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# CADMIUM MANAGEMENT IN NEW ZEALAND'S HORTICULTURAL SOILS

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## Abstract

Cadmium (Cd) is a heavy metal trace element which presents risks for the horticultural industry in New Zealand (NZ). This element is added to soils through phosphate fertiliser application, and once there may be available for plant uptake and food chain transfer. When food products exceed international standards for Cd concentrations, these products may be excluded from international markets upon which NZ relies to maintain its economy. This presents a reputational risk for NZ's horticultural exports. Soil pH and organic matter (OM) content are the two key drivers influencing Cd's bioavailability, and field trials are currently being undertaken in four horticultural sites throughout NZ – Pukekawa, Manawatu, and two adjacent sites at Lincoln – to test the efficacy of the use of lime and compost amendments to influence these soil variables and thus reduce Cd plant uptake from soils. Potatoes are grown at all sites while Lincoln also includes wheat. This research aimed to characterise these soils, including total and plant-exchangeable Cd concentrations, pH, OM content, cation exchange capacity, total and plant-exchangeable Zn concentrations, aluminium and iron oxide content, total phosphorus and total nitrogen content. Findings indicated that total Cd concentrations varied among sites, with the highest ( $0.52 \text{ mg kg}^{-1}$ ) at Pukekawa, followed by Manawatu ( $0.26 \text{ mg kg}^{-1}$ ) and Lincoln Wheat and Potato sites (both  $0.13 \text{ mg kg}^{-1}$ ). Exchangeable Cd concentrations were low at all sites ( $0.01\text{-}0.02 \text{ mg kg}^{-1}$ ) indicating little risk of plant uptake from these soils.

The mitigation strategy tested in this work focuses on pH as a key soil variable that can be readily changed to restrict Cd uptake. However, the effectiveness of amendment rates to effect target pH values is dependent on soil chemistry and rates will vary across sites. Incubation experiments were conducted to determine amendment rates for lime and sulphur, and to compare the pH of amended soil in a laboratory situation with the in-field situation. Incubation and field situations were found to be similar, with no significant differences between pH values after a period of 274 days in the incubator and 169 days in the field. The accuracy of the calculated amendment rates at achieving target pH values was assessed with extended incubation experiments. The results here varied between soils, with the sulphur application rate proving more accurate in the Pukekawa soil, however too high for the Manawatu and Lincoln potato soils. The calculated liming application rate similarly resulted in a higher-than-target pH, however after a period of 231-274 days the pH reduced and approached the target value.

A cost-benefit analysis was undertaken to determine the economic viability of the proposed mitigation strategy at each potato site. Results proved the strategy to be a viable option, which would remain viable in the face of varying uncertainty and reductions in potato yields. Practical considerations including timing and weather conditions, and compost availability were considered. Implementation of this strategy within NZ's current framework of the Tiered

Fertiliser Management System, which focuses on total rather than exchangeable Cd concentrations, may present difficulties, and thus there is a clear need for risk-based, soil and crop specific guidelines for Cd management within a NZ context.

Considering the apparent difficulties in designing pH amendments strategies, a model to convert pH buffer curve-generated lime application rates which can be derived in as little as 24 hours, to field applicable application rates which target a specific soil pH was developed for the Pukekawa soil. A similar model was not achieved for the Lincoln Wheat soil, and thus the development of such a model is not possible for all soil types. Where possible, the development of this model would be an innovative and useful tool for farmers with which to accurately and quickly determine required lime application rates to achieve a targeted soil pH. This would be of great benefit in the implementation of a Cd mitigation strategy using lime amendments, and would allow greater control over, and management of, soil pH in a horticultural context.

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## Table of Contents

Abstract.....	iii
Acknowledgements.....	v
List of Figures.....	x
List of Tables.....	xii
List of Appendix Tables.....	xiv
1 Introduction.....	1
2 Background.....	2
2.1 Cadmium – A Non-Essential Trace Element.....	2
2.2 Cadmium’s Harmful Effects on Plants and Microorganisms.....	3
2.3 Soil Characteristics Influencing Cadmium Bioavailability.....	4
2.3.1 Total and Exchangeable Cadmium Content.....	4
2.3.2 Soil pH.....	5
2.3.3 Organic Matter Content.....	7
2.3.4 Cation Exchange Capacity.....	9
2.3.5 Zinc.....	9
2.3.6 Aluminium & Iron Oxides.....	10
2.3.7 Total Phosphorus.....	10
2.3.8 Total Nitrogen.....	10
2.4 Plant Factors Influencing Cadmium Bioavailability.....	12
2.4.1 Plant Species.....	12
2.4.2 Plant Cultivar.....	13
2.4.3 Plant Tissue.....	14
2.4.4 Leaf Age.....	15
2.5 Cadmium Accumulation in a New Zealand Context.....	15
2.5.1 Background.....	15
2.5.2 Risks and Implications of Cadmium Accumulation for New Zealand.....	18
2.5.3 New Zealand’s Cadmium Management Strategy.....	19
2.6 Mitigations for Cadmium Plant Uptake.....	21
2.6.1 Organic Amendments.....	21
2.6.2 Lime.....	25
2.7 Environmental Management of Cadmium in New Zealand Soils.....	28
2.8 Current Cadmium Research in New Zealand.....	29
2.9 Research objectives.....	30
2.9.1 Current Research Aims.....	30



