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CADMIUM AND NEW ZEALAND AGRICULTURE AND HORTICULTURE: A REFRESHED STRATEGY FOR LONG-TERM RISK MANAGEMENT

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Abstract

This paper sets out the Cadmium Management Group's (CMG) refreshed strategy for managing cadmium in New Zealand agriculture over the long term. The refreshed strategy is intended to stand until it is reviewed again in 2026. We also comment on the achievements of the previous strategy, and the key findings of an independent review that led to its refreshing.

The CMG is a multi-stakeholder group of regional councils, primary sectors and central government convened by the Ministry for Primary Industries (MPI) to manage cadmium in the primary sector.

Cadmium is a naturally-occurring heavy metal in the earth's rocks, soils, water and air. Cadmium is only acutely toxic at high levels of intake (mostly from accidental industrial exposure), but it can accumulate in kidneys and livers which can lead to chronic toxicity problems. Phosphate fertiliser is the primary source of gradual cadmium accumulation in agricultural soils, so the fertiliser industry has enacted a voluntary limit on the levels of cadmium in fertilisers.

The refreshed Cadmium Management Strategy objective is to *"Ensure that cadmium in rural production poses minimal risks to health, trade, land use flexibility and the environment over the next 100 years".*

The refreshed strategy approach is to focus on research, monitoring, education and supporting practices that enable food standards to be met and that control soil cadmium accumulation to:

- protect human health;
- protect the environment;
- maintain trade access and a vibrant productive sector; and
- maintain flexibility in land use options.

The new strategy has been partitioned into five components. These are:

- governance and oversight of cadmium management in New Zealand;
- monitoring to ensure the risks are being managed appropriately, and contributing to the knowledge base of where and how risks from cadmium arise;

- managing the accumulation of cadmium in soils through the Tiered Fertiliser Management System, by assessing priority produce for non-compliance with food standards, and developing a communication and education programme;
- research to improve understanding and ways to manage cadmium; and
- scanning of the trade, regulatory and research sectors to identify new emerging issues.

Background

Cadmium is a non-essential, naturally-occurring heavy metal. It occurs in trace amounts in air, water, soils and most foods. Cadmium is also a naturally-occurring impurity in most phosphate sources and cannot be removed from fertilisers economically. With ongoing phosphate fertiliser application, gradual accumulation in soil will continue to occur. Phosphate is required on an ongoing basis to optimise plant growth and food production. Imported phosphate rock is needed to manufacture fertiliser to replace phosphate loss through product removal, soil binding and soil loss.

Because of potential toxicity of cadmium to humans and other organisms, concerns have been raised about the gradual long-term accumulation of cadmium in soils. Other than industrial exposure, accidents and smoking, the major route of cadmium intake for humans is through food or water.

Cadmium Policy History in New Zealand

In the late 1980s, concerns were raised about cadmium by the OECD. Based on several reports, New Zealand decided on regulatory action from 1991 to discard kidneys from sheep older than 30 months from the human food chain, due to the potential for a high proportion of kidneys from older animals to breach the food safety standard in New Zealand.

Since 1995, the New Zealand fertiliser industry has implemented voluntary limits for the level of cadmium in fertiliser sold. Fertiliser cadmium levels were gradually reduced. From July 1995 – December 1996, the upper limit was 340 mg Cd/kg P, and from January 1997 onwards the current upper limit of 280 mg Cd/kg P has been in place. From 2001, independent audits of fertiliser cadmium content were incorporated into the Fertmark scheme administered by Federated Farmers.

Renewed interest in cadmium occurred in the mid-2000s due to Waikato Regional Council's concerns about historical and ongoing accumulation of cadmium in soils in their region. The Chief Executives Environmental Forum comprised of regional council and environmental central government department chief executives established the Cadmium Working Group (CWG) in 2006. The CWG was tasked with assessing the potential risks of cadmium to New Zealand agriculture and food systems, and to develop a response.

Numerous reports contributed to setting out the CWG's strategy for managing cadmium over the long term (100 years) (Cadmium Working Group 2008; Warne, M. J., 2011; Ministry of Agriculture and Forestry, 2011).

Recent Cadmium Strategy History in New Zealand

After completion of the reports and the development of the first Cadmium Management Strategy (CMS) in 2011 (Ministry of Agriculture and Forestry, 2011), the CWG was disbanded. The Cadmium Management Group (CMG) was formed to implement the CMS

over seven years. The strategy was to be reviewed at the end of this period. In 2018 the CMS was reviewed by Mike McLaughlin and David Miller, and in 2019 a refreshed CMS was developed together with a refreshed Tiered Fertiliser Management System (Sneath, 2020).

