The Financial Pressures Facing Kiwifruit Orchards from the Removal of Hydrogen Cyanamide

A report prepared for Zespri Group Limited

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www.tdb.co.nz

TDB Advisory Limited
L5, Wakefield House
90 The Terrace
P.O. Box 93
Wellington
New Zealand

Email: info@tdb.co.nz

Team members involved:

Dave Grimmond
david.grimmond@tdb.co.nz
021 155 1766

Phil Barry
phil.barry@tdb.co.nz
021 478 426

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Executive summary

This report presents estimates of the financial harm that the Environmental Protection Authority's (EPA) proposal to end the use of Hydrogen Cyanamide will potentially impose on individual New Zealand kiwifruit growers.

Reports prepared by NZIER and Sapere suggest that at an industry level a removal of Hydrogen Cyanamide could reduce annual orchard gate returns for kiwifruit growers by $200 million.

This report presents the potential financial implications for growers based on analysis at the individual orchard level.

The results presented should be regarded as indicative rather than definitive, but suggest that the removal of Hydrogen Cyanamide could make around 15% (around 450) of currently profitable orchards unprofitable.

As a cross-check on our analysis we use the Altman Z-score approach for identifying the risk of bankruptcy. This approach suggests our estimate of 15% of orchards becoming unprofitable may be conservative. The Altman Z-score analysis suggests that up to 30% of orchards (around 900) could be placed into financial distress by a removal of Hydrogen Cyanamide use.

The impacts are likely to be more serious for growers of Hayward kiwifruit and particularly for growers in the Auckland and Waikato regions. Around one quarter of Hayward operations and half of kiwifruit orchards in Auckland and Waikato appear to be at risk of becoming unprofitable without access to bud-enhancing applications.

1 Introduction

1.1 Background

Zespri Group Limited (Zespri) has requested TDB Advisory (TDB) to prepare a report estimating the financial harm that the Environmental Protection Authority's (EPA) proposal to end the use of Hydrogen Cyanamide will potentially impose on New Zealand kiwifruit growers. Hydrogen Cyanamide (HC) is the key active ingredient in a spray used by kiwifruit growers and other fruit growers to help buds form over winter and to raise the yield of export-quality fruit. HC helps stimulate budbreak and the production of flowers which go on to grow into kiwifruit and is a crucial tool in late winter to compensate for inadequate winter chill. Even in areas with adequate winter chill, HC is used to condense flowering and promote uniform budbreak.

Concerns about the use of HC revolve around the potential health risk to workers from repeated exposure over time, with particular concerns that HC may be toxic to the reproductive system and thyroid. The EPA has proposed that HC be reclassified as a suspected carcinogen, leading to a total ban in five years.[1]

A report[2] prepared by NZIER in 2020 for New Zealand Kiwifruit Growers Incorporated (NZKGI) estimated that the ban of HC, particularly in more northern districts, would result in additional direct costs to growers of $230 million to $300 million per year (with a present value impact of $2.2 billion to $2.8 billion over ten years). Although it was not the focus of their study, NZIER also noted that there could be impacts for the rest of the economy, such as disruptions for packhouses and other suppliers to the kiwifruit industry, potentially with a ten-year impact of up to $1.3 billion.

The EPA commissioned Sapere to review and undertake its own assessment of the likely economic impacts of phasing out HC[3]. Although Sapere's results are moderately lower than the NZIER estimates, Sapere estimate significant economic impacts, estimating that removing HC would result in reduced Orchard Gate Returns of around $2 billion (range of $1.8 billion to $2.35 billion) in present value terms over a ten-year period. This includes a one-year impact on growers of around $212 million (range of $180 million-$238 million).