3 Site Characterisation – Introduction to Study Farms.....	32
3.1 Materials and Methods .....	32
3.1.1 Soils and Sampling .....	32
3.1.2 Soil Characterisation (Pre-amendment Analysis) Methods:.....	33
3.2 Results and Discussion .....	35
3.2.1 Pukekawa.....	35
3.2.2 Manawatu .....	38
3.2.3 Lincoln Potato .....	38
3.2.4 Lincoln Wheat .....	39
4 Research to Derive Accurate Application Rates to Achieve Target pH Values in Soil .....	41
4.1 Materials and Methods .....	41
4.1.1 Soils .....	41
4.1.2 Lime and Sulphur .....	41
4.1.3 Soil Buffering Capacity .....	41
4.1.4 Amendment Rate Determination .....	42
4.1.5 pH Incubations.....	43
4.2 Results & Discussion.....	43
4.2.1 Soil Buffering Capacity .....	43
4.2.2 Amendment Rates for use in pH Incubations .....	44
4.2.3 pH Incubation Results .....	47
4.2.4 Calculation of Field Trial Amendment Rates.....	50
4.2.5 Extended pH Incubation Results .....	50
4.2.6 pH: From Incubation to Field .....	54
5 Cost-Benefit Analysis.....	58
5.1 Methodology.....	58
5.1.1 Criteria for Viability .....	58
5.1.2 The Project Scenario.....	58
5.1.3 Determination of Costs and Benefits.....	59
5.1.4 Determination of the Project’s Net Present Value.....	61
5.1.5 Sensitivity Analysis .....	62
5.2 Results .....	62
5.2.1 Sensitivity Analysis .....	66
5.3 Environmental Management: How Realistic is this Mitigation Strategy? .....	69
5.3.1 Soil pH and Potato Scab .....	69
5.3.2 Compost Supply .....	69
5.3.3 On-farm Considerations .....	69

5.3.4 Towards a Key Step: Achieving a Target pH .....	70
5.3.5 Recommendations for Implementation .....	74
6 Conclusions.....	75
7 References.....	77
8 Appendices.....	1
Appendix A: Personal Communications.....	1
Appendix B: Soil Characterisation Data.....	1
Appendix C: Soil pH Buffering Capacity and Amendment Calculations.....	1
Appendix D: Discount rates and factors for CBA purposes, and equations .....	1

## List of Figures

Figure 1. Topsoil Cd concentrations throughout NZ as determined by Taylor et al. (2007, p. 15).....	17
Figure 2. $K_d$ values of organic amendments and soils through a range of pH values, produced by Al Mamun et al. (2016a). .....	24
Figure 3. Location of horticultural soil sites used. Soil types at each site are detailed in the map legend according to the New Zealand Soil Classification. ....	33
Figure 4. Buffer curves of all soils inclusive of pH target range.....	48
Figure 5. Pukekawa soil pH after seven days of incubation with aglime, hydrated lime and elemental S amendments .....	48
Figure 6. Pukekawa soil pH after 10 days of incubation with aglime, hydrated lime and elemental S amendments .....	48
Figure 7. Manawatu soil pH after seven days of incubation with aglime, hydrated lime and elemental S amendments .....	48
Figure 8. Manawatu soil pH after 10 days of incubation with aglime, hydrated lime and elemental S amendments .....	48
Figure 9. Lincoln Potato soil pH after seven days of incubation with aglime, hydrated lime and elemental S amendments .....	49
Figure 10. Lincoln Potato soil pH after 10 days of incubation with aglime, hydrated lime and elemental S amendments .....	49
Figure 11. Lincoln Wheat soil pH after seven days of incubation with aglime, hydrated lime and elemental S amendments .....	49
Figure 12. Lincoln Wheat soil pH after 10 days of incubation with aglime, hydrated lime and elemental S amendments .....	49
Figure 13. Manawatu incubation pH at day 58 for aglime*10, elemental S*3 and control samples .....	52
Figure 14. Manawatu incubation pH at day 121 for aglime*10, elemental S*3 and control samples .....	52
Figure 15. Manawatu incubation pH at day 231 for aglime*10, elemental S*3 and control samples .....	52
Figure 16. Lincoln Potato incubation pH at day 101 for aglime*10, elemental S*3 and control samples .....	53
Figure 17. Lincoln Potato incubation pH at day 274 for aglime*10, elemental S*3 and control samples .....	53
Figure 18. Pukekawa soil incubation pH after 101 days .....	56
Figure 19. Pukekawa soil incubation pH after and 274 days .....	56