Key Cadmium Strategy Achievements - 2011 to 2018

The key achievement of the CMS has been that less cadmium has been applied to soil through fertiliser. In spite of a maximum voluntary industry standard of 280 mg Cd/kg P, fertiliser cadmium levels have dropped to an average mean of 180 mg Cd/kg P), a 36 percent decrease from the maximum standard. During the independent review of the CMS, the view was also expressed that the cadmium strategy in New Zealand represent best practice.

There has also been strong engagement between CMG member organisations and primary industry sector groups, resulting in a collective approach with a good understanding and respect for different positions held by members.

Extended soil sampling and reporting of fertiliser cadmium content across New Zealand has been carried out. This has delivered greater transparency and understanding of cadmium levels in the environment (e.g. Abraham et al., 2016), and a renewed focus on soil sampling in the legacy areas of Waikato, Taranaki, and Bay of Plenty.

A series of significant research programmes, investing approximately $1 million in funding, were completed to better understand the influence of soil characteristics and plant variety on uptake. The programmes developed science capability while engaging and coordinating a wide range of research institutes, including Manaaki Whenua Landcare Research, AgResearch, Massey and Lincoln Universities, and also a wide cross-section of primary sector representative groups, regional councils and central government. Additional research and investment by CMG members included funding support for several PhD studies relating to cadmium and crop variety assessments for cadmium levels, e.g. chicory.

Cadmium levels were reported in regional state of environment monitoring and reporting by CMG members and regional councils and were also reported in *New Zealand's Environmental Reporting Series: Our land 2018* (Ministry for the Environment & Stats NZ, 2018).

MPI and other CMG members responded to regular enquiries and media interests. CMG members presented at extension opportunities, wrote media articles and provided information on management of cadmium. Presentations about cadmium in primary production land have been given to primary sector groups/science groups/regulators, e.g. Waikato Federated Farmers, Waikato Regional Council, National Trace Element Conference, Fertiliser and Lime Research Centre conferences (numerous presentations), AGCARM Conference, the Onion Growers Association and the Wheat Industry Forum, to name a few.

Better Understanding of Cadmium in New Zealand

The independent review (McLaughlin and Miller, 2018) identified the following research highlights that have occurred over 2011 to 2018 the duration of the strategy. These highlights were often stimulated through CMG recognition of information needs.

- Greater understanding of background cadmium has been gained and the input burden of cadmium and its distribution nationally has been better quantified (McDowell et al., 2013 Cavanagh, J., 2014).
- Research has demonstrated the significant spatial variability of cadmium across a farm which aids better sampling approaches (Stafford et al., 2017).
- Losses of cadmium in leaching and surface runoff have also been better quantified (McDowell, 2010; Gray & McDowell, 2016; Gray et al., 2017;
- The higher risk of cadmium accumulation by animals grazing plantain and chicory forages was identified. These forage species are receiving increasing interest on pastoral farms (Stafford et al., 2016; Stafford, 2017).
- Recent research on wheat and spinach has shown they can occasionally exceed cadmium food standards even when soil cadmium concentrations are low (<0.5 mg Cd/kg) (Cavanagh et al., 2017a).
- While there has been concern about the impact of cadmium on soil microbiology, recent research has shown that accumulation of cadmium in soil from fertiliser applications is unlikely to affect the clover-rhizobium symbiosis (Cavanagh et al., 2017b), critical for nitrogen fixation in pastures.
- Finally, a new cadmium soil test that identifies available soil cadmium has been developed.

Further understanding of soil cadmium and its uptake is still necessary if New Zealand is to meet net zero accumulation, the long-term vision of the CMS (CMG, 2019).

Key Review Recommendations

The review noted that the activities of the CMG to date have had a focus on developing better monitoring systems for cadmium. They recommended that the focus for the CMG going forward should be on education and management of the cadmium issue to minimise further cadmium accumulation in soils and the food chain. Given the incidence of high cadmium (Tier 3) soils already in the Waikato, Taranaki and Bay of Plenty regions, they recommended that it was critical the Tiered Fertiliser Management Strategy be revised and implemented for all farmers and growers whose soils are in cadmium Tiers 2 and above. They also recommended that the assessment of temporal changes in food crop cadmium should be assessed in a national monitoring program carried out every 5-7 years under the CMS. Suggested initial target crops were leafy vegetables, potatoes, onions and wheat.

