expect that:

- Some industries will continue to evolve their current pests and disease control approaches
- If implemented, pest and disease strategies are likely to be:
  - stand-alone and configured differently, which possibly raises the cost of the programme, and of other future initiatives that rely on a coherent picture of pests and disease management
  - riskier, as distributed capability will raise strategy implementation risks.

At the same time, a distributed approach does have the benefit of spreading risk, allowing local solutions to match the local situation, however it does not assist in experimentation and learning from successes and mistakes made by others.

Regardless, under the counterfactual, industries are likely to pursue pests and disease strategies on their own initiative. They will also incur costs of investing and running the associated programmes.

A lack of information means we are not able to identify such actions, and thus cannot identify these costs and effects in any credible way. Instead, our approach is to assume that both the full costs and the full benefits would not have occurred in the absence of a coordinated industry approach.

4.2. Assessment of benefits

United States and New Zealand research points to loss of output of approximately 10% per annum due to pests and disease resistance to existing control measures. A further 5% is added since existing control methods are likely to be less environmentally friendly and will require replacement (potentially through the EPA reassessment process).

The objectives of the PGP project aim to ameliorate some of those losses.

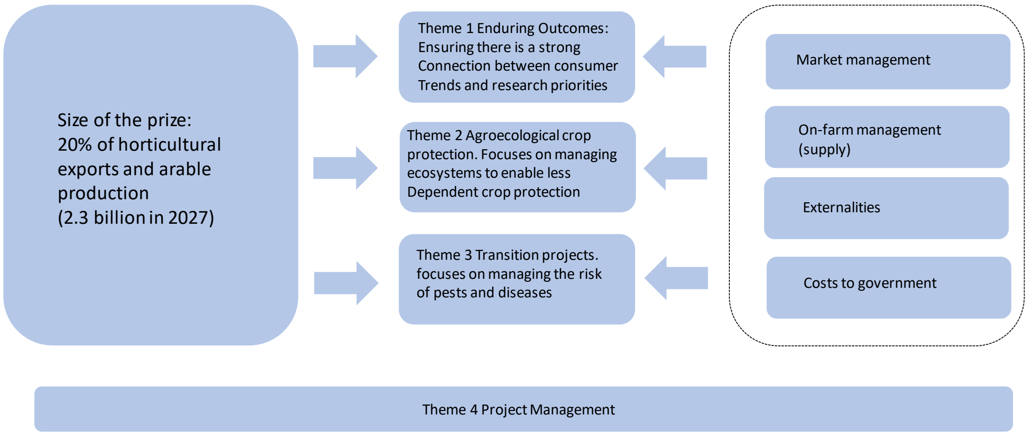
Of course we do not expect this PGP project to be able to capture 100% of the maximum possible benefit. Therefore, we have estimated the maximum possible benefit that a successful PGP project would capture for each of the PGP objectives.

The following diagram sets out the overview of the approach. To proxy possible benefits we have used 15% per annum of the projected value of horticultural exports and arable production between 2022 and 2027 as a maximum estimate of the possible benefit.

If successful we expect that the gains will be between 23% and 63% of total losses from pest and disease control. These benefits come from all objectives.

Figure 5 Valuing the benefits

Values at 2027



Source: NZIER

Below we have set out each objective and the estimated benefits.

4.2.1. Theme 1 Enduring Outcomes

We have not set out an explicit value for Theme 1 Enduring Outcomes since the aim of Theme 1 is to underpin and build the capability to support other themes. Without Theme 1, benefits in other themes would be difficult to achieve.

4.2.2. Theme 2 Agroecological crop protection

Supply management

Improving the pathway to market for biopesticides, improving the biological control capability, identifying new biological control organisms and demonstrating their worth (proof of concept) on-farm (through extension) for supply side management is critical.

We do not know the benefit attribution between supply and demand management (this applies to all objectives). However, they are equally important, therefore we expect that the benefits of a successful PGP project will fall between 2.5% and 7.5% of maximum possible benefit. The benefit is attributed to the ability to stay on top of on-going pests, disease issues, and improve environmental outcomes by giving farmers effective practical options for control.

Table 3 Agroecological crop protection – supply management benefit

Benefit in 2027, $ millions

Benefit area		
Biopesticides	**2.5%**	**5.0%**
Orchard	38.5 m	76.9 m
Arable farming	5.8 m	11.7 m
Sub total	44.3 m	88.6 m
Biological control/new organisms	**2.5%**	**7.5%**
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8
Proof of concept/extension	**2.5%**	**7.5%**
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8
Total	**132.8 m**	**354.2 m**
Note: Numbers rounded.		

