Final Report of the National Cadmium Management Committee (NCMC) (2000 – 2006)

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Executive Summary

This is the final report of the National Cadmium Management Committee (NCMC) which has had the responsibility of implementing the National Cadmium Minimisation Strategy (NCMS). The NCMC was established in 2000 by the Standing Committee on Agriculture and Resource Management (SCARM) at the recommendation of the Cadmium in Agriculture Task Force. The NCMC set high-level priorities and directions for a part-time National Coordinator from CSIRO Land and Water that was co-funded by Fertilizer Industry Federation of Australia (FIFA), Grains Research and Development Corporation (GRDC) and Horticulture Australia Limited (HAL). These three organisations were represented on the NCMC, as were four State Government Departments (New South Wales (NSW), Queensland (QLD), Victoria (VIC), Western Australia (WA)), the Commonwealth and Rural Industry.

All of the original objectives of the NCMC plus additional objectives that emerged over the six-year term of the committee were achieved. The major outputs of the committee were:

- the development of a national database and geographic information system for cadmium in agricultural produce;
- the establishment of a website with information resources (see www.cadmium-management.org.au) including a listing of Australian scientific papers and reports on cadmium in agriculture;
- the writing, publication and distribution of six Best Management Practice brochures. These were also made available on the NCMC website (www.cadmium-management.org.au/publications.html#brochures) and a seventh brochure was written for publication by the Meat and Livestock Association;
- the calculation of cadmium balances for soil-plant-animal systems at both a state and national level;
- fertiliser regulations and biosolid guidelines for cadmium that are progressively being included in state regulations;
- input into the Australian Fertilizer Industry's Code of Practice and to that industry's FERTCARE® Product Stewardship Training and Accreditation program for fertiliser purchasers, dealers and spreaders (www.fertcare.com.au);
- the compilation and release of a listing of Australian laboratories that were deemed by the Australasian Soil and Plant Analysis Council (ASPAC) to be proficient in the measurement of cadmium in plant tissue;
- a workshop on cadmium in biosolids and other organic wastes; and
- a workshop outlining the major achievements of the NCMC.

The NCMC has been very successful in implementing the NCMS and actively managing the issue of cadmium in agriculture. Major outcomes of the activities of the NCMC include:

- a large decline in the quantity of cadmium being added to Australian soils as contaminants in phosphatic fertilisers and in some trace element formulations. The Australian Fertiliser Industry contributed significantly to this highly desirable outcome;
- significant improvements in the regulation and use of biosolids, designed to minimise the loading of soils with cadmium (and other undesirable contaminants);
- national harmonisation of fertiliser labelling and warning regulations;
- improved knowledge and awareness of the issues of cadmium in agriculture and practices to minimise cadmium contamination of crops; and
- scientifically sound and sensible decisions being made at the International level regarding acceptable cadmium contamination levels in foods.

Background

In July 1988, following a resolution of Australian Agricultural Council 130 several reviews on the issue of cadmium in agriculture were commissioned. The Working Party reported to the then Standing Committee on Agriculture in July 1990 (Meeting 146, Agenda No. 6.6). Four technical sub-committees reported on cadmium residues in grains, meat and animal products, fishery products and fruit, vegetables and tobacco. Following this, the Federal Standing Committee on Agriculture and Resource Management (SCARM) established the Cadmium in Agriculture Task Force, which reviewed the issue of cadmium in agriculture. Several key recommendations resulted from this review (SCARM, 1999) and these formed the core of the National Cadmium Minimisation Strategy (NCMS). These were that:

1) all state agriculture/primary industry departments harmonise regulations for maximum permitted concentrations in phosphatic fertilisers at a level of 300 mg cadmium/kg phosphorus;
2) the issue of cadmium in organic wastes (sewage biosolids and animal manures) should be examined to minimise cadmium inputs to agricultural soils;
3) all States consider having fertilisers labelled with their cadmium content and warning statements attached;
4) best management practices be adopted by industries in high-risk situations;
5) FIFA develop a code of practice for fertiliser use that minimises cadmium concentrations in products; and
6) a National Cadmium Coordinator be appointed to oversee the strategy, provide a focus for government and industry action, and ensure implementation of appropriate actions to minimise cadmium accumulation in Australian agriculture.

The NCMS is managed and implemented by the NCMC. This committee was established in July 2000. It is comprised of representatives of State departments from NSW, QLD, SA, VIC and WA; horticultural and fertiliser industries, the peak farmers organisation and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). The NCMC originally had a 5-year term. However, due to cost savings (see explanation in the financial statement section) the term was extended to 6 years (i.e. until June 30, 2006) following endorsement by Horticulture Australia Ltd (HAL) and the Fertilizer Industry Federation of Australia (FIFA).

The membership of the NCMC has changed considerably during its six-year term. Details of the membership of the committee are provided in Appendix 1. The committee met a total of 16 times – details of which are provided in Appendix 2.

