Reassessment of substances with the active ingredient of hydrogen cyanamide

The costs and benefits of withdrawing hydrogen cyanamide from the New Zealand market

NZIER report to New Zealand Kiwifruit Growers Incorporated

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Key points

Objective

This report provides an estimate and further understanding of the costs and benefits of removing hydrogen cyanamide from New Zealand kiwifruit orchards.

Main findings

Hydrogen cyanamide provides a key foundation for the successful development of the kiwifruit industry and potentially has multiple costs if removed:

- Significant on-orchard yield losses. Even in conservative scenarios, the use impacts of hydrogen cyanamide are significant. Without hydrogen cyanamide, the ability to "standardise" production on-orchard from bud-break to picking is greatly reduced. This leads to fewer flowers, fewer fruit and more variable maturity.
- The reduction in fruit picked and variable maturity will cause major disruption for packhouses and Zespri. Packhouses will suffer from reduced throughput, stranded assets, and poorer quality outcomes[1] while Zespri will find it difficult to grow existing markets and develop new markets.
- The lack of hydrogen cyanamide will:
  - Make labour less efficient on-orchard since the differing maturity levels of fruit in the same block will reduce standardisation of tasks– increasing the costs per tray as workers will need to revisit production blocks several times to do one task.
  - Reduce employment since crop volume will be smaller.
- Have a detrimental impact on regional development and government regional development objectives.

The analysis takes into account the impact over 10 years in line with good public policy practice.

The benefits of withdrawing hydrogen cyanamide are reduced risk of adverse effects on the health of operators and bystanders from accidental exposure, although the toxicology report commissioned for the reassessment labels the risks to bystanders and applicators as acceptable.[2] If applied incorrectly it is potentially toxic to aquatic organisms and birds, depending on the dose.

Error! Reference source not found. summarises the estimated impacts of withdrawing hydrogen cyanamide from kiwifruit orchards. The analysis examines first-year costs and costs over 10 years.

Under our central scenario, the direct costs of removing hydrogen cyanamide are very large. These direct costs are mainly driven by lower yield and the lack of standardisation of

1 There is a distinction between different maturity rates which lead to poor quality outcomes which likely to occur "without" hydrogen cyanamide use and the underlying quality of the fruit produced which is a durable competitive advantage for the industry.

2 Australian Environmental Agency Pty Ltd (2020)

the production process. There are also costs to packhouses, Zespri, businesses that support kiwifruit, and government regional development objectives.

We produced a low estimate and a higher estimate (based on optimistic assumptions about the potential improvement in the efficacy of alternatives and as growers gain experience with alternatives). Currently, alternatives to hydrogen cyanamide are less effective and less reliable because they have a much narrower window of optimal use – adverse weather conditions (namely rain within three days of application) greatly reduces their efficacy. Also, the level of physiological knowledge required about the vines is much higher when using alternatives.[3]

Table 1 Summary of costs and benefits

6% present value

	First year	Over ten years	Comment
Direct Costs			
Growers	Between $233.8 and $300.5 million	Between $2,187 and $2,811 million	Significant losses. Increased impact the further north the orchard is.
Packhouses (illustrative only)	Between $23.2 and $29.8 million	Between $203.9 and $262.2 million	Significant losses and labour shedding.
Zespri	Severe short-term pressure on costs and opportunity cost of lost sales	Loss of markets or crop grown elsewhere	Increased cost per tray marketed.
Total direct costs	**Between $233.8 and $300.5 million**	**Between $2,187 and $2,811 million**	Numbers rounded
Other cost impacts			
Orchard management costs (illustrative only)			
Winter pruning	$17.3 million	$136.3 million	Costs increase by 30%.
Less overall labour reduction	$5.8 million	$46.1 million	Costs increase by 20%.
Impact on other industries	Between $93.5 and $120.2 million.	Between $874.7 and $1,124.7 million.	Suppliers to the kiwifruit industry.
Government regional development objectives	Constrained.	Likely to be a major constraining factor as time goes on.	Likely to reduce the ability of government to reach its regional development objectives.
Impact on iwi development	Impact on new growth opportunities.	Could constrain options as treaty settlements occur.	Nearly 10% of the industry.
Direct benefits			
Human health			

3 That is, the current success of alternatives to hydrogen cyanamide relies on them being applied at exactly the right physiological stage and that can be difficult to determine without expert advice. This is impractical given that a large number of orchards will require expert advice at the same time.

Short term health benefit	Not considered major (Schep et al., 2008).	Na	Impact on operators and bystanders.
Handler	Risk acceptable if appropriate PPE used.	Na	Must have specified protective clothing.
Bystander	Risk acceptable if appropriate distances observed.	Na	Observe instructions and wind conditions.
Animals			
Birds	Risks acceptable on dormant vines.	Na	Birds scarce in the orchard in the July – August period.
Environment			
Aquatic organisms	Risk acceptable with mitigation.	Na	The Australian Environmental Agency (2020).

Source: NZIER

Caveats and notes

Most of our assumptions are derived from New Zealand studies funded by Zespri. Some of these studies have been published in peer-reviewed journals. These studies have the advantage of being based on New Zealand conditions.

The figures in this report should be regarded as an order of magnitude calculation rather than a definitive measure. However, the numbers do support previous analysis in the 2006 benefit reassessment process.

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1 Introduction

The New Zealand Environmental Protection Authority (EPA) has decided that grounds exist for the formal reassessment of substances containing hydrogen cyanamide.

Products with the active ingredient of hydrogen cyanamide are used in deciduous plants as a plant growth regulator. It has the advantage of initiating and promoting uniform bud break and promoting even flowering in kiwifruit. It can also be used on other crops.

It is used typically in the July – August period to overcome the effects of mild winter temperatures. The most well-known product that uses hydrogen cyanamide as an active ingredient is HiCane. Appendix B sets out other Agricultural Chemicals and Veterinary Medicines (ACVM) registered products containing hydrogen cyanamide.

The reassessment is a formal legal process where the EPA reviews the approval of a chemical classed as a hazardous substance. The outcome of a reassessment can be that approval for use is revoked, banning the chemical, or that the rules controlling the chemical are changed, or no change is required. WorkSafe also has a role in how the requirements are implemented.

There are a number of reasons for the application of hydrogen cyanamide in the kiwifruit industry. These include:

- Productivity (yield) gains associated with:
  - Promoting uniform and increased bud break.[4]
  - Increasing the number of flowers and preventing flower loss, in a compact timeframe (standardisation).
  - Increasing the number of king flowers[5] and reducing the number of unwanted lateral flowers.
  - Developing a compact leaf canopy and better bee access, reducing the need for more expensive artificial pollination.
  - Ensuring early leaf growth giving a longer growing season and bigger fruit.
  - Removal of lichen and scale insects.
- Positive impacts on packhouses (crops are higher yield and more uniform).
- Reduced orchard management costs.
- Improved regional outcomes since kiwifruit is an important part of some regional growth strategies.
- Impacts on iwi businesses. Kiwifruit is seen as a growth opportunity for iwi (in terms of revenue and labour employment).