Source: NZIER

Demand management

While the focus of the work is on farm/orchard, the impact of the successful application of biopesticides and biological control products will have a positive impact on the ability to market products abroad. In particular, using naturally occurring substances to combat pests and disease will assist in keeping markets open for New Zealand products (as existing chemicals are being reassessed).

Therefore, as a conservative estimate it is likely to yield a benefit of between 2.5% and 7.5% of the likely losses.

Table 4 Agroecological crop protection – demand management benefit

Benefit in 2027, $ millions

Benefit area		
Biopesticides	**2.5%**	**5.0%**
Orchard	38.5 m	76.9 m
Arable farming	5.8 m	11.7 m
Sub total	44.3 m	88.6 m
Biological control/new organisms	**2.5%**	**7.5%**
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8
Proof of concept/extension	**2.5%**	**7.5%**
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8
Total	**132.8 m**	**354.2 m**
Note: Numbers rounded.		

Source: NZIER

Externalities

The ability to contain pests and disease through natural means will have a major impact on the environment. Horticulture in particular is known for its intensive use of chemicals; therefore, we expect a positive impact on the environment and important licence to farm benefits.

This has been incorporated into the addition of new biological control/new organisms and proof of concept/extension projects.

Government costs

Successful application of biopesticides is likely to reduce government costs associated with regulation, monitoring and enforcement. More transparent attempts by the industry to use naturally occurring substances to control pests and disease is likely to reduce the regulatory burden on horticultural and arable farmers.

4.2.3. Theme 3 Transition projects

Managing resistance and prevention and a focus on minor crops

Supply management

Managing resistance and fast-tracking new age crop protection (particularly for minor crops) will provide a significant benefit for New Zealand.

We do not know the benefit attribution between supply and demand management (this applies to all objectives). However, they are equally important, therefore we expect that the benefits of a successful PGP project will fall between 2.5% and 7.5% of maximum possible benefit. The benefit is attributed to the ability to stay on top of on-going pests and disease issues by giving farmers effective options for control, particularly for minor crops.

Table 5 Transition projects (prevention managing resistance) – supply management benefit

Benefit in 2027, $ millions

Benefit area	2.5%	7.5%
Resistance management		
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8 m
Minor Crops		
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8 m
Total	**88.6 m**	**265.7 m**
Numbers rounded.		

Source: NZIER

Demand management

The package of transition projects are critical in the on-going efforts to keep markets open for New Zealand produce. Transition projects (Theme 3) is closely linked to Ensuring Outcomes (Theme 1) since Theme 1 sets up a capability that focuses on ensuring that we have market access for the goods that consumers want. This is likely to generate significant benefits.

Potentially it gives minor crops a chance to be exported and continue to meet standards set down by importing regions. Sustainability is improved/supported as these crops move from broad spectrum products to more focused crop protection products.

Therefore, successful resistance management is likely to yield a similar benefit to supply management i.e. between 2.5% and 7.5% of the total impact of pests and disease.

Table 6 Transition projects (resistance prevention and management) – demand management benefit

Benefit in 2027, $ millions

Benefit area	2.5%	7.5%
Resistance management		
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8 m
Minor Crops		
Orchard	38.5 m	115.3 m
Arable farming	5.8 m	17.5 m
Sub total	44.3 m	132.8 m
Total	**88.6 m**	**265.7 m**
Numbers rounded.		

Source: NZIER

A good example of a New Zealand demand management initiative to maintain markets and increase market premiums is the Apple Futures Programme. Apple Futures was focused on market access, on matching the production method to a specific market. Maintaining access to sensitive European markets was a key reason for the programme and a key driver for participants' involvement. By restricting agrichemical use, New Zealand apple growers have been able to access European markets that are sensitive to chemicals and residues. Reducing residues is important to growers of varieties that rely on those markets.

NZIER (2012) estimated that, in each year of the programme, industry returns would have been between $25m and $35m lower without Apple Futures. Without Apple Futures, the industry would have been forced to export more to non-EU markets, such as the US, resulting in lower average prices for the industry.

Externalities

The ability to contain pests and disease will have some positive impacts on the environment. If containment can be achieved with softer chemicals and biological controls, then it is not only better for the environment it underpins the licence to farm for horticulture and arable farming.