Objectives of the NCMC

The key objectives of the NCMC were:

1) the development of best management practices (BMPs) for the production and processing of agricultural produce for those industries and/or areas which have an existing or potential problem with excessive cadmium levels in their produce;
2) the development of a code of practice which would target low cadmium fertiliser to those areas/industries which have an existing or potential cadmium problem;
3) to encourage all State departments to re-affirm their previous commitment to reduce the regulated level of cadmium in phosphatic fertilisers to 300 mg cadmium/kg phosphorus by 2000;
4) to encourage all State departments to strongly consider requiring phosphatic fertilisers and trace element fertilisers and soil ameliorants to be labeled with their cadmium content,

and a warning which alerts growers to the need to consider the cadmium content of their fertilisers in case it causes them problems now or in the future;

5) to increase the awareness by SCARM and all State departments of the risks of the use of biosolids and other soil ameliorants in adding cadmium to the soil, and to take this risk into account when setting standards for their use; and

6) that the National Coordinator collect and analyse data and information on cadmium in fertilisers, soils and produce, and its impact on trade, and monitor the success of the National Cadmium Minimisation Strategy.

Outputs and Outcomes of the NCMC

This section details how the objectives of the NCMC were addressed and the related outputs and outcomes.

Objective 1 - *the development of best management practices (BMPs) for the production and processing of agricultural produce*

One of the key aims of the NCMC was to educate farmers and agricultural sectors about the current best practices to minimise uptake of cadmium by produce. The NCMC was very active in this regard and wrote and published seven BMP brochures:

1. Cadmium in potatoes: Managing the risk from saline irrigation water;
2. Managing cadmium in potatoes for premium quality produce;
3. National Cadmium Strategy: Australian agriculture acts to reduce cadmium levels;
4. Managing cadmium in summer grain legumes;
5. Vege Notes: Managing cadmium in vegetables;
6. Vege Notes: Managing cadmium in vegetables (Vietnamese translation); and
7. Managing for cadmium minimisation in Australian livestock.

These brochures were distributed to people in the relevant industry by Potato Australia, Horticulture Australia Ltd, and the Grain Research and Development Corporation and SAFEMEAT.

All of these BMP brochures are available from the NCMC web-site (www.cadmium-management.org.au). Copies of the BMP brochures are provided in Appendix 3. Based on monthly web-site use statistics approximately 20 000 copies of the BMP brochures have been downloaded in addition to those that were distributed as mentioned above.

Even though the Meat and Livestock Industry did not financially support the NCMC, the committee wrote a BMP brochure for SAFEMEAT, and Meat and Livestock Australia (MLA). They were very happy with the text and adopted it subject to some minor modifications. Between 20 000 – 40 000 copies of the brochure will be distributed to appropriate people in the meat and livestock industry. In addition, they will be placing a smaller version of the document on their website. The brochure has also been added to the NCMC web-site.

Objective 2 - *the development of a code of practice which would target low cadmium fertiliser to those areas/industries which have an existing or potential cadmium problem*

Prior to the commencement of the NCMC, the fertiliser industry worked with Australian Governments to reduce cadmium concentrations in phosphorus fertilisers to the then lowest commercially achievable level. This was set at 350 mg cadmium/kg phosphorus initially and then moved down to 300mg cadmium/kg phosphorus. During the term of the NCMC, the fertiliser industry through the Fertiliser Industry Federation of Australia (FIFA) has developed and implemented a voluntary agreement to produce a phosphatic fertiliser with a maximum cadmium concentration of 100 mg cadmium/mg phosphorus for at-risk industries (i.e. horticulture).

The average concentration of cadmium in phosphorous fertilisers sold in Australia is now around 100 mg cadmium/kg phosphorus.

Information provided by FIFA indicates that sales of this new product are not large and that currently only one manufacturer makes a low cadmium single super phosphate (SSP). Due to higher costs and problems with its application because it has an irregular grain size this product has not sold extensively and the company has decided to cease production. Farmers have instead been using high analysis fertilisers which typically have much lower cadmium concentrations. However, there is still demand for low cadmium SSP in Nitrogen, Phosphorus and Potassium (NPK) fertiliser blends and another company will meet this need.

The European Union is currently considering new restrictions on the maximum permitted concentration of cadmium in fertilisers. With the developments outlined above Australian fertilisers already meet this proposed limit and therefore Australian agriculture is unlikely to be impacted by the proposed changes.

The FERTCARE program, developed by FIFA and the Australian Fertilizer Services Association (AFSA), will be a further major positive influence on the implementation of this code of practice. FERTCARE is a national training and accreditation program for all staff of fertiliser manufacturers, distributors and applicators and businesses dealing with soil ameliorants (e.g. lime, gypsum, etc.). It is designed to ensure that Australian farmers receive consistent high quality advice for fertiliser and soil ameliorant handling and use, which will in turn benefit the industry and the Australian community. Potential environmental and human health impacts associated with the use of fertilisers and contaminants in fertilisers are two crucial issues addressed in the FERTCARE program. Cadmium contamination issues are specifically addressed. Members of the NCMC wrote and/or refereed the training material related to cadmium and other contaminant issues. Both FIFA and AFSA have made a commitment to ensure that FERTCARE becomes the industry standard. They aim to have 100% of eligible staff FERTCARE trained, 100% of spreaders Accu-Spread tested and 100% of eligible premises FERTCARE accredited by June 2008. Currently, 33% of 1000 eligible staff have been trained, tested or accredited. Details of the FERTCARE program can be obtained from www.fifa.asn.au/default.asp?V_DOC_ID=1101

FERTCARE®

An additional development has been the 75% reduction of the cadmium inputs to agriculture from fertilisers. This has occurred due to the Fertiliser industry using low cadmium phosphate rock and through the decreased use of single super phosphate fertilisers and their replacement by high analysis fertilisers.