4 Bud break is the opening of a dormant bud as new growth appears, typically in spring. It is the first stage of the cycle that yields fruit in the autumn.

55 The more king flowers the more fruit grown (Snelgar et al., 2010).

The purpose of this report is to provide a cost benefit analysis (CBA) which examines the impact of withdrawing hydrogen cyanamide from use in the kiwifruit industry.

We have drawn on international and domestic studies in peer-reviewed journals, case studies, information from the industry, and a previous ERMA reassessment in 2006.

The analysis is intended to give decision-makers an indication of the likely costs and benefits to assist in the reassessment process.

There remain a number of important uncertainties on costs, and impacts. As such, the depth of the CBA reflects the initial scoping nature of the assessment, in line with good policy practice.[6]

2 The current situation

2.1 Previous judgements about the risk of hydrogen cyanamide use

The previous reassessment (2006) determined that if hydrogen cyanamide "*was used in conditions that minimised the likelihood of spraydrift with adequate buffer zones in place, using calibrated equipment, an operator having at least minimum qualifications, then the risk should be considered as low*". P4 Summary of submissions.[7]

If best practice was ignored, then the impact was deemed as being medium. A medium risk was also considered appropriate by the EPA because of the restricted time period that hydrogen cyanamide was applied (typically between July and August).[8]

2.2 Why is hydrogen cyanamide important for the kiwifruit industry?

The use of hydrogen cyanamide is of critical importance to kiwifruit growers, particularly in areas where warmer temperatures occur in the Bay of Plenty and further north. This is because kiwifruit require a degree of chilling in winter to ensure adequate and uniform budbreak and flowering.

The multiple benefits of hydrogen cyanamide allow for a significant increase in flower improvement, the yield of vines, reduction in management costs, and larger more consistent fruit. This is set out in Table 2.

In the previous 2006 reassessment, NZKGI estimated that hydrogen cyanamide was used on between 75% and 85% of the national kiwifruit crop. The benefit of hydrogen cyanamide was considered to be very large. This was in a situation where 11,000 hectares had been planted. In 2019 the number of hectares producing was 12,905 hectares (17% higher).[9]

Forecasts by Zespri suggest that the NZ kiwifruit crop will increase over time from 154m trays in the 2020/21 season to 186m trays in the 2024/25 season (Zespri's 5 year outlook).

6 See https://treasury.govt.nz/sites/default/files/2019-12/full-impact-statement-template-dec2019.docx

7 https://www.epa.govt.nz/assets/FileAPI/hsno-ar/HRC05001/Final_Agency_Report.pdf

8 The EPA asserts that operators are more likely to spray in conditions where spray drift can occur if spray times are restricted.

9 Further the efficiency of the spray process has improved since 2006. Zespri now mandate the use of air inclusion nozzles. Combined with a drift reducing agent and used in specified conditions it greatly reduces spray drift.

Table 2 The multiple benefits of hydrogen cyanamide on kiwifruit orchards

Growers, packhouses, and Zespri

Impact	Comment
Growers	
Overview of grower impacts (see Table 6 for range of impacts)	
Growers of Hayward (green)	Supports survival and improves yields (between 28% and 60%) and reduces labour costs per hectare. "Without" hydrogen cyanamide products, green growers will be caught between a reduction in yield and revenue per hectare and increased labour costs per hectare at the same time as other production costs are increasing. Converting to organic green would not be viable as the increased supply would collapse the price. Currently the "average revenue per gross submitted trays" premium for green organic is approximately 26%.
Growers of Gold3 (gold)	Improves volumes between 25% and 50%. Without hydrogen cyanamide, Gold3 would be much less profitable. Growers may limit expansion plans and consider other land use options if hydrogen cyanamide was not available.
Standardisation	Hydrogen cyanamide improves the predictability of each stage of the growth cycle. This is hugely important for orchard management since it increases the predictability of budbreak timing, encourages a compact flowering stage, improves pollination, allows for other spraying activities to be effective, and develops uniform and consistently large fruit.
Orchard Yield	The impact on yield is the biggest quantifiable benefit.
Increases bud breaking	Maximises the chances of a predictable and optimal crop.
More uniform bud break	Assists in orchard management through standardisation of tasks.
Induces earlier bud break	Assists in fruit development thereby maximising the chances of a consistent export quality crop.
Increases the number of "king" flowers	A correlation exists between the number of king flowers and fruit grown and therefore crop yield.
Allows for a compact flowering time	Improves management coordination across the orchard. Also improves chances of a consistent crop.
Develops the leaf canopy earlier	Encourages fruit consistency and standardisation.
Removes lichen and scale insects	Removes pests after flowering.
Pollination	Compresses the flowering period which means bees are in the orchard for a shorter time and artificial pollen is more effective. An increase in the flowering time would also delay sprays that deal with insect infestations. Increased demand for artificial pollen will also increase its price.
Orchard management	Variable impacts. Highly important because labour is 75% of on orchard costs. Improves efficiency of labour force by reducing the need for winter and summer pruning.
Packhouses	
Packhouse (labour)	Increases consistency of fruit size and maturity. Less labour required per tray (since fewer fruit rejected).
Packhouse (throughput)	Increasing supply of Gold3 increases the workforce. Large growth in demand for Gold3. It also has higher productivity in the orchard.
Packhouse (coolstores)	Increased utilisation of coolstore capacity. Capacity built for an industry that uses the volumes that hydrogen cyanamide supports.

Packhouse (infrastructure)	Infrastructure fully utilised. Capacity built for an industry that uses the volumes that hydrogen cyanamide supports.
Zespri	Increases the volume, quality and consistency of the crop. This enables the development of new markets and the maintenance of existing markets.

Source: NZIER

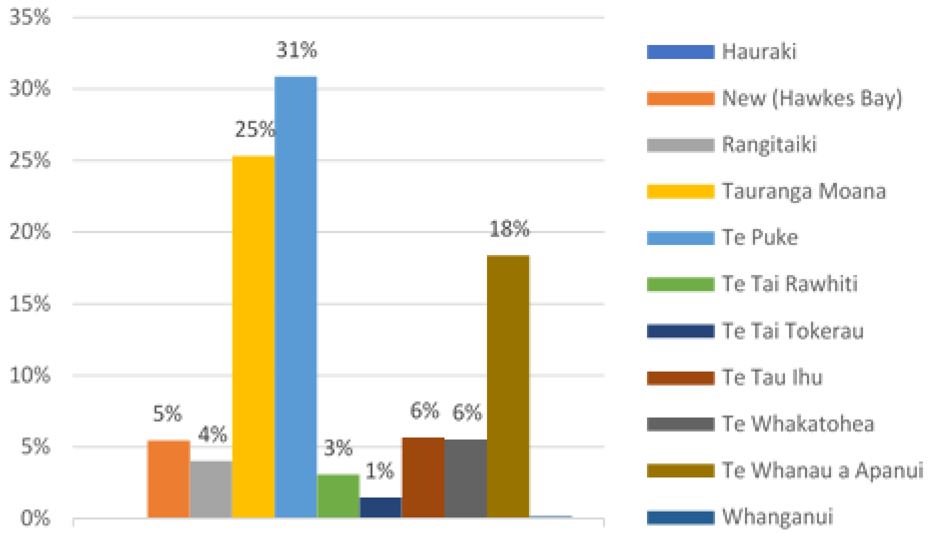
2.2.1 Iwi landowners

The previous reassessment included a submission from a cluster of iwi orchard owners in the Te Puke area. Their view was that hydrogen cyanamide benefits included:

- Increases in production and profits which fund grants for education, the elderly, marae projects, and local schools for sports.
- Increases local employment opportunities for shareholders and their whānau.