1.2 This report

In this report we focus on estimating the potential financial stress that the removal of HC will place on individual kiwifruit growers. Changes in costs and yields will affect different orcharding operations differently. Some factors are dictated by orchard location, and others are strategic decisions by growers. We use confidential individual orchard production information (e.g., hectares of different fruit and fruit production) to account for orchard-specific factors. This information is combined with survey and trial data that provides an assessment of regional variations in production costs and on the impact of HC on fruit yields. From this data we derive estimates of the impact of HC use on orchard-gate revenue, net orchard returns and the profitability of 2,908 individual orchards. This cost and revenue analysis suggest that currently around 250 (9% of total) orchards were not profitable in 2020/21. We estimate that the removal of HC would potentially increase this number to around 700 (or 24% of kiwifruit growers). This implies that the removal of HC use could undermine the sustainability of

[1] https://www.epa.govt.nz/public-consultations/open-consultations/hydrogen-cyanamide-reassessment/

[2] Nixon C, 'Reassessment of substances with the active ingredient of hydrogen cyanamide: The costs and benefits of withdrawing hydrogen cyanamide from the New Zealand market', Report for New Zealand Kiwifruit Growers (NZIER, May 2020).

[3] Davies P and Barton B, 'Economic assessment of hydrogen cyanamide use in New Zealand', Report to the Environmental Protection Authority (Sapere, January 2021).

business operations for around 450 current kiwifruit growers (or 15% of kiwifruit growers). The impact is greater for Hayward kiwifruit operations, with our analysis indicating that the removal of HC risks making 24% of Hayward kiwifruit growing operations unprofitable.

This analysis is supplemented with the use of Altman Z-scores to test the potential of the removal of HC to create the type of financial stress that would undermine business sustainability for kiwifruit growers. Altman's Z-Score model is a numerical measurement that is used to predict the chances of a business going bankrupt in the next two years.[4] With respect to non-manufacturing firms a Z-score below 1.8 is indicative of bankruptcy threatening financial stress. The model was developed by American finance professor Edward Altman in 1968 as a measure of the financial stability of companies.

We do not have access to the type of accounting information for individual growers that would allow accurate estimation of Z-scores for the individual orchards. Instead we benchmark kiwifruit orchard estimates around industry-wide horticulture estimates based on Statistics New Zealand Annual Enterprise Survey data. This approach allows estimated Z-scores for individual orchards to vary based on differences in net orchard returns and the implicit impact this has on market valuations (estimated using discounted cash flows). Implicitly this approach assumes that all kiwifruit growers are currently leveraged to the same degree as the average for all horticulture businesses.

Using this limited Z-score approach allows the analysis to account not just for the impact of removal of HC on earnings but also the impact on orchard market values. By reducing earning prospects, the removal of HC is also likely to reduce orchard market values, which for a given level of debt will increase the leverage position of kiwifruit growers. The incorporation of lower orchard market values and the implicit increase in leverage in Z-score measures means that the Z-score approach will better pick up the increase in financial vulnerability that a removal of HC will impose on kiwifruit growers.

Our benchmark estimates based on orchard earnings indicate that around 9% of kiwifruit growers could currently be operating unprofitable operations. The benchmark Z-score results do not suggest that as many orchards are currently experiencing financial distress, with only 3% with a Z-score below the 1.8 financial distress threshold. This perhaps reflects that most current experiences of unprofitability are temporary in nature.

On the other hand, accounting for the impact of a removal of HC on earnings and orchard market values suggests a larger level of financial distress than implied from a focus on profitability. A removal of HC is expected to make 15% of growers (or around 450 growers) unprofitable, but allowing for the flow-on impact onto orchard market values suggests that the removal of HC could threaten the financial viability of almost 900 kiwifruit growers, or 30% of the total.

It should be noted that our analysis does not account for the ability of individual growers, and the industry in general, to innovate and adjust to the changes imposed by a removal of HC use. However, at least to date, the alternative bud-breaker enhancers to HC that exist have not been found to be as effective as HC[5] and such alternatives have their own health and environmental impact issues[6]. So even if the 30% impact implied by Z-score analysis is taken as a high-side estimate, it seems likely that a removal of HC would have major disruptive impacts for the kiwifruit industry.