Objective 3 - *encourage all State departments to re-affirm their previous commitment to reduce the regulated level of cadmium in phosphatic fertilisers to 300 mg cadmium/kg phosphorus by 2000*

The NCMC wrote to the Directors-General of all the appropriate state and territory departments seeking harmonisation of state fertiliser regulations at a level of 300 mg cadmium/kg phosphorus. All the appropriate State departments re-affirmed their commitment and have now legislated that the maximum permissible concentration of cadmium in phosphatic fertilisers is 300 mg cadmium/kg phosphorus with a maximum permissible cadmium concentration in other fertilisers of 10 mg cadmium/kg except for trace element fertilisers.

Objective 4 - *encourage all State departments to consider requiring phosphatic fertilisers and trace elements and soil ameliorants to be labelled with their cadmium content, and a warning which alerts growers to the need to consider the cadmium content of their fertilisers in case it causes them problems now or in the future*

The harmonization of fertiliser labelling throughout Australia has been actively pursued by the NCMC, FIFA and the Fertilizer Working Group (FWG - which reports to the Primary Industries Standing Committee, PISC). Despite considerable efforts harmonization has not yet been fully achieved.

The cadmium content of fertilisers is only required to be stated for all fertilisers in NSW, in SA it is only required for phosphatic fertilisers and in VIC it is required for any fertiliser where the concentration is > 1 mg cadmium/kg. The remaining jurisdictions have no requirements that the labels state the cadmium concentration.

The current legislative position regarding warnings on the labels is that WA does not require any warning statement on fertilisers. The Northern Territory (NT) and QLD only require a warning concerning feeding fertilisers to feedstock. The warning for both these jurisdictions is "Must not be fed to livestock" if the cadmium concentration is > 100 mg cadmium/kg phosphorus. No other jurisdictions require a warning concerning cadmium and the feeding of fertilisers to livestock.

NSW, SA and VIC have essentially the same general warning regarding cadmium in fertilisers which is required if the concentration is > 1 mg cadmium/kg. The wording of the warning varies slightly between the jurisdictions but essentially states:

"WARNING – Use of this product may result in residues in excess of the maximum permissible concentration (MPC) in plant and animal products and may result in the accumulation of these residues in soils."

Tasmania also has a general warning which is required when the concentration is > 10% of the MPC that is defined in the Tasmanian regulations. The warning is:

"WARNING – This fertiliser contains cadmium. Use of this fertiliser may increase cadmium concentrations in soil and in produce."

In addition, State and Commonwealth Agriculture Departments were contacted seeking support for the development of a National Code for Fertiliser Standards and Labelling for mineral fertilisers. This was followed by an approach to the Agricultural and Veterinary Chemicals Policy Committee (AVCPC). One of the mechanisms suggested by AVCPC for the development of such a code was by establishing an Australian Standard through Standards Australia. This proposal has been endorsed by FIFA and a proposal has been made to Standards Australia for the development of a national standard. The FWG and FIFA are currently negotiating with Standards Australia and the state jurisdictions to develop a Standard to cover labelling of fertilisers and warnings. In the mean time FIFA has developed a draft Code of Practice which requires all FIFA members to adhere to all labelling and warning requirements of jurisdictions.

Objective 5 - *SCARM, and all State departments to be aware of the risks of the use of biosolids and other soil ameliorants in adding cadmium to the soil, and to take this risk into account when setting standards for their use.*

The NCMC conducted a survey of cadmium regulations for organic fertilisers and sewage wastes and found that there were considerable discrepancies between States. Furthermore, the scientific basis for the regulations was not considered strong. It was decided to hold a workshop attended by representatives of industry, government and academic researchers that would review the various guidelines and determine if harmonisation was feasible, and at what level standards should be set.

Approval was sought from, and granted by the SCARM for a workshop to be held to resolve these issues. The workshop was held in Melbourne in February 2002, and brought together 23 scientists, regulators, and representatives of the water industry from throughout Australia, to discuss the issue of cadmium loadings to agricultural soils through disposal/use of organic wastes (e.g. sewage biosolids).