Current regional iwi production by share is set out in Figure 1. Many iwi growers are located in coastal areas that have moderate climates. Winter chilling in these areas is an issue so the use of hydrogen cyanamide is important for these growers.

Figure 1 Iwi production by region



Note: Percentages are those of iwi production.

Source: Zespri

The Māori Kiwifruit Growers Incorporated Annual Report states that:

> *"Māori kiwifruit growers own approximately 8.5% of the land established in kiwifruit in New Zealand and have exported just under 10% of the industry volume of 13.9 million trays for 2019. In the last two years there have been numerous orchard acquisitions and new developments with Māori kiwifruit growers increasing their footprint in the industry."*

This is despite record licencing fees of approximately $290,000 per hectare for Gold3 and Gold3 orchard values around $1,000,000 per hectare (in the Bay of Plenty area).[10]

Of note is the investment in Gold3 by iwi in regions where hydrogen cyanamide is used. Gold3 represents two-thirds of the current kiwifruit returns to iwi interests (see Table 3).

Table 3 Regional orchard gate returns for blocks identified as having iwi investment/interest

Total Orchard gate returns (OGR), 2019 (March year) NZ$

Region	Hayward OGR	Gold3 OGR	Total OGR
Northland	732,847	1,618,405	2,351,252
Auckland	-	2,485,801	2,485,801
Waikato	135,632	607,649	743,281
Bay of Plenty	42,127,082	81,082,745	123,749,826
Poverty Bay	165,782	283,151	448,932
Sth North Island	86,817	-	86,817
Nelson	1,210,554	1,605,271	2,812,082
Total	**$44,458,714**	**$88,219,277**	**$132,677,990**

Source: Zespri

2.3 Known impacts in New Zealand

Schep et al. (2008) used data from the New Zealand National Poisons Centre (NPC) to further understand the human clinical effects of exposures to hydrogen cyanamide between 1990 and 2006. The conclusion reached by Schep et al. (2008) suggests that acute exposure to hydrogen cyanamide may not pose a significant immediate threat to human health.

A further updated report by the NPC has provided feedback on the incidences and injuries caused by hydrogen cyanamide (NZKGI/Zespri (2020). The NPC data examines the years 2002 to 2019 where there were 174 calls received by the NPC over 17 years:

- 100 calls related to 103 human exposures.
- 41 calls were information only calls.
- 33 calls related to animals exposed (28 dogs, 1 cat, 1 horse, 1 sheep, and 1 rabbit). Insufficient data was made available to comment on specific cases.

The data was reviewed, and it was noted that 20 reports are unlikely to relate to the use of hydrogen cyanamide in kiwifruit or are not related to an exposure case, reducing the total to 154.

The data from the 103 human exposures has been analysed to investigate causes of the incidents reported including a description of the circumstances of each incident. The data description makes it difficult to draw concrete conclusions related to kiwifruit orchards. However, the following points can be made:

10 https://comms.anz.co.nz/tp/download/691383/e979b12bd5aadaa8f1420822dbf518c3/anz20702-Kiwifruit-white-paper-2019-11.pdf

- Of the enquiries made 41 (40%) of all exposures were reported prior to the amended controls on hydrogen cyanamide implemented in 2006.
- Reported incidents dropped from 10.25 per year pre 2006 to 4.43 per year on average from 2006 - 2019.
- Medical referral occurred in 53 (51%) of the 103 calls. Of these 53, 19 required active investigation/treatment.
- No treatment or self-treatment occurred in 48 (47%) of cases or were unrelated medical incidents or non-medical referrals.
- Of those that occurred in the workplace (50% or 51 of the 103) 6 cases were directly related to insufficient PPE.
- Less than 10% (11 of the 103) of the incidents related to public spaces and environmental exposure.
- The majority of calls (87.4%) were received in the July - September period (application of hydrogen cyanamide to kiwifruit is recommended between late July and early September).

The majority of cases appear to be accidental exposure with the rest unable to be substantiated.

Table 4 shows the route to exposure from the raw data.

Table 4 NPC exposure summary

Route of exposure	Number
Inhalation	45
Skin	34
Ingestion	12
Inhalation, skin	5
Eyes, ingestion, skin	3
Unknown	4
Total	**103**

Source: CFI 2020

The key findings point to exposure associated with the following activities:

- Spray drift (18 calls).
- Specific mention of hydrogen cyanamide and kiwifruit orchards (13 calls).
- Drinking alcohol following exposure (11 calls).
- Not wearing PPE or PPE malfunction (10 calls).
- Non-kiwifruit use (citrus, grapes, and apples) (2 calls).
- Kiwifruit consumed following spraying (1 call).
- Re-entry to property before sign says it was safe (1 call).

The Australian Environmental Agency Pty Ltd (2020) has used NZ EPA methodology to examine concerns raised in the grounds for reassessment of hydrogen cyanamide. The assessment relies on international regulators assessment, specifically, the European Food Safety Authority (EFSA) and the United States Environmental Protection Agency (US EPA).

Table 5 summarises that assessment.

Table 5: Risk assessment of Hydrogen Cyanamide

Persistent in the environment?	No.
Toxic to aquatic organisms?	Yes. Also, highly mobile.
Impact on birds?	Yes. Acute risk deemed acceptable. Chronic risk mitigated by additional field studies show birds are not expected to spend much more than 20% of their time in treated fields.
Human health considerations	
Handler exposure?	Refined model using latest dermal and inhalation exposure values applied by the US EPA for mixing/loading proved acceptable with chemical resistant gloves worn. Also required are washable coveralls, hat, chemical resistant gloves and respirator or enclosed cab.
Bystander risk?	Risk acceptable if appropriate warning signs posted and sufficient distances are observed.

Source: Australian Environmental Agency Pty Ltd (2020)

2.4 Results of the 2006 reassessment

The independent committee appointed by ERMA (now the EPA) in the 2006 reassessment set out the following points:

- They were satisfied with the controls (set out in the reassessment document) to manage adverse effects.
- The substance posed negligible to medium risks to the environment and to human health and safety, and massive benefits to the economy.
- Some risks are non-negligible but they were satisfied that the benefits outweigh the risks and costs.

3 Developing the cost benefit analysis

We have used a cost benefit framework to examine the value of removing hydrogen cyanamide from use on kiwifruit orchards in New Zealand.