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[4] https://corporatefinanceinstitute.com/resources/knowledge/credit/altmans-z-score-model/

[5] For example, trials with an alternative bud-break enhancer, Erger, were found to induce flower production 62.4% above the control but 24.4% below HC (Hernández, G. and Craig, R.L. (2016). Identifying agrichemical alternatives to hydrogen cyanamide in 'Zesy002' ('Gold3') kiwifruit. Acta Hortic. 1130, 123-130).

[6] For example, Erger, mentioned in the previous footnote is classified as Hazardous according to the Hazardous Substances (Minimum Degrees of Hazard) Regulations, 2001 (see https://horticentre.co.nz/wp-content/uploads/Safety%20Datasheets/ERGER_NZ_SDS.pdf).

2 Data

Estimates of the impact of HC on fruit yield by fruit and region are based on 26 trials conducted by Zespri in different regions. The implications for fruit yield are presented in Table 1. These trials found that HC applications produce a moderately higher yield impact for Hayward (green) kiwifruit than for Gold3, and considerable differences between regions. In regions with cooler winters, like Nelson, there is no material benefit from the use of HC. The impact of HC on kiwifruit yields is larger for Auckland, Waikato and Northland than other regions.

Table 1: Percentage of yield attributable to HC

Region	Hayward	Gold3
Northland	48%	42%
Auckland	58%	52%
Waikato	58%	52%
Bay of Plenty	29%	26%
Hawkes Bay	29%	26%
Poverty Bay	29%	26%
Nelson	0%	0%

Source: Zespri.

The orchard revenue numbers underpinning our analysis were provided by Zespri based on their payments system. The source for per-hectare revenue for this analysis is Zespri's Outlook data relating to the most recently completed financial year ended 31 March 2021.[7]

Kiwifruit growers' revenue is often referred to as Orchard Gate Return (OGR). OGR reflects grower income as market return net of market costs paid by Zespri, less fruit loss and post-harvest costs.

From their OGR, growers must fund on-orchard costs – i.e., the actual costs of growing fruit for a season. The OGR minus on-orchard costs equals Net Orchard Return (NOR). NOR must fund any non-growing costs such as insurances, rates, any management fees, as well as costs of any borrowings. Based on advice provided by Zespri, our working assumption is that the average for these non-growing costs is $4,500 per hectare per year. Only if these costs are covered by NOR, does the grower achieve any return on capital invested.

The OGR figures on a per hectare basis were provided by Zespri for individual orchards (on a confidentialised basis) for both Hayward and Gold3 kiwifruit for the most recently completed financial year ended 31 March 2021.

On-orchard costs were supplied by Zespri, drawing on information supplied by a sample of growers to Zespri as well as some figures supplied to NZKGI (particularly for regions other than the Bay of Plenty). This data accounts for regional differences in per-hectare costs for both Hayward and Gold3 fruit. Unfortunately these costs are not available on an individual orchard basis, but are assumed to apply across all orchards in the region.

Estimates of the changes in growing costs due to the removal of HC are based on information obtained by Zespri that growers expect major increases in summer pruning costs of +30% and winter pruning costs of +20% if HC is removed. The cost of HC application has been removed. Zespri note that there is potential for the absence of HC to add to other costs but these other potential costs have not been

[7] https://www.zespri.com/en-NZ/publications/5-year-outlook

included in the present calculations. For example, it has been noted that pollination costs could increase as beehives need to be hired for longer with a less uniform flowering but no allowance for those extra potential costs has been made in this analysis.

The per hectare costs underpinning our calculations are presented in Table 2.