Government costs

The focus of regulation is likely to be on-farm. More transparent attempts by the industry to use a variety of methods to control pests and disease is likely to reduce the regulatory burden on horticultural and arable farmers.

4.2.4. Summary of benefits

Gross benefits in the 2027 year

Below we have set out the gross benefits in 2027 from each objective. We have added the quantified benefits from supply and demand management for each objective to obtain a total.

Table 7 Gross benefits

2022 - 2027, $ millions

Objective	Low	High	Externalities	Cost savings for government
Theme 1 Enduring outcomes management	Incorporated into estimates below	Incorporated into estimates below	Positive	Positive
Theme 2 Agroecological crop protection	$265.7 m	$708.5 m	Very Positive	Very Positive
Theme 3 Transition projects	177.1 m	531.4 m	Positive	Positive
Theme 4 Project management	Na	Na		
Total	**$442.8 m**	**$1,239.8 m**		
Notes: Numbers rounded.				

Source: NZIER

Full revenue benefits are expected at the end of the period as the project develops. The first year of benefits will be in 2022 (see Figure 6).

Figure 6 Projected profiability from PGP

2022 - 2027

Source: NZIER

Benefits over time

Above we have set out the benefits expected in 2027. We also need to convert the gross benefit (from the Table below into 2019 dollars (see Figure 7). For stakeholders to understand the full benefit up to 2027 two things are required:

- An understanding of benefit realisation timing i.e. when will the benefits be realised? In this project we have estimated that the benefits will occur in the following way. Note that this means full benefits will be generated relatively quickly and while we have not set them out, significant benefits will be generated beyond 2027

Table 8 Timing of benefits

	2022	2023	2024	2025	2026	2027
Benefits realised in each year (percent)	10%	20%	30%	40%	50%	100%

Source: NZIER

- Application of a discount rate (6% as per Treasury guidelines).

By applying the timing of benefit realisation and the discount rate we estimate the approximate benefits to be between $546.0 million (or 23% of total possible benefits) and $1,528.8 million (or 63% of the total possible benefits). This is set out in Figure 7. We have also estimated a contribution to GDP for the project.

Figure 7 Estimated benefits of the PGP project

2019 dollars

Discount rate	6%												
Benefits													
Low	25%												
High	70%												
Maximum benefit that could be achieved													
		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Horticulture (15% of exports)						955,660,832	1,022,870,705	1,094,807,326	1,171,803,117	1,254,213,881	1,342,420,444	1,436,830,411	1,537,880,059
Arable (15% of production)						180,314,971	187,076,782	194,092,162	201,370,618	208,922,016	216,756,591	224,884,964	233,318,150
Possible benefits from PGP: 2020 onwards													
Low (maximum possible benefit)						283,993,951	302,486,872	322,224,872	343,293,434	365,783,974	389,794,259	415,428,844	442,799,552
High (maximum possible benefit)						795,183,062	846,963,241	902,229,641	961,221,614	1,024,195,128	1,091,423,924	1,163,200,762	1,239,838,746
Timing of benefits from programme								10%	20%	30%	40%	50%	100%
Likely benefits from PGP													
Low	546,002,005	0	0	0	0	-	-	32,222,487.19	68,658,687	109,735,192	155,917,703	207,714,422	442,799,552
High	1,528,805,613	0	0	0	0	-	-	90,222,964.12	192,244,323	307,258,538	436,569,570	581,600,381	1,239,838,746
Contribution to GDP in 2019													
Low	245,700,902												
High	687,962,526												

Source: NZIER

5. Conclusions

Of the components that could be quantified, results suggest that benefits are substantial.

The principal benefits of the PGP project that we have estimated quantitatively are:

- The reduction in production losses to on-farm and on-orchard activities from resistant pests and diseases
- The improved chances of maintaining, expanding and opening new markets from a better quality product with less residues (see Apple Futures programme as an example)
- The reduction in "harder" chemical use (not quantified).

We must stress that the paucity of information available on different aspects limits the reliability of the quantitative benefit estimates. The robustness of the analysis may also be affected by the potential bias in the information provided. However, the quantitative benefit estimates do not include benefits such as environmental outcomes, and solidifying the licence to farm which may be significant.

The figures in this report should be regarded as an order of magnitude calculation rather than a definitive measure and the analysis can use improved information if it becomes available.

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