CBA is a long-established technique intended to assess the economic impacts on different groups and efficiency of a proposed project, regulation, or policy change. Efficiency is broadly about maximising outputs obtained from available inputs, but there are different variants used in economics:

- Technical efficiency (scale) refers to the most cost-effective way of providing a given service or producing a product, for instance, reducing the cost per tray of exported kiwifruit.
- Allocative efficiency (matching) refers to the ease with which resources can move across an orchard to their most productive use. For instance, hydrogen cyanamide improves task standardisation around the orchard. This increases the ability to match labour to specific jobs at specific times as fruit grows and is picked.[11]
- Dynamic efficiency (innovation) refers to innovation and changing to new activities over time.

If the withdrawal of hydrogen cyanamide increases costs per tray of kiwifruit, it will reduce technical efficiency. To the extent that it shifts resources from a more productive activity to a less productive activity, it also reduces the allocative efficiency (specifically of labour). If it also closes off options for more efficient ways to produce kiwifruit then it also reduces dynamic efficiency over time.

A CBA proceeds by comparing effects and outcomes associated with the introduction of regulations that withdraw hydrogen cyanamide against what would have occurred under a counterfactual, i.e. “without” the proposed change. This counterfactual can be described as a projection of the status quo into the future as supply and demand conditions change.

3.1 Counterfactual or baseline

The benefits and costs “without” the withdrawal of hydrogen cyanamide scenario is required (the counterfactual) and is based on a detailed examination of the status quo. It includes a commentary on what exists on the ground at the moment including use of alternatives (i.e. estimates of crop production for next year and forecasts).

The counterfactual also includes examining the likely business/future policy developments. While this can be speculative, we have focused on examining any recent changes and any expectations for future developments. The aim is to identify probable changes over the next 5–10 years, to establish a realistic base case.

[11] Without hydrogen cyanamide orchard management becomes more difficult. As one grower commented: ”*with hydrogen cyanamide you have the ability to control crop timing. Through coordination, one block can be a few days earlier than another so you can match up labour resources to tasks required. By having the ability to shift workloads in the orchard, the application of hydrogen cyanamide becomes a major benefit.*”

Not only does Gold3 command a price premium but it is also more productive (produces more trays per hectare than Green).[12]

We can be more confident in setting up the baseline in this situation because of the significant land values,[13] the longer lead times for production to start and the large financial contribution required:

- It takes some time to establish a new kiwifruit orchard – between 2 and 3 years depending on a grower's development plan.
- Significant capital is required to set up an orchard (between $400,000 and $600,000 per hectare).
- The licence fees for new varieties such as Gold3 are substantial (median price paid $290,000 per hectare in 2019 and all indications are this will be exceeded in the 2020 licence release).

As a result of this, the grower is committed and very substantial investments are made over a long period of time; therefore, plantings are more certain.

We acknowledge that there are potentially a number of credible scenarios. However, the level of commitment by growers to invest is relatively high, improving the confidence of the forecasts.

3.2 Alternatives to using hydrogen cyanamide

In the status quo those using alternatives to hydrogen cyanamide are mainly organic growers. They make-up approximately 4% of the hayward variety green crop.[14]

Some conventional growers report that while they have considered other treatments, hydrogen cyanamide is mainly used because of its wide window of efficacy. Alternatives have a much narrower window of efficacy outside of which their effectiveness is greatly reduced. The much reduced use of alternatives is mainly due to:

- Alternatives providing only a narrow window of use (three days) where they can be effective. If it rains during this period or the spray contractor is not available, then alternatives are ineffective. The chances of a three day clear spell in July – August are between 10–35% in target areas – see Table 8.
- Alternatives require growers to have a much better sense of the conditions through winter and an understanding of the likely physiological stage of the vines to get the timing right. There are winter chill models available that can help with this as well as the BreakNSure test (monitors the physiology of the vines to determine the optimal time to apply budbreak treatment). However the risk of getting the timing wrong and therefore losing efficacy is much higher with the alternative products than with hydrogen cyanamide.
- The costs of alternatives are much higher than hydrogen cyanamide (see **Error! Reference source not found.** in Appendix B).

12 It is difficult to make exact comparisons since you need to compare mature green vines with mature gold vines. Gold vines are relatively new however productivity could be as much 35% more than green.

13 Up to a $1 million per hectare.

14 Figures are not available for the organic gold crop but it is expected to be much smaller than the green crop value.

- The level of knowledge required to apply alternatives at the right time is much higher than hydrogen cyanamide. Difficulty in determining appropriate time, lack of confidence and or inexperience means that hydrogen cyanamide products are the preferred choice of growers.

3.3 Stakeholders

This is a 'partial' cost benefit analysis in the sense that some effects will be too difficult to reliably quantify. For instance, it may well be that there are benefits and costs to society of maintaining the status quo such as increasing industry growth over and above the forecasts or a cost increase associated with environmental damage. While we can identify these benefits and costs, it is not feasible to value them in economic terms, given time and resources. For practical reasons the analysis has focused on effects that are readily quantified and valued. Other impacts are described qualitatively.

From the feedback from NZKGI, the 2006 reassessment, contacts within the industry, and other published material a number of costs and benefits have been identified that need to be considered in the CBA, whether they can be quantified or not. A number of groups are considered to be important:

- **Growers**. Will incur high direct costs with the withdrawal of hydrogen cyanamide through production losses and cost increases.
- **Packhouses**. Will incur high costs as the crop reduction will leave them with stranded assets that cannot be utilised for other products. They will also shed labour.
- **Zespri**. Will incur a high cost with the withdrawal of hydrogen cyanamide since it will not be able to capitalise on the forecast rapid growth in demand for Gold3 and other new varieties. The potential to lose new markets and be unable to service existing markets fully and deliver planned growth is very high.
- **Government**:
  - Regional growth objectives are likely to be constrained with large decreases in specific region's growth prospects.
  - Tax revenue will be affected because of the large decrease in earning power and spending in regional communities.
- There will be a benefit to the **environment**. Hydrogen cyanamide is not persistent in the environment. However, there are risks to aquatic organisms, birds, and other animals which can be mitigated.
- **Worker and bystander protection** improved. Accidental contact with hydrogen cyanamide does cause short term health problems. Risks to both bystanders and workers can be mitigated.
- Labour costs per hectare will increase but the number of **workers** overall will reduce. More labour will be needed on orchards and packhouses per tray of kiwifruit produced; however, less volume will also reduce overall demand for labour.
- **Rural communities** will suffer as kiwifruit incomes are reduced. This will result in fewer jobs and reduced ability of these communities to grow and thrive. Wellbeing and regional GDP will reduce. Potentially some green growers will go out of business or change land use.

4 The costs of withdrawing hydrogen cyanamide

We have focused on costs and benefits associated with the withdrawal of hydrogen cyanamide. In this way, stakeholders receive a 'big picture' view of the likely costs and benefits.

Typically, the cost of any particular proposal is much more easily understood than the benefits. This is very much the case for hydrogen cyanamide. Below we look at the issues to be considered and the expected costs.

4.1 On-orchard impacts

4.1.1 Yield costs

The much-reduced flowering and subsequent yield loss is the major cost associated with the withdrawal of hydrogen cyanamide products. Zespri has conducted 26 trials comparing the 'with and without' hydrogen cyanamide impacts.