Table 2: Costs per hectare assumed

	Current		Without HC	
Region	**Hayward**	**Gold3**	**Hayward**	**Gold3**
Northland	$35,983	$46,474	$38,891	$49,572
Auckland	$46,931	$60,613	$50,724	$64,654
Waikato	$41,665	$53,812	$45,032	$57,400
Bay of Plenty	$39,025	$50,402	$42,179	$53,762
Hawkes Bay	$42,728	$55,185	$46,181	$58,864
Poverty Bay	$42,728	$55,185	$42,728	$55,185
Nelson	$42,728	$55,185	$46,181	$58,864

Source: Zespri.

Calculations are initially undertaken on a per hectare basis:

Net Orchard Return = Orchard Gross Return – On-Orchard Costs

Profitability = Net Orchard Return – $4,500

Thus the profitability of an orchard is defined as

$$\Pi_i = \pi_i^h \cdot H_i^h + \pi_i^g \cdot H_i^g$$

whereby profit (Π) for orchard i is the per hectare profitability (π) of each fruit (Hayward, h, and Gold3, g) multiplied by the number of hectares (H) planted with each fruit.

Our calculations matched per hectare return and cost data with hectares planted in each orchard (matched by a confidentialised unique orchard number). Different orchards differ in their emphasis on Hayward and Gold3; some growers specialise in one type of kiwifruit, while others have a mix of both types. Regions' average orchard sizes are presented in Table 3. The average area of kiwifruit orchards in New Zealand is 4.55 hectares, which is less than the sum of the average areas planted in each fruit (i.e., 6.56 = 3.34+3.22).

Table 3: Average kiwifruit orchard size, Ha

Region	Hayward	Gold3	Total
Northland	1.77	2.90	3.40
Auckland	3.75	2.83	4.54
Waikato	3.22	3.89	5.76
Bay of Plenty	3.36	3.13	4.53
Hawkes Bay	2.26	4.84	4.67
Poverty Bay	2.49	5.31	5.61
Nelson	3.27	3.05	4.13
Total	3.34	3.22	4.55

Source: TDB estimates based on data provided by Zespri.

The impact of the removal of HC on revenues is calculated by assuming that per hectare revenue reduces by the yield percentages attributed to HC for each fruit in each region as presented in Table 1. The impact on per hectare costs are calculated by the difference between the first two columns of Table 2 and the values in the third and fourth columns (i.e., the difference in costs between the with HC and without HC scenarios).

3 Profitability analysis

3.1 Hayward kiwifruit

Our assessment of the impact of removing HC on Hayward kiwifruit operations is summarised in Table 4, with the implications for production levels presented in Table 5.

In the left-hand block of four columns in both tables is our benchmark base-case estimate of the number of orchards that are currently struggling to be profitable (i.e., even with the use of HC). The benchmark position is that 297 of the 2,113 Hayward kiwifruit operations yielded negative Net Orchard Returns (NOR) in 2021, assuming they faced the typical operational costs identified by Zespri. Taking into account the typical $4,500 per hectare non-growing costs, it would suggest that 386 or 18% of Hayward kiwifruit operations were potentially not profitable in 2021.

The estimates in the paragraph above provide a benchmark against which the potential impact of removing HC use can be assessed. When HC use is removed, the expected fall in fruit yield and slight increase in costs result in the estimate of the number of unprofitable Hayward kiwifruit operations increasing to 898 orchards (or 42.5% of the Hayward kiwifruit operations). The implication is the removal of HC use will potentially make close to one quarter of Hayward kiwifruit operations unprofitable: 898 – 386 = 512, which is 24.2% of the 2,113 Hayward orchards.

In terms of location, the Bay of Plenty is where the greatest impacts are felt, with an estimated 400 of the 512 operations made unprofitable by the removal of HC located there. This largely reflects the dominance of the Bay of Plenty for Hayward kiwifruit operations, with 1,801 Hayward orchards located there. In terms of relative impacts, the largest impacts of HC removal are expected to occur in Northland and Auckland, with HC removal expected to make around 70% of Northland and around 52% of Auckland Hayward kiwifruit operations unprofitable.