Agreement was reached on the following actions:

1. Controls at source (i.e. trade waste policies) to be reviewed. Traceback of cadmium in biosolids in treatment works with high cadmium concentrations to determine where additional controls are needed on influent concentrations;
2. A maximum annual loading rate of 30 g cadmium/ha/yr averaged over 5 years (i.e. 150 g cadmium/ha/5yr) should be adopted;
3. A maximum soil concentration of 1.0 mg cadmium/kg should be adopted, unless local data indicate a lower limit is appropriate; and that the national guideline for biosolid cadmium grading should be adopted (when finalised);
4. Research to develop more appropriate guidelines concerning cadmium in biosolids and their application in agriculture;
5. An analytical quality assurance program be encouraged through the Australasian Soil and Plant Analysis Council (ASPAC); and
6. Controls on cadmium in wastes other than biosolids to be considered e.g. other animal and urban wastes and composts.

Letters were dispatched to all state environmental agencies seeking the introduction of the new proposed loading limits. To date, three agencies have responded (WA DEP, VIC EPA and QLD EPA) positively to the proposals, and intend to incorporate the proposals in their guidelines for biosolids reuse.

Recommendation one was not actively pursued as information generated by research projects conducted as a result of recommendation five would indicate whether this was necessary or not. It was noted that the cadmium concentrations and those of many other metal contaminants in biosolids have decreased considerably in the last 10-20 years due to improved trade waste licensing (Whatmuff, pers. comm.; Oliver et al. 2005).

Recommendation two has been adopted into the VIC State Biosolids Guidelines, in the current draft revision of the SA Biosolids Reuse Guidelines and in the National Biosolids guidelines. This has not been adopted by NSW and TAS as, at this time, they have not amended their Biosolids Guidelines. Queensland currently does not have any biosolids guidelines. The Qld EPA examines each submission for biosolids application on a case-by-case basis in terms of a beneficial re-use approach. In terms of contaminant guideline values and risk management, QLD defaults to the approach contained in the NSW Biosolids Guidelines. An Operations Policy on Biosolids Re-use is being drafted for QLD and it is likely to adopt recommendation two from the workshop (Glenn Barry, QDRM&W, pers. comm.).

Recommendation three was adopted by the VIC, SA (new draft) and WA State Biosolids Guidelines and the National Biosolids Guidelines. This maximum soil concentration limit of 1.0 mg cadmium/kg had already been adopted in the NSW Biosolids Guidelines. It has not been adopted in TAS as they already have a more stringent value (0.7 mg cadmium/kg). An Operations Policy on Biosolids Re-use for QLD is being drafted and it is likely to adopt recommendation three from the workshop (Glenn Barry, QDRM&W, pers. comm.).

Recommendation four led to the establishment of the National Biosolids Research Program (NBRP) in late 2002. It is funded by a range of government and industry bodies. This program has projects in QLD, NSW, VIC, SA and WA. The aims of the NBRP are to:

- quantify and demonstrate the benefits of agricultural application of biosolids in a range of climates and soils around Australia;
- assesses the potential risks associated with metals (cadmium, copper and zinc) in the biosolids; and
- review guidelines for the use of biosolids in Australian agriculture.

The experimental component of the NBRP, which finishes in late 2006, will provide guidance and information that should permit new soil-specific guidelines for biosolids (particularly relating to the contaminants cadmium, copper and zinc) to be developed and thus provide a basis for the sustainable, Australia-wide use of biosolids in agriculture. Further information on the NBRP can be found at www.clw.csiro.au/publications/general2005/NBRP-biosolids_2005.pdf.

Recommendation five was actively followed up by NCMC as it was often asked to recommend laboratories that could proficiently determine cadmium concentrations in plants and soils. In 2000, there were no analytical proficiency programs for cadmium analysis of crops, soils or soil amendments (e.g. fertilisers, composts, etc.). Therefore, an Inter-laboratory Plant Proficiency Program (ILPPP) for cadmium analyses of plant samples was commissioned through the ASPAC. Due to privacy issues ASPAC could not publicise the outcomes of the program. Results indicated that the quality of commercial cadmium analyses was not good, and there was considerable scope for improvement in laboratory procedures. Improvement in analytical performance was pursued by the NCMC with ASPAC. The NCMC contacted all 31 laboratories that participated and asked if they had gained ASPAC proficiency for cadmium analysis in plants and if they had, would they agree to their contact details being placed on the NCMC website. The resulting list of cadmium proficient laboratories (2002) was provided on the NCMC web-site (www.cadmium-management.org.au). This was the first publicly available information on laboratories that were proficient in cadmium analysis. This encouraged the use of laboratories capable of analyzing cadmium accurately and enabled users to select appropriately skilled laboratories for conducting their analyses.

During 2004 ASPAC decided to change the structure of the ILPPP. In the new program laboratories can be declared proficient in analyzing cadmium in both soil and plant samples. The soil and plant programs each consist of three sets of samples to be analysed annually with four samples per set. The results of the ILPP will shortly be made available by ASPAC. As soon as this is done a hyperlink from the NCMC website to the appropriate section of the ASPAC website will be made. This will continue encouraging users to utilise quality laboratories.

Recommendation six - was not pursued by the NCMC principally because there was insufficient information available to address the issue of cadmium contamination in animal manures and other organic wastes. Due to this lack of data, either no guidelines are applied to these waste materials or the various state biosolids guidelines are used as the default. The issue of contaminant guidelines in such composts and other waste products produced by alternative waste technologies is currently being addressed by a project funded by the Waste Management Association of Australia. Results will be examined by NSW Department of Environment and Conservation with the view of defining guidelines for contaminants in composts for NSW only.