The trials found:

- The further north you go, the higher the impact of the withdrawal of hydrogen cyanamide.
- The main per-hectare impact is in Northland, Auckland, and Waikato.
- The main value reduction overall occurs in Bay of Plenty (because of the larger number of growers).
- The lower North Island and Nelson does not require hydrogen cyanamide.

Bud break has a major impact on the number of flowers and kiwifruit yield. Table 6 shows the impact under trial conditions of hydrogen cyanamide (which can assists bud break) vs untreated vines. Hayward (green) is slightly more affected than Gold3.

Table 6 Hydrogen cyanamide vs untreated

Percentage increase of extra trays per hectare above untreated

	Yield improvement	
Region	Gold3	Hayward
Northland	41.9%	48.2%
Auckland	51.7%	58.3%
Waikato	51.7%	58.3%
Bay of Plenty	25.8%	28.9%
Hawkes Bay	25.8%	28.9%
Sthn NI	0.0%	0.0%
Poverty Bay	25.8%	28.9%
Nelson	0.0%	0.0%

Note that alternatives to hydrogen cyanamide are not factored into this analysis.

Source: Zespri trial data

When per-hectare and per-tray conversion factors are multiplied by the number of hectares and value per tray, then the regional impacts can be set out. Table 7 sets out the total on-orchard gain per region (vs untreated).

Table 7 The value of hydrogen cyanamide vs untreated

March year 2019, OGR, regional value, not including the domestic market.

	Impact of withdrawal of HC		Current revenue	
Region	**Gold3**	**Hayward**	**Gold3**	**Hayward**
Northland	$ 15,976,420.90	$ 1,823,829.89	$ 38,168,923.64	$ 3,781,739.64
Auckland	$ 14,297,587.27	$ 6,808,378.93	$ 27,670,199.30	$ 11,669,082.00
Waikato	$ 11,860,947.72	$ 10,982,402.50	$ 22,954,557.38	$ 18,823,064.43
Bay of Plenty	$ 141,933,200.02	$ 115,755,256.69	$ 550,128,682.26	$ 400,411,265.28
Hawkes Bay	$ 5,371,982.91	$ 434,034.48	$ 20,821,639.20	$ 1,501,377.12
Sthn NI	$ -	$ -	$ 125,916.90	$ 3,982,600.93
Poverty Bay	$ 8,140,322.54	$ 541,071.22	$ 31,551,637.75	$ 1,871,629.99
Nelson	$ -	$ -	$ 25,742,595.93	$ 6,249,584.88
Sub total	**$ 197,580,461.36**	**$ 136,344,973.71**	**$ 717,164,152.36**	**$ 448,290,344.27**
Total impact	**$ 333,925,435.07**			
Total grower return from the export crop			**$ 1,165,454,496.63**	

Note that alternatives to hydrogen cyanamide and organic growers are not factored into this analysis.

Source: Zespri trial data and NZIER analysis

The main impacts of the yield reduction are set out in Table 2, i.e. how hydrogen cyanamide assists in standardising the crop production process, the impact on bud-break, distribution of king flowers and other impacts.

We have not included the domestic market in this analysis because:

- The small nature of the domestic market relative to the export market – 96 percent of New Zealand-grown kiwifruit was exported in the 2018/19 season (Zespri).
- The uncertainty of how it will be impacted. Potentially, the quality of fruit might be lower (because of the inconsistent fruit quality produced by orchards), however the amount of fruit supplied to the domestic market is likely to be at a similar level.

We do know costs will increase independently of the potential yield impacts. These costs are looked at below.

4.1.2 Likely impact on pollination costs

Hydrogen cyanamide assists in pollination by triggering a compact flowering period. It means that pollination can occur in a short timeframe.

Without hydrogen cyanamide it is much more likely that flowering will happen over a longer timeframe with flowers appearing at different times. This requires extra pollination passes mainly with the use of artificial pollination methods. With extra passes required it is likely that pollination costs will increase, and the price of artificial pollen will increase as demand rises.

We have not included a quantitative impact given the impact will be different from orchard to orchard and region to region.

4.1.3 Adjustment for alternatives

Work has continued looking at alternatives to the use of hydrogen cyanamide. Initial research has been undertaken by Hernández and Craig (2013) exploring alternatives to hydrogen cyanamide funded by Zespri. Products such as Armobreak™ have been trialled as a possible replacement for hydrogen cyanamide products. See trial data summary in Appendix A.

A key issue is timing. Hydrogen cyanamide products are much more forgiving and can be applied within a longer period of time relative to alternatives. Alternatives typically have a very narrow window for application. Orchardists experimenting with these products suggest that "*if you get it right it can be used*". But if you misjudge the narrow window of opportunity, and it rains, or you have other conditions that don't allow full application then the crop can be 20–30% less than expected. This is a significant issue and growers like all business owners require certainty.

Over time using alternatives to hydrogen cyanamide could mitigate some of the production losses but the impact would be still very substantial. This is the most important reason why most growers in the north of the North Island still rely on hydrogen cyanamide.

The weather can play a huge part in the success of alternatives. The July/August period produces more rain in New Zealand conditions than any other time. As an illustration we have looked at rainfall in the affected areas over the past 60 years (Table 8).

Table 8 Rain-free periods over 1 July to 31 August

Average number of periods with three consecutive days of zero rainfall over the years shown.

Region	Location	Proportion	Years covered
Northland	Kerikeri	8.95%	1982 to 2016
Northland	Whangarei	10.76%	1960 to 2016
Auckland	Auckland	14.27%	1962 to 2016
Bay of Plenty	Tauranga	23.89%	1960 to 2016
Waikato	Hamilton	18.89%	1960 to 2016
Hawke's Bay	Napier	29.47%	1960 to 2016
Sth North Island	Whanganui	23.19%	1960 to 2016
Nelson	Nelson	34.42%	1960 to 2016

Note that Sth North Island and Nelson do not use hydrogen cyanamide.

Source: NZIER analysis of rainfall data from the Ministry for the Environment[15]

The data shows that there is between a 9% and 30% chance of no rain over a 3-day period in July/August excluding Nelson (never mind whether this coincides with the window of

15 https://data.mfe.govt.nz/tables/category/environmental-reporting/atmosphere-climate/precipitation/?mt=Streets&l=52462&cv=0&z=6&c=-41.00000%2C174.00000&mv=0&e=0

opportunity where alternatives can be optimally used). We have used this to adjust the impact of the 'without' hydrogen cyanamide baseline. The process of doing this includes:

- Detailing the impact of hydrogen cyanamide in each region (percentage yield increase – see Table 5).
- Multiplying the yield improvement per tray per hectare (per region) by the orchard grower return per tray (per region) and the number of hectares (per region). This equals the total value (per region) of the hydrogen cyanamide impact use on kiwifruit orchards (see Table 6).
- The value is then adjusted by the potential impact of alternatives (estimated between 10% and 30% as effective as hydrogen cyanamide) of the total value set out in Table 6.

This is set out in Table 9.