The implications of HC removal on a production (trays) basis are presented in Table 5. This table presents calculations of the reduction in production that would occur if the orchards that become unprofitable were to cease production. That is, the table presents the number of unprofitable orchards weighted by the current number of trays produced at these orchards. The at-risk orchards currently produce 15.7% of Hayward kiwifruit. The percent of orchards at risk (24.2% from Table 4) is greater than the percent of trays at risk (15.7% from Table 5) because the operations most at risk tend to be those orchards with relatively low yields. Note these calculations of the number of trays at risk do not account for falls in yield in ongoing orchards, just the reduction if production ceased at unprofitable orchards.

Table 4: Number of Hayward kiwifruit operations placed at risk by HC proposal

	Base - with HC				Without HC				Operations placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region
Northland	6	13.0%	9	19.6%	36	78.3%	41	89.1%	30	65.2%	32	69.6%
Auckland	28	43.1%	30	46.2%	64	98.5%	64	98.5%	36	55.4%	34	52.3%
Waikato	24	22.4%	28	26.2%	68	63.6%	68	63.6%	44	41.1%	40	37.4%
Bay of Plenty	184	10.2%	256	14.2%	515	28.6%	656	36.4%	331	18.4%	400	22.2%
Hawkes Bay	11	61.1%	12	66.7%	15	83.3%	17	94.4%	4	22.2%	5	27.8%
Poverty Bay	11	68.8%	13	81.3%	13	81.3%	14	87.5%	2	12.5%	1	6.3%
Nelson	33	55.0%	38	63.3%	33	55.0%	38	63.3%	0	0.0%	0	0.0%
Total	297	14.1%	386	18.3%	744	35.2%	898	42.5%	447	21.2%	512	24.2%

Table 5: Hayward kiwifruit production placed at risk by HC proposal, by number of trays

	Base - with HC				Without HC				Production placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region
Northland	0	0.0%	0	0.0%	196,485	27.3%	378,962	52.7%	196,485	27.3%	378,962	52.7%
Auckland	178,234	9.1%	245,701	12.6%	1,552,037	79.4%	1,763,920	90.3%	1,373,803	70.3%	1,518,219	77.7%
Waikato	238,970	10.2%	273,290	11.6%	1,498,951	63.7%	1,530,129	65.0%	1,259,981	53.5%	1,256,839	53.4%
Bay of Plenty	1,147,639	1.8%	2,018,871	3.2%	6,486,121	10.3%	9,673,221	15.4%	5,338,482	8.5%	7,654,350	12.2%
Hawkes Bay	85,457	35.0%	85,457	35.0%	143,161	58.6%	152,003	62.2%	57,704	23.6%	66,546	27.2%
Poverty Bay	99,971	41.4%	99,971	41.4%	113,987	47.2%	121,045	50.1%	14,016	5.8%	21,074	8.7%
Nelson	264,072	21.6%	309,871	25.3%	264,072	21.6%	309,871	25.3%	0	0.0%	0	0.0%
Total	2,014,343	2.9%	3,033,161	4.4%	10,254,814	14.8%	13,929,151	20.1%	8,240,471	11.9%	10,895,990	15.7%

3.2 Gold3 kiwifruit

Table 6 and Table 7 repeat the analysis of the potential impact of HC removal on Gold3 kiwifruit operations. The impact for Gold3 kiwifruit operations is not estimated to be as severe as that estimated for Hayward operations. The removal of HC is estimated to make 82 or 4.3% of Gold3 operations unprofitable. From a regional perspective, the impact varies, with almost one quarter of operations in Waikato and Auckland, and 15% in Northland, potentially becoming unprofitable if HC could no longer be applied.

The impact on potential Gold3 production losses (Table 7) is estimated to be similar to the impact on the number of operations, with 4.3% of Gold3 grown in the operations at risk of becoming unprofitable.