Objective 6 - *that the National Coordinator collect and analyse data and information on cadmium in fertilisers, soils and produce, and its impact on trade, and monitor the success of the National Cadmium Minimisation Strategy*

This objective was addressed through the generation of two items:

- a national cadmium database and geographic information system; and
- national and state cadmium budgets.

Details of each of these are provided on the following page.

National Cadmium Database and Geographic Information System

A national database for cadmium in agricultural produce was established and contains 40 567 vegetable, cereal, fruit, human breast milk and other foodstuffs (including shopping basket) values and 54 854 livestock values. In order to facilitate the use and interpretation of the data in the database it was merged with a geographic information system (GIS). The spatial analysis algorithms within the GIS permit maps of Australia or any part thereof, to be generated that indicate the range of concentrations of cadmium to be found in the selected agricultural products.

The data were obtained from a variety of regulatory and industry sources and there are issues of confidentiality associated with the database. For this reason it is not available to the public and the approval of the owners of the data must be sought before releasing any information. Due to these confidentiality issues the database has not received any publicity.

This database has been used to provide geographically based information on cadmium concentrations to Agriculture Victoria, the Farm Chemical Branch of Primary Industries and Resources SA (PIRSA), SAFEMEAT and the WA Department of Agriculture.

The database is held by the NCMC Coordinator (Dr Michael Warne). In order to use the database to generate maps, people experienced with Access databases and GIS software are required. It was agreed by the NCMC that Dr Warne and CSIRO would retain possession of the database and that he would deal with any inquiries. Use of the database would be on a cost recovery basis.

An Australian National Cadmium Budget

A national cadmium budget for Australia was developed by the NCMC. This quantifies the amounts of cadmium that enter, are transported and leave Australia by all the various sources and pathways. It will permit managers and regulators to identify those parts of the whole system that would make the most difference to cadmium levels in agricultural produce and the environment.

A draft manuscript on the cadmium budget has been written ('State and national balances for cadmium in Australian agricultural soils' by Lennox and McLaughlin) and has been reviewed by the NCMC, however further work is required. The manuscript was not submitted for publication before the NCMC was finalised. Dr McLaughlin has made a commitment to complete this manuscript and submit it to a scientific journal for publication.

Additional Outputs from the NCMC

A NCMC web-site

During 2002 work commenced to establish a web-site for the NCMS and the activities of the NCMC. The web-site is located at www.cadmium-management.org.au. During the term of the NCMC the web-site has been maintained by CSIRO Land and Water. The site has six sections:

1. Overview – which provides an overview of the NCMS and NCMC;
2. Key objectives of the NCMS;
3. Some background information about cadmium and why it is a potential concern to Australian agriculture;
4. Publications – this has three sub-sections (a) the seven best management practice brochures that have been developed by the NCMC for various agricultural industries, (b) some general articles that have arisen from the activities of the NCMC and (c) a compilation of 290 scientific articles relating to cadmium research in Australian agriculture;
5. News – contains important information relating to where reliable analyses for cadmium in soil and plants can be obtained;
6. Links to other web-sites that could be of interest and value to those concerned with cadmium in Australian agriculture; and
7. Contacts: the names and contact details of the current members of the NCMC.

The site is regularly visited by Australian and international users, with use increasing steadily every year. For example, the average monthly number of hits was 1048 in 2002 - 2003, 1552 in 2003 - 2004 and 2362 in 2004 – 2 005. Over the 3.5 years the web-site has been active (until the completion of the NCMC) it has received approximately 66 000 hits and 20 000 BMP brochures were downloaded (Figures 1 and 2).