Table 9 Adjustment to the value of hydrogen cyanamide taking into account alternatives

$, per annum, on orchard impacts

	10%	30%
Impact 'without' hydrogen cyanamide with varying alternative efficacy	$300,532,982	$233,747,805

Source: Interviews, Zespri data, NZIER

4.1.4 Labour costs (on-orchard)

The increased standardisation and time sequencing of each stage of the production cycle on-orchard also has a major impact on the use of labour. The major advantages that would be lost by orchardists are:

- The predictability of when labour is needed on each block is reduced.
- Extra work required on orchard management.

There are varying effects on orchard with the loss of hydrogen cyanamide. There are increases and decreases in costs for picking and thinning.

We do expect increased costs for winter pruning (30%) and summer pruning (20%), although these costs will vary from orchard to orchard. The reason is more cane has to be tied down in winter (because each cane has fewer flowers) so that requires more vine maintenance work in summer.

These costs are for illustrative purposes only (see Table 10).

Table 10 Illustrative cost increases for orchard management

Per hectare, per annum

	Extra av. hours per ha.	$ per hour	Total
Orchard management cost increase			
Winter pruning (30%)	89.4	$18.90	$17.2 million
Summer pruning (20%)	30.2	$18.90	$5.8 million
Total illustrative costs (per annum)			**$23.1 million**

Source: NZKGI (2019)

4.2 Impact on packhouses

The flow-on impact to packhouses will be significant (see

Table 11). These cost categories and impacts are illustrative only. The variable maturity and size of fruit coming through from the orchards and the extended season since fruit will ripen at different rates will be a major problem for packhouses. Similar to orchards, the cost per-tray will increase but the total number of employees is likely to drop.

Our analysis is based on a 13% – 16% drop in value across the current crop. Although one packhouse argues that Hayward (green) volume is likely to decrease more than Gold3 because the increased cost will result in a lower return (approximately a 26.5% drop in the crop).[16] This significant drop in value for Hayward producers will likely mean a further reduction in labour and other inputs. A reduced ability to manage the orchard (i.e. lack of labour or other inputs) is likely to make them less efficient.

At the 13–16% value reduction level, packhouses will be under huge pressure as cost per-tray increases and profits are squeezed.

Other significant costs for packhouses include:

- Coolstore capacity under-utilisation. With a 13% –16% in value reduction there would be between 14.7 and 19.2 million trays of unutilised coolstore capacity. This would result in between $99 million and $128 million of surplus infrastructure held by post-harvest operators. The holding costs of this unutilised infrastructure is between $3.4 and $4.5 million per annum.
- Packhouse asset under-utilisation. Post-harvest packing assets are now geared to the capacity of Gold3, with Hayward (green) now "*a shoulder season programme used to extend asset utilisation and defray overhead costs*". The crop value reduction of between 13–16% of fruit will not decrease the need for packing infrastructure, nor is it expected to decrease overheads, as businesses are set up to cater for Gold3 peak capacity. At a variable (gross) margin of $1.50 per tray, the reduction of between 14.3 and 18.4 million trays will decrease post-harvest revenues by between $22 and $28 million per annum.
- Throughput inefficiencies. Fruit would be less homogenous, lower volume, and possibly smaller, spread over a longer maturity period, all leading to inefficiencies in the packhouse. Packhouses estimated the cost of these inefficiencies at approximately $0.05–$0.07 per tray. This is an additional labour cost of between $1.1 and $1.5 million per annum.

The decrease in kiwifruit throughput will also reduce labour overall. The decrease in direct cost of employment comes about with an approximate drop of between 400 and 520 trays per labour day. This equates to between 150,000 and 200,000 hours of labour not required or between $2.8 and $3.6 million per annum in wages (based on $20 per hour).

16 They also argue that organic premiums will also collapse as Hayward growers attempt to convert their orchards to organic in attempt to increase their price per tray.

Table 11 An illustrative example of the increased costs associated with packhouses

per annum

	Impacts	Comment
Reduction in value	Between 13% and 16%	One packhouse argues that the impact on Hayward (green) will be much higher (26.5%). This is because they are caught between declining revenues and increasing costs. As a result, they will have to reduce input costs, reducing productivity and investment in workers which has an impact across the value chain.
Coolstore under-utilisation	Between $3.4 and $4.5 million	This is based on a reduction in throughput.
Asset infrastructure under-utilisation	Between $22.0 and $28.0 million	Based on a throughput reduction and a gross throughput cost of $1.50 per tray.
Throughput inefficiencies	Between $1.2 and $1.5 million	Based on the variable nature of the crop.
Less reduced labour costs	Between $2.8 and $3.7 million	Between 150,000 and 200,000 hours less labour at $20 per hour.
Total	**Between $23.0 and $30.0 million**	**Numbers rounded**

Notes: This is based on a 13–16% value reduction in crop yield. These are very conservative numbers since it is suggested that Hayward (green) growers would be under greater pressure. This will be investigated further in scenario 2. Reduced labour costs are seen as a benefit. However, this is a negative if concerned about regional employment opportunities.

Source: Packhouse estimates and NZIER adjustments

4.3 Impact on Zespri

There will also be a major impact on Zespri since demand for Gold3 is increasing in key markets. Not only will there be a reduction in value driven by reduced supply (conservatively estimated at between 13–16%) but markets will be lost or under-supplied. The growth of the industry will be severely curtailed, and it is very unlikely that forecasts can be achieved if hydrogen cyanamide is withdrawn.

This will put pressure on existing staff and growers since costs per tray are likely to increase. We have not quantified this in this analysis but it is likely that the impacts will be significant for Zespri.

4.4 Impacts on government and regions

The removal of hydrogen cyanamide would hamper government regional development efforts. The shrinkage of the industry will also have an impact on other businesses within specific regions. It will also reduce the tax take.

As an illustration, if we applied a conservative multiplier of 1.4 (see for example NZIER, 2016) then the impact on other New Zealand businesses is set out in Table 12.[17]

[17] The standard caveats about multiplier analysis apply. It does not consider redeployment of land or labour to other uses, assumes that prices remain the same as industries grow and decline.

Table 12: Impact on the wider business community

Present value calculated using a discount rate of 6% (in addition to the direct losses to the kiwifruit industry)

	Per annum	Over 10 years
Alternatives to HC are 10% effective	$120.2 million	$1,124.7 million
Alternatives to HC are 30% effective	$93.5 million	$874.7 million

Source: NZIER estimates

4.5 Summary of costs

The headline losses for the kiwifruit industry and New Zealand are significant. A 13–16% reduction in the crop value has a ripple effect through the industry and the wider economy causing significant losses (

Table 13).

Further, the lack of a ‘standardisation effect’ that hydrogen cyanamide triggers will increase on-orchard costs per tray despite the significant shrinkage in the industry.

Packhouses will also feel the impacts of the reduction in crop size and fruit maturity variability. Infrastructure has been built to manage the introduction of red varieties, the Gold3 crop, and Hayward (green) crop. Processing kiwifruit costs will increase (because of variable fruit size and maturity) while the crop will be smaller.

Zespri will also face significant cost increases as cost per-tray increase and market share erodes with lower volumes.