Table 6: Count of Gold3 kiwifruit operations placed at risk by HC proposal

	Base - with HC				Without HC				Operations placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region
Northland	1	0.7%	2	1.5%	19	14.0%	22	16.2%	18	13.2%	20	14.7%
Auckland	4	4.8%	4	4.8%	21	25.0%	24	28.6%	17	20.2%	20	23.8%
Waikato	2	3.8%	2	3.8%	13	25.0%	14	26.9%	11	21.2%	12	23.1%
Bay of Plenty	29	2.0%	32	2.2%	51	3.5%	54	3.7%	22	1.5%	22	1.5%
Hawkes Bay	0	0.0%	1	2.9%	3	8.8%	4	11.8%	3	8.8%	3	8.8%
Poverty Bay	1	1.7%	1	1.7%	6	10.2%	6	10.2%	5	8.5%	5	8.5%
Nelson	2	2.5%	2	2.5%	2	2.5%	2	2.5%	0	0.0%	0	0.0%
Total	39	2.0%	44	2.3%	115	6.0%	126	6.6%	76	4.0%	82	4.3%

Table 7: Gold3 kiwifruit production placed at risk by HC proposal, by number of trays

	Base - with HC				Without HC				Production placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region
Northland	1,622	0.0%	8,670	0.2%	265,849	5.1%	360,696	7.0%	264,227	5.1%	352,026	6.8%
Auckland	32,345	1.0%	32,345	1.0%	944,745	27.9%	1,373,320	40.5%	912,400	26.9%	1,340,975	39.6%
Waikato	53,726	2.1%	53,726	2.1%	453,702	18.1%	529,888	21.1%	399,976	16.0%	476,162	19.0%
Bay of Plenty	281,671	0.4%	334,453	0.5%	1,170,213	1.7%	1,688,608	2.5%	888,542	1.3%	1,354,155	2.0%
Hawkes Bay	13,084	0.7%	34,986	1.9%	114,469	6.3%	128,185	7.1%	101,385	5.6%	93,199	5.1%
Poverty Bay	18,119	0.5%	18,119	0.5%	122,317	3.7%	129,934	3.9%	104,198	3.1%	111,815	3.3%
Nelson	45,134	1.2%	45,134	1.2%	45,134	1.2%	45,134	1.2%	0	0.0%	0	0.0%
Total	445,701	0.5%	527,433	0.6%	3,116,429	3.6%	4,255,765	4.9%	2,670,728	3.1%	3,728,332	4.3%

3.3 Combined impact

Although the analysis presented here shows the impact on Haywards and Gold3 operations separately, there is considerable overlap with most operations supplying both fruit types. Of the total of 2,908 kiwifruit operations in New Zealand, 1,126 orchards grow both Hayward and Gold3 kiwifruit. This means that although the removal of HC use has a more direct impact on Hayward operations, the ability to cross-subsidise between operations will potentially alter the overall impact of the removal of HC on the overall viability of kiwifruit operations. This ability to cross subsidise is a two-edged sword: on one side the presence of Gold3 operations can shield some orchards from the hit on Hayward operations, but from the other side, the hit on Haywards might overwhelm otherwise viable Gold3 operations.

In the remainder of this report we analyse the potential impacts of the removal of HC use on the overall financial performance of orchards. A summary of an assessment of the potential impact of removing HC on Net Orchard Returns (NOR) and orchard profitability[8] is presented in Table 8. The focus here is on the expected number of orchards that are likely to be placed under financial distress by the phasing out of HC use. In 2021,195 orchards (6.7% of the 2,908 orchards assessed) appear to have had negative NOR. Using the working assumption that orchards are likely to face per hectare non-growing costs of $4,500, this would suggest that 249 orchards (or 8.6%) were unprofitable in 2021. This estimate provides a benchmark from which one can assess the impact of ending the use of HC.

When the reductions in revenue and increases in costs expected from the removal of HC are included, the estimated number of unprofitable orchards increases to 697. This implies that the removal of HC could potentially make 448 orchards, or 15% of kiwifruit growers, unprofitable.