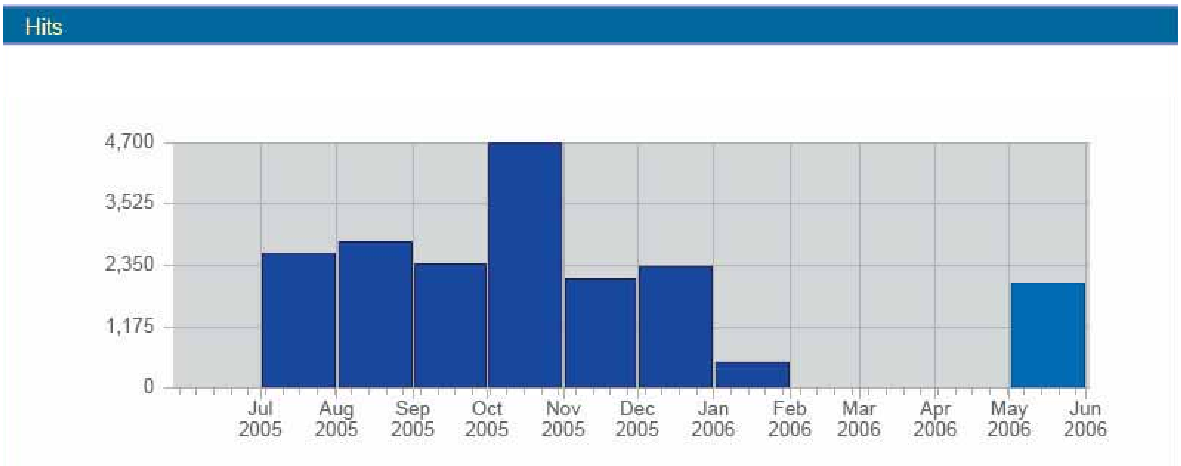
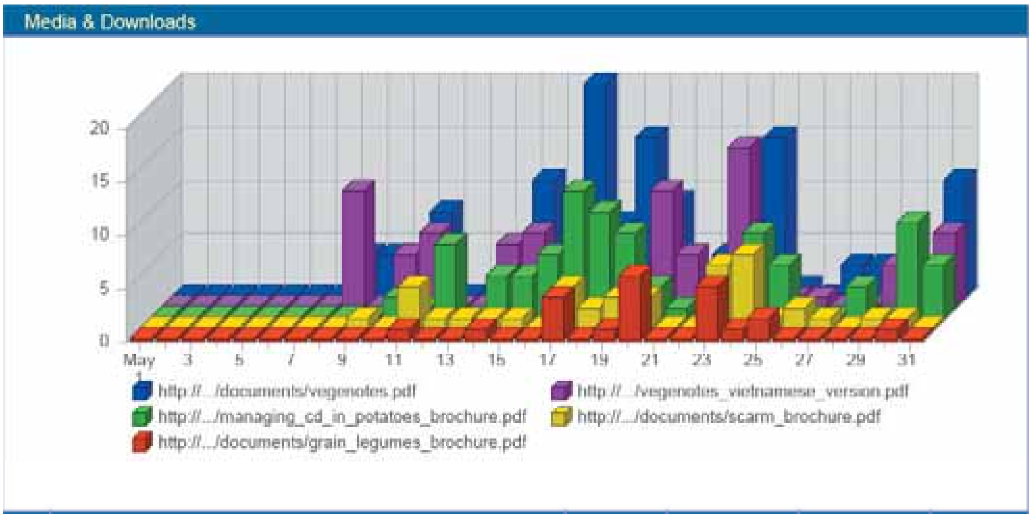


Figure 1 The monthly number of hits to the NCMC website for July 2005 until May 2006. Note that website use information was not available for February until April 2006.



#	File	Total Downloads	Average Downloads Historically	Change	Percent of Downloads
1.	http://.../documents/vegenotes.pdf	138	185.44	+138 ▲	34.24%
2.	http://.../vegenotes_vietnamese_version.pdf	99	62.56	+99 ▲	24.57%
3.	http://.../managing_cd_in_potatoes_brochure.pdf	88	75.44	+88 ▲	21.84%
4.	http://.../documents/scarm_brochure.pdf	40	35.00	+40 ▲	9.93%
5.	http://.../documents/grain_legumes_brochure.pdf	22	67.81	+22 ▲	5.46%
6.	...nts/cd-in-potatoes-managing-risk-brochure.pdf	16	27.13	+16 ▲	3.97%
		403	453		

Figure 2 The number of each Best Management Practice brochure that was downloaded in May 2006. The total downloads for May was 403, slightly down on the overall average of 453.

The breakdown of users by region is very stable over time. Typically 20% of the users are from Australia and New Zealand, 40% from North America, 15% each from Europe and Asia and 10% from Africa and South America combined (Table 1).

#		Continent	Total Visits	Average Visits Historically	Change	Percent of Visits
1.		North America	130	117.00	+15 ▲	43.77%
2.		Oceania	56	96.50	-46 ▼	18.86%
3.		Asia	54	50.50	+7 ▲	18.18%
4.		Europe	40	45.00	-10 ▼	13.47%
5.		Africa	16	14.50	+5 ▲	5.39%
6.		South America	1	3.00	-3 ▼	0.34%

Table 1. The percent of visits from different regions for November 2005. These values are remarkably consistent over time.

The NCMC resolved that the NCMC web-site should continue to be hosted by CSIRO for a period of five years. A nominal cost of approximately $250 per annum for the five year period has been transferred to CSIRO to host the website. In addition, a sum of $500 was allocated to permit updates of the web-site as appropriate.

Workshop entitled – "Effective management of cadmium: A case study"

A workshop was organised and hosted by the NCMC on 21 November, 2006. The purpose of the workshop was to review the success and outcomes of the NCMC and to discuss and document the lessons learned from the NCMC approach, to guide and inform the management of similar contaminant issues. It was attended by 29 representatives of state and federal government departments and the fertiliser and galvanising industries. Members of the NCMC gave presentations. As well Prof. Eric Smolders (Belgium) gave a key note presentation on the European Union Cadmium Risk Assessment process.