Figure 20. Pukekawa field pH of control, S and lime plots 147 days after amendment application.....	56
Figure 21. Lincoln Wheat incubation pH of control and aglime*10 samples after 101 days .....	57
Figure 22. Lincoln Wheat incubation pH of control and aglime*10 samples after 274 days .....	57
Figure 23. Lincoln Wheat field pH of control and lime amendment plots after 139 days.....	57
Figure 24. Lincoln Wheat field pH of control and lime amendment plots after 169 days.....	57
Figure 25. Relationship between buffer curve-generated and field application rates of lime to achieve a target pH in Pukekawa soil .....	71
Figure 26. Relationship between buffer curve-generated and field application rates of lime to achieve a target pH in Lincoln Wheat soil.....	72

## List of Tables

Table 1. Differences in Cd accumulation between types of vegetables as reported by different authors .....	13
Table 2. Summary of mean NZ Cd concentrations for varying land-uses sourced from Cavanagh (2014) .....	17
Table 3. Summary of soil Cd concentrations throughout regions of NZ, as presented in Cavanagh (2014, p. 8) .....	18
Table 4. Soil contaminant standards for Cd determined to protect human health in NZ's NES..	19
Table 5. Representation of the Tiered Fertiliser Management System from Cavanagh (2012, p. 1), showing tiers, trigger values, and required management actions .....	20
Table 6. Studies assessing the effects of lime on soil and plant Cd, with application rates and primary observations .....	27
Table 7. Mean soil characteristics of the study farms at Pukekawa, Manawatu and Lincoln .....	37
Table 8. Volumes of 0.2 M NaOH, 0.2 M HCl and deionised H <sub>2</sub> O added to beakers of 20 g soil to create pH buffer curve for each soil site.....	42
Table 9. Bulk density and field capacity of each soil .....	43
Table 10. Native pH and buffering capacities of incubated soils .....	44
Table 11. pH incubation amendments and rates for each site, derived from pH buffer curve data to achieve a range of target pH values.....	45
Table 12. Amendment rates of elemental S or aglime per plot used in field trial work in four experimental locations.....	50
Table 13. Percentage variations from target pH of Lincoln Wheat soil in incubations at day 101 and in field at day 139 .....	55
Table 14. Factors considered within the CBA and their associated values .....	60
Table 15. Cost-benefit analysis of mitigation at the Pukekawa site, detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	64
Table 16. Cost-benefit analysis of mitigation at the Manawatu site, detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	64
Table 17. Cost-benefit analysis of mitigation at the Lincoln site, detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	65
Table 18. Cost-benefit sensitivity analysis for the Pukekawa site using a potato yield of 50 t ha <sup>-1</sup> , detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	67

Table 19. Cost-benefit sensitivity analysis for the Manawatu site using a potato yield of 50 t ha <sup>-1</sup> , detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	67
Table 20. Cost-benefit sensitivity analysis for the Lincoln site using a potato yield of 50 t ha <sup>-1</sup> , detailing benefits from potato revenue, costs of mitigation, present values of total costs and benefits, the project's net cash flow and the overall NPV .....	68
Table 21. pH changes in the Lincoln Wheat soil during field trial work, and their associated lime application rates .....	73

## List of Appendix Tables

Table B-1. Pukekawa soil characterisation results .....	B-1
Table B-2. Manawatu soil characterisation results .....	B-1
Table B-3. Lincoln Potato soil characterisation results .....	B-2
Table B-4. Lincoln Wheat soil characterisation results .....	B-3
Table C-1. pH buffer curve results for Pukekawa soil .....	C-1
Table C-2. pH buffer curve results for Manawatu soil .....	C-1
Table C-3. pH buffer curve results for Lincoln Potato soil .....	C-1
Table C-4. pH buffer curve results for Lincoln Wheat soil .....	C-1
Table C-5. Soil buffering capacity and amendment application rate calculation table for Pukekawa and Manawatu soil .....	C-2
Table C-6. Soil buffering capacity and amendment application rate calculation table for Lincoln Wheat and Lincoln Potato soil .....	C-3
Table D-1. Discount factors by year for discount rates ranging from 1-10% .....	D-1