Those industries that are linked to kiwifruit will also come under pressure. We expect a significant drop in demand for those supplying the industry.

Table 13 Summary of costs

First year estimate. Losses increase since growth is expected in the baseline.

	Cost, first year	Comment
Headline losses		
Yield losses to growers	Between $233.8 and $300.5 million per annum	The impact is felt more the further north orchards are located.
Losses to packhouses (illustrative and not included in the total cost)	Between $23.2 and $29.8 million per annum	Throughput reduced causes significant downsizing of the industry.
Losses to Zespri	Not determined	Increases pressure on Zespri as cost per tray increase and markets are under supplied.
Other considerations		
Increase in on-orchard costs (illustrative and not included in the final costs)	$23.1 million	Increase in summer and winter pruning per annum.
Labour shedding by packhouses	Between 150,000 and 200,000 hours per annum	Likely to have negative impacts on regional development.
Zespri	Opportunity cost of selling more fruit	Loss of significant overseas earnings.
Government and the wider economy	Between $93.5 and $120.2 million	Reduces chances of meeting regional development objectives and reduces the tax take.

Source: NZIER

5 Benefits of withdrawing hydrogen cyanamide

Schep et al. (2008) examined cases of exposure to hydrogen cyanamide in New Zealand between 1990 and 2006. The short term impacts were not significant. No comment was made on long term impacts.

A further updated report by the NPC provided feedback on the incidences and injuries between 2002 and 2019. These are summarised in section 2.3.

Further the Australian Environmental Agency Pty Ltd (2020) used NZ EPA methodology to examine hydrogen cyanamide impacts. These findings are also summarised briefly in section 2.3. The assessment relies on international regulators assessments, specifically, the European Food Safety Authority (EFSA) and the United States Environmental Protection Agency (US EPA).

Table 14 summarises the benefits of removing hydrogen cyanamide.

Table 14 Summary of benefits

Relevant benefits

	Impacts	Source
Human health		
Short term impacts	Nausea and vomiting, headaches, contact, dermatitis, erythema	No significant immediate threat to human health (Schep et al.,2008).
Handler exposure	Refined model using latest dermal and inhalation exposure values applied by the US EPA for mixing/loading proved acceptable with chemical resistant gloves worn. Also required are washable coveralls, hat, chemical resistant gloves and respirator or enclosed cab.	The Australian Environmental Agency (2020).
Bystander exposure	Risk acceptable with mitigation.	The Australian Environmental Agency (2020).
Animals		
Birds	Risk acceptable on dormant kiwifruit vines.	The Australian Environmental Agency (2020).
Environment		
Aquatic organisms	Risk acceptable with mitigation.	The Australian Environmental Agency (2020).

Source: Schep et al. 2008, Australian Environmental Agency Pty Ltd (2020)

6 Summary of costs and benefits

Table 15 sets out the costs and benefits of removing hydrogen cyanamide from New Zealand kiwifruit orchards. We cannot say that the costs outweigh the benefits since we have no quantified value of the benefit from the withdrawal of hydrogen cyanamide.

What we can say is that the benefit would have to be very large since the economic losses will have significant ongoing ramifications for New Zealand. This is of particular concern as the value that hydrogen cyanamide provides to kiwifruit production is likely to increase as climate change effects accumulate.

Table 15 Summary of costs and benefits

6% present value

	First year	Over ten years	Comment
Direct Costs			
Growers	Between $233.8 and $300.5 million.	Between $2,187 and $2,811 million.	Significant losses. Increased impact the further north the orchard is.
Packhouses (illustrative only)	Between $23.2 and $29.8 million.	Between $203.9 and $262.2 million.	Significant losses and labour shedding.
Zespri	Severe short-term pressure on costs and opportunity cost of lost sales.	Loss of markets or crop grown elsewhere.	Increased cost per tray marketed.
Total direct costs	**Between $233.8 and $300.5 million.**	**Between $2,187 and $2,811 million.**	Numbers rounded.
Other cost impacts			
Orchard management (illustrative only)			
Winter pruning	$17.3 million.	$136.3 million.	Costs increase by 30%
Summer pruning	$5.8 million.	$46.1 million.	Costs increase by 20%
Impact on other industries (suppliers to kiwifruit)	Between $93.5 and $120.2 million.	Between $874.7 and $1,124.7 million.	Estimated impact on other industries.
Government regional development objectives	Constrained.	Likely to be a major constraining factor as time goes on.	Likely to reduce the ability of government to reach its regional development objectives.
Impact on iwi development	Impact on new growth opportunities.	Could constrain options as Treaty settlements occur.	Nearly 10% of the volume.
Direct benefits			
Human health			
Short-term health benefit	Not considered major (Schep et al., 2008).	Na	Impact on operators and bystanders.

Handler	Risk acceptable if appropriate PPE used.	Na	Must have specified protective clothing
Bystander	Risk acceptable with mitigations.	Na	Observe instructions and wind conditions
Animals			
Birds	Risks acceptable on dormant vines.	Na	Birds scarce in the orchard in the July – August period.
Environment			
Aquatic organisms	Risk acceptable with mitigation.	Na	The Australian Environmental Agency (2020)

Source: NZIER

7 Scenario analysis

We have looked at a number of scenarios that could potentially occur with the withdrawal of hydrogen cyanamide. These are set out below.

7.1 Scenario 1: Increased effectiveness of alternatives

One potential scenario is that an increased focus on alternatives improves the efficacy of these treatments. These alternatives could become more effective and to illustrate the potential impact, we have increased efficacy rates of alternatives to 50% of hydrogen cyanamide.

The results are set out in Table 16. It shows a dramatic reduction in the cost impact – however those costs are still very significant.

Table 16 Impact if alternatives are 50% effective

PV 6%

Costs	First year	Over 10 years
Grower	$166.9 million	$1,562.0 million
Post-harvest (illustrative only)	$16.5 million	$145.6 million
Zespri	Not known	
Total direct grower costs	*$166.9 million*	*$1,562.0 million*
Other costs		
Impact on regions	$66.7 million	$624.8 million
Increased labour costs	Difficult to calculate. Possibly between $15 and $20 million per annum	
Regional policies	Significant constraint on regional development plans	
Benefits	Reduced exposure to hydrogen cyanamide but impact unknown	

Source: NZIER

7.2 Scenario 2: Sharper reduction in Hayward production

The impact on Hayward (green) production is likely to be more dramatic than Gold3. This is primarily because Hayward responds more effectively to hydrogen cyanamide than Gold3 and also because returns are lower and Hayward productivity per-hectare is lower than Gold3. As one packhouse operator suggested it is entirely possible that Hayward growers would face significant losses and some may become uneconomic as a result.

According to this industry participant, rather than the predicted 13–16% reduction in value (set out in the central scenario) it could be that that Hayward value will decrease further as they are caught between a reduction in revenue and increases in costs. A reduction of 26.5% in profitability is proposed.

This is a plausible scenario since returns are unlikely to bounce back and some smaller growers may find that profits reduce substantially. Therefore, they would have to reorganise their business models and reduce inputs (mainly labour). This would trigger a reduction in production efficiency. Table 17 sets out the likely impact in this scenario.