In terms of the regional spread of the expected increase in financial distress, most of the impact occurs in the Bay of Plenty (with 300 of the 448 unprofitable orchards). However, on a proportionate basis the biggest impact is expected in Auckland and Waikato. These are the regions where HC use has the biggest impact on yield. The removal of HC could make 50% of the orchards in these two regions no longer profitable.

Table 9 provides an assessment of the potential production implications from a removal of HC. The tables present calculations of the reduction in production that would occur if the orchards that become unprofitable were to cease production. That is, they represent the number of unprofitable orchards weighted by the current number of trays produced at these orchards. Note these calculations do not account for falls in yield in ongoing orchards but the reduction if production ceased at unprofitable orchards. This indicates that the 15% of kiwifruit orchards expected to be at most risk from the removal of HC use produced 9% of kiwifruit production in 2021.

[8] As noted in Section 2 above, profitability is defined in this report as NOR per hectare less $4,500 per hectare to account for non-growing costs, multiplied by the number of hectares in production.

Table 8: Count of kiwifruit orchards placed at risk by HC proposal

	Base - with HC				Without HC				Orchards placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region	Count	% of region
Northland	1	0.7%	2	1.4%	29	20.7%	35	25.0%	28	20.0%	33	23.6%
Auckland	18	17.0%	19	17.9%	65	61.3%	72	67.9%	47	44.3%	53	50.0%
Waikato	19	20.0%	21	22.1%	65	68.4%	69	72.6%	46	48.4%	48	50.5%
Bay of Plenty	123	5.2%	170	7.2%	365	15.5%	470	20.0%	242	10.3%	300	12.7%
Hawkes Bay	7	15.9%	8	18.2%	14	31.8%	16	36.4%	7	15.9%	8	18.2%
Poverty Bay	7	11.1%	7	11.1%	12	19.0%	13	20.6%	5	7.9%	6	9.5%
Nelson	20	18.9%	22	20.8%	20	18.9%	22	20.8%	0	0.0%	0	0.0%
Total	195	6.7%	249	8.6%	570	19.6%	697	24.0%	375	12.9%	448	15.4%

Table 9: Kiwifruit production placed at risk by HC proposal, Hayward and Gold3 combined, by number of trays

	Base - with HC				Without HC				Production placed at risk by HC proposal			
	Negative NOR		Unprofitable		Negative NOR		Unprofitable		Negative NOR		Unprofitable	
Region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region	Trays	% of region
Northland	1,622	0.0%	8,670	0.1%	462,334	7.8%	739,658	12.6%	460,712	7.8%	730,988	12.4%
Auckland	210,579	3.9%	278,046	5.2%	2,496,782	46.7%	3,137,240	58.7%	2,286,203	42.8%	2,859,194	53.5%
Waikato	292,696	6.0%	327,016	6.7%	1,952,653	40.2%	2,060,017	42.4%	1,659,957	34.2%	1,733,001	35.7%
Bay of Plenty	1,429,310	1.1%	2,353,324	1.8%	7,656,334	5.9%	11,361,829	8.8%	6,227,024	4.8%	9,008,505	7.0%
Hawkes Bay	98,541	4.8%	120,443	5.8%	257,630	12.5%	280,188	13.6%	159,089	7.7%	159,745	7.8%
Poverty Bay	118,090	3.3%	118,090	3.3%	236,304	6.6%	250,979	7.0%	118,214	3.3%	132,889	3.7%
Nelson	309,206	6.3%	355,005	7.3%	309,206	6.3%	355,005	7.3%	0	0.0%	0	0.0%
Total	2,460,044	1.6%	3,560,594	2.3%	13,371,243	8.6%	18,184,916	11.6%	10,911,199	7.0%	14,624,322	9.4%

4 Z-score analysis

A focus on the profitability of orchards may understate the potential for business failure in the kiwifruit industry from the removal of HC. This is because a reduction in yield will not only increase the risk of immediate losses, but it can also effectively reduce the market value of the business, increase the effective leverage and make existing debt positions less sustainable.