Key findings and recommendations from the workshop were:

1. That the NCMC had been highly successful, and was an excellent model for dealing with such inter-disciplinary issues;
2. That the NCMC had met all of its aims and as such there was no need for the committee to continue. However, it was deemed important that periodic reviews of the issue of cadmium in agriculture be conducted in order to ensure that should the issue arise again that it can be dealt with effectively;
3. That key outputs of the NCMC such as the best management brochures, the national database of cadmium residues in agricultural produce be maintained. It was suggested that the Fertilizer Working Group might be an appropriate repository for these in addition to CSIRO;
4. A committee of a similar structure to the NCMC could be of great value in addressing other contaminant issues. It was not clear to whom such a committee should report to – perhaps the Fertilizer Working Group; and
5. A number of different foci for such a new committee were recommended. These included contaminants in general or developing a list of contaminants of concern and working through these on a priority basis. Alternately several specific contaminants such a fluorine; lead; dioxins, furans and other highly persistent organic chemicals; and radiological issues including superphosphate and gypsum were recommended.

It was resolved that these recommendations would be pursued by members of the now defunct NCMC.

Media/communication articles/media response

A number of media and communication articles have been prepared and published:

a) Media release to coincide with the release of the BMP brochure "National Cadmium Strategy: Australian agriculture acts to reduce cadmium levels";
b) Weekend Australian;
c) Farming Ahead, February;
d) Environmental Health Perspectives;
e) Food Chemical News;
f) Potato Australia; and
g) ECOS magazine;

The NCMC has also been active in rapid responses to queries from journalists, non-governmental organisations and the public regarding issues related to cadmium in Australian agriculture. The composition of the committee, representing various discipline strengths (analytical chemistry, soil science, agronomy, crop science, toxicology, trade, etc.) has resulted in comprehensive responses to these queries being achieved, and the defusing of several expressions of concern based on poor information and unnecessarily heightened perceived risks by certain sections of the Australian community.

Presentations at industry and scientific conferences

Members of the NCMC have made the following presentations regarding cadmium, the NCMS and the activities of the NCMC:

- "Perspectives on cadmium inputs to the food chain" to SCOPE Environmental Cadmium meeting, Brussels, Belgium, September 2000;
- "Heavy Metal Contaminants in Foods – A Real Risk" to Tasmania Quality Assured Conference, Hobart, Tasmania, November 2000;
- "Impact of crop and soil management on accumulation of cadmium by peanut and soybean" To the 6th Australian Agronomics Conference, Hobart, Tasmania, January 2001;
- "Impact of soil contaminants on food safety. A real risk?" To the First New Zealand HACCP Conference, Auckland, New Zealand, 3-4 April 2001;
- "Australia's National Cadmium Minimisation Strategy" to the National Conference of the Fertilizer Industry Federation of Australia, Couran Cove, Queensland, May 2001;
- "From Soil to Produce – Pathways of Cadmium Uptake by Plants" to the QDPI Workshop on "'Management of cadmium in peanuts, soybeans and navybeans', Kingaroy, Queensland, October 2001;
- "Australia's National Cadmium Minimisation Strategy and the role of soil and plant analysis" to the Australasian Soil and Plant Analysis Council National Conference, Perth, Western Australia, November 25-27, 2001;
- "Cadmium – from plough to plate" and "Australia's National Cadmium Minimisation Strategy - from science to policy and advice to farmers" to the Food 21 Sustainable Food Production program and the Swedish Cadmium Network, Stockholm, May 2002;
- "Cadmium management in Australia and issues for the meat industry" to SAFEMEAT, September 2003;
- "Heavy metals – the full picture" to the National Conference of the Fertilizer Industry Federation of Australia, Couran Cove, Queensland, August 2004;
- "The National Cadmium Management Committee, The Contaminants in Fertilizers Project and the Implications for the Fertilizer Industry" to the Fertilizer Industry Federation of Australia AGM and member forum, Canberra, ACT, September 2005;
- "Cadmium Behaviour in the Soils of Greater Sydney". To the National Measurement Institute, Sydney, November 2005; and
- "The National Cadmium Management Committee (NCMC). What has been achieved? What are the lessons for the future?" to the Fertilizer Industry Federation of Australia AGM and member forum, Canberra, ACT, September 2006.

In addition to formal presentations to conferences, workshops and seminars the NCMS and the activities of the NCMC were discussed at numerous other fora including:

- A Workshop on land application of biosolids. Health risk and contaminants. Brisbane, August 2003;
- VicWater, General Meeting, November 2003. VicWater, General Meeting, November 2003;
- CSIRO Division of Land and Water Seminar, Adelaide, April 2003;
- A Workshop on land application of biosolids. Health risk and contaminants. Brisbane, August 2003;
- A radio interview with Radio 3BBR-FM, Gippsland - Lynn Wells;

- Biosolids Specialty Conference II (Brisbane) and III (Melbourne) in 2004 and 2006 respectively; and
- Multi-jurisdictional Working Party Reviewing the National Environment Protection Measure (Assessment of Site Contamination) March 2005.