Table 17 Sharp decline in Hayward production

PV 6%

Costs	First year	Over 10 years
Grower	$491.1 million	$4,594.3 million
Post-harvest (illustrative only)	$48.8 million	$428.4 million
Zespri	Not known	A significant opportunity cost
Total direct costs	*$491.1 million*	*$4,594.3 million*
Other costs		
Impact on regions	$196.4 million	$1,837.7 million
Increased labour costs	Similar to the central scenario (23.1 million)	
Regional policies	Significant constraint on regional development plans	
Benefits	Unchanged from the central scenario	

Source: NZIER

7.3 Scenario 3: Increased value because of climate change

The impact of climate change may mean that the need for hydrogen cyanamide will increase as growers from Hawke's Bay and further south could require its use. This will be a gradual process and has not been calculated to have an impact within the forecast period.

The rationale for setting out this scenario is to emphasise the probable increase in reliance on hydrogen cyanamide over the long term if no practical alternative is developed.

8 Conclusions

Our analysis indicates that the costs of banning or limiting the use of hydrogen cyanamide to the kiwifruit industry are very large compared to the likely value of the potential benefits.

The principal parts of the analysis are:

- The very large cost for growers as their costs increase (mainly labour) and their yields decline. This will be felt hardest by Hayward (green) growers whose revenues and productivity are lower.
- The very large cost for packhouses as their costs per-tray increase on lower crop volumes.
- A benefit to bystanders and operators, although the impacts in the short term are relatively minor. Longer-term benefits are also unclear.
- A large cost to Zespri over time with losses of sales and potentially the loss of markets.
- A potential benefit to the environment.

We must stress that there are limitations in the quantified analysis due to the information available on different aspects. The robustness of the analysis is influenced by the potential bias in the information provided and the potential magnitude of unquantified costs and benefits, such as uncertainty about how much the Hayward (green) crop will reduce.

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Appendix A Alternatives to Hydrogen Cyanamide – Kiwifruit Research

The identification and assessment of alternatives to hydrogen cyanamide has been a priority for Zespri Innovation for the past 10 years with all potential products identified then investigated. Following the 2006 reassessment of hydrogen cyanamide and more recently with Zespri's focus on sustainability, the pursuit of alternative products has increased in importance, however, this is countered by a shortage of emerging products to trial.

Investment to date by Zespri has amounted to an $900,000 to date with a further $400,000 approved in 2020, with additional investment by manufacturers. The extent of the research investment has been limited by lack of potential products to test rather than the funds to test them. One of the challenges is, that on a global scale, kiwifruit is a relatively minor crop making up just 1.5 percent of globally-traded fruit, therefore developing budbreak enhancers for our industry is not a priority and the opportunities tend to come from smaller companies or research institutes.

In addition, Zespri's $20 million annual investment in its joint new varieties breeding programme with Plant & Food Research actively seeks to identify varieties that will be productive in areas which lack chilling. Investment has also been made into physiological treatments for improving budbreak. This work is harder to cost as those trials usually have other primary goals.

A.1 Impact of alternatives

This report considers alternatives to hydrogen cyanamide for the kiwifruit industry and provides an assessment of the impacts if alternatives are 10% and 30% effective. A further scenario is provided where alternatives are 50% effective but this is extremely optimistic as trial work and practical use by growers suggests this scenario is unlikely.

A.2 Uptake of alternatives

While some of the commercially-available alternative products have been available for some time, there has been limited uptake by growers because effectiveness is highly variable and impact of failure on profitability is high. Growers cannot afford to take the risk of using alternatives unless they are proven to provide consistent results.

The alternative products all have very sensitive application windows and products need to be applied at exactly the right time to work. If weather conditions delay application or if spray contractors are not available, the optimal timing can be missed. With hydrogen cyanamide there is a wider window of application and it is therefore easier to get the timing right.

A.3 Summary of alternatives research

Zespri has evaluated 18 alternative budbreak products. This includes products commercially available in New Zealand and in the Zespri Crop Protection Standard, products commercially available in other countries and a number of coded formulations, which are not commercially available. Five products are listed in the Zespri Crop Protection Standard as alternative budbreak enhancers.

Trial work is generally based on small plot trials which evaluate percentage budbreak achieved and number of king flowers per winter bud produced. Promising alternatives need to be further evaluated at full orchard level with assessment of yield and other benefits to determine if they are practically viable. This work is undertaken by the manufacturer and by growers. It will take several years of trial work to establish if an alternative compound provides consistently good outcomes and this work must be completed before it could be considered a viable alternative.

More detailed information on the outcomes of alternatives research is available on request from Zespri.

A.4 Key findings:

- Commercially-available alternative products were significantly less effective compared with hydrogen cyanamide both within the same trials and when looking at data combined from multiple trials.
- In these trials, the average efficacy (increase in king flowers per winter bud) versus hydrogen cyanamide ranged 51-93% in Gold3 and 24-133% in Hayward, dependant on region. The impact was greater in Hayward, and in in warmer regions that experience less winter chill.
- Armobreak efficacy ranged 26-46% in Gold3 and 27% in Hayward. Regional differences in efficacy were less noticeable than for hydrogen cyanamide. Trial results in Hayward were extremely variable.
- In Gold3 trials, Advance Gold resulted in approximately half the efficacy of hydrogen cyanamide, ranging 25-49%. Generally Advance Gold is believed to work best in the cooler regions, however, that is not what is seen in the trial results.
- BluPrins has demonstrated potential to give good increases in king flower production, however, when viewing results of multiple trials, the product resulted in only approximately 40% of the efficacy of hydrogen cyanamide in Gold3 and less in Hayward.
- Erger has had minimal testing through these trials, however results indicate that this product can give similar increases as hydrogen cyanamide in king flower production in Gold3 and trial results indicate this product may be better suited to warmer regions like Kerikeri (limited data). Low level efficacy has been observed in Hayward.
- In these trials, Waiken demonstrated very poor results (single trial per variety with 5 application timings).
- Getting application timing right is important for all products. The results from trials where multiple timings were tested indicates there is a narrow window of application for these alternative products, far more so than is the case with hydrogen cyanamide.

Appendix B ACVM registered products for hydrogen cyanamide

Table 18 ACVM Registered products for the substance

Trade name	Registrant	ACVM Registration Number	Registration Date	HSNO Approval number
HiCane	Nufarm Limited	P003566	1st June 1988	HRC000001
Treestart	Agrinova NZ Ltd. (trading as Grochem)	P007333	12th July 2005	HRC000001
Hortcare Hi-break	Grosafe Chemicals Ltd	P007018	29th July 2002	HRC000001
Synergy HC	Agsin PTE Ltd	P007840	5th May 2008	HCRC00001
Gro-Chem HC-50	Agrinova NZ Ltd. (trading as Grochem)	P005858	29th Nov 2001	HCRC00001
Cyan	Agrinova NZ Ltd. (trading as Grochem)	P007190	15 Sept 2004	HCRC00001

Source: EPA