The review also recommended that more emphasis should be placed on developing management options to minimise cadmium accumulation in the food chain through future land use changes of high cadmium soils. They recommended that communication and education of farmers and growers regarding the cadmium issue should be implemented using a more “push” proactive program, rather than just a “pull” web-based information dissemination strategy.

The Refreshed Cadmium Management Strategy

The CMG brings together the major industry and regulatory stakeholders in the management of cadmium in New Zealand’s primary sector. The refreshed CMS is the CMG’s statement on how and why cadmium needs to be managed going forward over the long term.

The National CMS's objective is:

> *"To ensure that cadmium in rural production poses minimal risks to health, trade, land use flexibility and the environment over the next 100 years".*

The refreshed strategy addresses the following specific risk areas:

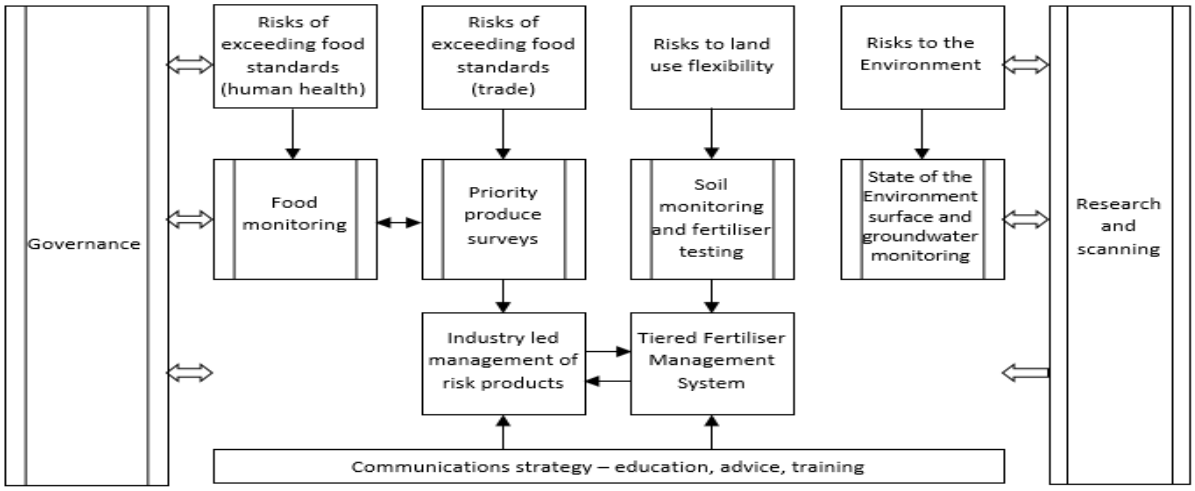
- protecting human health;
- protecting the environment;
- maintaining trade access and a vibrant productive sector; and
- maintaining flexibility in land use options.

The revised CMS has been partitioned into five components. These are:

- governance and oversight of cadmium management in New Zealand;
- monitoring to ensure the risks are being managed appropriately, and contributing to the knowledge base of where and how risks from cadmium arise;
- managing the accumulation of cadmium in soils and of priority produce for non-compliance with food standards;
- research to improve understanding and ways to manage cadmium; and
- scanning of the trade, regulatory and research sectors to identify new emerging issues.

All the elements are represented in Figure 1 which identifies the different risks and elements in the CMS including the avenues through which risk would be addressed.

Fig. 1: Structure of the Refreshed National Cadmium Management Strategy



Conclusion

The revised CMS presents an example of continued industry, regional and central government partnership and collaboration in the development of a voluntary, non-regulatory approach to address the accumulation of cadmium in soil, which otherwise has the potential to be an issue in the long term (100 years).

Membership of the Cadmium Management Group and further information

The following organisations are represented on the Cadmium Management Group:

DairyNZ, HortNZ, Meat and Wool NZ, Federated Farmers, Fertiliser Quality Council, MPI, Ministry for the Environment, Fertiliser Association of New Zealand, Ravensdown, Ballance AgriNutrients, Foundation for Arable Research, PotatoesNZ, Environment Waikato, Greater Wellington Regional Council, Environment BOP, Taranaki Regional Council.