To analyse the potential for these balance sheet impacts we use Altman Z-score measures. Altman's Z-Score model provides a numerical measure that is used to predict the chances of a business going bankrupt in the next two years. The model was developed by American finance professor Edward Altman in 1968 as a measure of the financial stability of companies. According to studies, the model showed an accuracy of 72% in predicting bankruptcy two years before bankruptcy occurred, and the model returned a false positive on 6% of occasions.[9]

Altman developed three versions of the measure. Here we use his measure for non-manufacturing firms:

$$Z = 6.56 \cdot A + 3.26 \cdot B + 6.72 \cdot C + 1.05 \cdot D$$

Whereby:

A = working capital/total assets	(reflects a company's ability to meet short term obligations)
B = retained earnings/total assets	(reflects dependence on borrowed funds)
C = earnings/total assets	(reflects business profitability)
D = market value of equity/total liabilities	(reflects investor confidence)

The critical values for the measure's results are a score of:

0 to 1.8 indicates distress and a high probability of bankruptcy in two years;

1.8 to 3.0 is the grey zone; and

3.0 to 4.0 is considered the safe zone.

In the prior analysis in this report, the focus was entirely on profitability. The Z-scores add perspectives about the history of individual firms that have led to their current circumstances. Bankruptcy occurs when a company cannot meet its short-term obligations. Bankruptcy can happen to highly leveraged firms that are profitable, but not profitable enough to service their debt. Conversely, unprofitable firms can survive for long periods if their debt levels are low and/or they enjoy strong investor confidence.

We do not have access to the type of accounting information that would allow accurate estimation of Z-scores for individual orchards. Instead we benchmark orchard estimates around horticulture industry-wide estimates based on Statistics New Zealand Annual Enterprise Survey data. This approach allows estimated Z-scores for individual orchards to vary based on differences in net orchard returns and the implicit impact this has on market valuations (estimated using discounted cash flows). Implicitly this approach assumes that all kiwifruit growers are currently leveraged to the same degree as the average for all horticulture businesses.

[9] https://corporatefinanceinstitute.com/resources/knowledge/credit/altmans-z-score-model/

Using even this limited Z-score approach allows the analysis to account not just for the impact on earnings but also the impact of the decline in orchard market values. That is, by reducing earnings prospects, the removal of HC will also reduce orchard market values, which for a given level of debt will increase the leverage position of kiwifruit growers. The incorporation of lower orchard market values and the implicit increase in leverage in Z-score measures means that the Z-score approach may better pick up the increase in financial vulnerability that a removal of HC will impose on kiwifruit growers.

This perspective is supported by comparing the results of the Z-score analysis with the prior focus on profitability. Our profitability-based estimates suggested that around 9% of kiwifruit growers were currently operating unprofitable operations (see Table 8). However, our Z-score estimates find only 88 growers (or 3%) had Z-scores indicating financial distress (ie, scores below 1.8). On the other hand, the Z score analysis, by accounting for the impact of a removal of HC on future expected earnings and orchard market values indicates a larger level of financial distress than implied from a focus on current profitability alone. A focus on current profitability as per Section 3 above indicates a removal of HC is expected to make 15% of growers unprofitable (see Table 8). Allowing for the flow-on impact onto orchard market values suggests that the removal of HC could threaten the financial viability of almost 900 kiwifruit growers, or 30% of the total.

Some important caveats to the above analysis should be noted. As indicated above the analysis is based on horticulture industry-wide estimates of leverage rather than kiwifruit-specific data. Further, the analysis does not account for the ability for individual growers, and the industry in general, to innovate and adjust to the changes imposed by a removal of HC use. But even if the 30% impact is taken as a high-side estimate, it seems likely that a removal of HC would have major disruptive impacts for the kiwifruit industry.