Further Information: https://www.mpi.govt.nz/protection-and-response/environment-and-natural-resources/land-and-soil/cadmium/ and many CMG partner websites.

References

Abraham, E., Cavanagh, J., Wood, P., Pearson, A. and Mladenov, P., 2016. Cadmium in New Zealand's agriculture and food systems. In: *Integrated nutrient and water management for sustainable farming.* (Eds L.D. Currie and R. Singh). http://flrc.massey.ac.nz/publication.html. Occasional Report No. 29. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

Cadmium Management Group, 2019. Cadmium and New Zealand Agriculture and Horticulture: A Refreshed Strategy for Long Term Risk Management.

Cadmium Working Group., 2008. Report One: Cadmium in New Zealand Agriculture

Report of the Cadmium Working Group, Ministry of Agriculture and Forestry.

Cavanagh, J., 2014. *Status of cadmium in New Zealand soils.* Landcare Research, Document LC1857, Landcare Research, Lincoln, NZ, pp. 44. http://fertiliser.org.nz/Site/research/completed_research/default.aspx

Cavanagh, J., Munir, K., Gray, C., Young, S., Wakelin, S., Yi, Z., Lehto, N., Robinson, B., Smith, S., Jeyakumar, J. & Anderson, C., 2017a. *Assessing cadmium uptake in New Zealand agricultural systems II.* Landcare Research, L. Research, Lincoln, NZ, pp. 162.

Cavanagh, J.E., Yi Y., Munir K., Lehto N., Robinson B., Gray C., Geretheran G., Jeyakumar J., Thompson-Morrison H., Anderson C., 2017b. Understanding the influence of soil properties on plant uptake of cadmium in New Zealand agricultural soil. In*: Science and policy:nutrient management challenges for the next generation.* (Eds L. D. Currie and M. J. Hedley). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 30. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

Gray, C. W. & McDowell, R. W., 2016. Cadmium losses from a New Zealand organic soil. *New Zealand Journal of Agricultural Research,* **59,** 185-193.

Gray, C. W., McDowell, R. W. & Noble, A., 2017. *Analysis of samples from the Winchmore long-term fertiliser trial for total soil cadmium contents.* AgResearch, Report prepared for the NZ Fertiliser Association, AgResearch, Client Report Number: RE450/2017/096, pp. 9.

McDowell, R. W. 2010. Is cadmium loss in surface runoff significant for soil and surface water quality: A study of flood-irrigated pastures? *Water, Air, and Soil Pollution,* 209, 133-142.

McDowell, R. W., Taylor, M. D. & Stevenson, B. A. 2013. Natural background and anthropogenic contributions of cadmium to New Zealand soils. *Agriculture, Ecosystems & Environment,* 165, 80-87.

McLaughlin, M., and Miller, D., 2018. Review of the New Zealand Cadmium Management Strategy, prepared for the Fertiliser Association of New Zealand and the New Zealand Ministry for Primary Industries.

Ministry of Agriculture and Forestry, 2011. Cadmium and New Zealand Agriculture and Horticulture: A Strategy for Long Term Risk Management: A report prepared by the Cadmium Working Group for the Chief Executives Environmental Forum, *Technical Paper No: 2011/02,* MAF, New Zealand.

Ministry for the Environment & Stats NZ, 2018. *New Zealand's Environmental Reporting Series: Our land 2018.*

Sneath, G., 2020. Revision of the Tiered Fertiliser Management System for Soil Cadmium. In: *Nutrient Management in Farmed Landscapes*. (Eds. C.L. Christensen, D.J. Horne and R. Singh). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 33. Farmed Landscapes Research Centre, Massey University, Palmerston North, New Zealand. 13 pages.

Stafford, A. D., 2017. Distribution of cadmium in long-term dairy soils, its accumulation in selected plant species, and the implications for management and mitigation. In: *Soil Science.* Massey University, Palmerston North, NZ, pp. 323.

Stafford, A. D., Anderson, C. W. N., Hedley, M. J. & McDowell, R. W., 2016. Cadmium accumulation by forage species used in New Zealand livestock grazing systems. *Geoderma Regional,* **7,** 11-18.

Warne, M. J., 2011. Review of, and recommendations for, the proposed New Zealand Cadmium Management Strategy and Tiered Fertiliser Management System, *MAF Technical Paper No: 2011/03*, Prepared for the Cadmium Working Group, MAF, New Zealand.