Collaboration with Other Organisations

Codex Alimentarious Commission of the World Health Organisation

The NCMC assisted the Australia New Zealand Food Authority (and subsequently Food Standards Australia New Zealand) and Agriculture, Fisheries and Forestry Australia (AFFA) (and subsequently the Department of Agriculture, Forestry and Fisheries - DAFF) in preparation of submissions to the Codex Alimentarius Commission (CAC) of the World Health Organisation/Food and Agriculture Organisation regarding maximum levels (MLs) for cadmium in foodstuffs. This was done on a regular basis. A member of the NCMC, Dr Paul Brent, is an Australian representative to CAC and plays a crucial role linking the efforts of the NCMC to international moves to protect human health from cadmium. Examples of the input by the NCMC include:

- At the Codex Committee on Food Additives and Contaminants (CCFAC) meeting in Rotterdam (Netherlands) from 11 to 15 March 2002 maximum limits (MLs) were proposed for cadmium in a number of commodities, including liver and kidney of cattle, sheep, poultry and pig at levels that would in some cases, have been problematic for Australia. Dr Paul Brent (ANZFA and NCMC) was part of the Australian team that argued with the support of several other member countries, that Codex MLs should only be established for foods that represent a significant source of dietary exposure, and the levels should be reasonably achievable by member countries throughout the world, provided that such levels do not pose a risk to human health. As a result CCFAC decided to discontinue development of MLs for some foods, including liver and kidney, because these did not contribute significantly to dietary exposure to cadmium;

- The NCMC Coordinator liaised with the Food Business Group in AFFA to ensure appropriate materials on heavy metal contamination (especially cadmium) was included in a new guideline document "Guidelines for On-Farm Food Safety for Fresh Produce". The guideline document was released through Senator Judith Troeth's office and can be found at www.affa.gov.au/corporate_docs/publications/pdf/food/guidelines_9-01.pdf; and

- The NCMC Coordinator joined a Task Group set up by AFFA to respond to proposed CODEX cadmium limits in traded food commodities. Several letters were sent by the Task Group to CODEX detailing Australia's position on proposed MLs.

Fertilizer Working Group and the Industrial Residues Working Group

The Fertilizer Working Group (FWG) and the Industrial Residues Working Group (IRWG) were established and ultimately report to the Primary Industries Standing Committee and the Environment Protection and Heritage Standing Committee respectively. Several members of the NCMC also belong to the FWG (i.e. Dr Michael Warne, CSIRO; Dr Michael McLaughlin, CSIRO; and Mr Nick Drew, FIFA. Dr Trevor Gibson, NSW DPI was previously a member of both committees). These members have ensured that key issues that are relevant to both groups are shared. In addition, the minutes of the NCMC and FWG were sent to the members of the other group to ensure issues of joint concern are brought to both groups attention.

The FWG is currently undertaking a major project on contaminants in fertilisers in conjunction with the IRWG. The aims of the project are to create a list of chemicals that should not be present in fertilisers, those that can be present but below certain concentrations that are to be determined as part of the project and a list of chemicals for which there are no restrictions on their presence in fertilisers. A key contaminant of concern is cadmium.

The NCMC was requested to review and provide specific information on a Department of Environment and Heritage submission to the United Nations Environment Program on Cadmium in the Environment, in September 2005. The NCMC was a major contributor to the Australian submission. In turn, the Australian submission features prominently in the UNEP report.

Submissions were made to two draft guideline documents, providing information and recommending actions to minimise cadmium accumulation in soils:

1. Review of Australian Standard AS4454 (Composts, Soil Conditioners and Mulches); and
2. National Water Quality Management Strategy Draft Guidelines for Sewage Systems Biosolids Management, May 2002.

Reports

Six monthly progress reports were written and submitted to Horticulture Australia Limited for distribution to Potato Australia and the Grains Research and Development Corporation. Reports were also sent to the Primary Industries Standing Committee.

Appendix One - Membership of the NCMC

The membership of the National Cadmium Management Committee during its term.

Position	Member	Replacement 1	Replacement 2
National Coordinator	Dr Mike McLaughlin, CSIRO (Jul 00 - Oct 02)	Dr Daryl Stevens, CSIRO (Feb 03 - Oct 03)	Dr Michael Warne, CSIRO (Feb 04 - Jun 06)
Chairman	Dr Lindsay Cook, NSW Ag (Jul 00 - Jun 03)	Mr George Rayment, Qld DNR (Jun 03 - Jun 06)	
Secretary	Ms Lee-Ling Sim (Jul 00 - Sep 01)	Her responsibilities were absorbed by the National Coordinator	Ms Sandra Tyrrell CSIRO (Mar 04 - Jun 06)
SA Rep	Mr Chris Etherton, PIRSA (Jul 00 - Dec 00)	Dr Mike McLaughlin, CSIRO (Dec 00 - Jun 06)	
NFF Rep	Mr Jim Lush (Jul 00 - Sep 01)	Mr Wayne Cornish (Sep 01 - Jun 06)	
WA Rep	Dr Ian McPharlin, Agriculture WA (Jul 00 - Jun 06)		
HAL Rep	Dr Leigh Sparrow, HRDC / HAL (Jul 00 - Jul 05)		
FSANZ Rep	Dr Peter Abbott, (Jul 00 - Sep 01)	Dr Paul Brent, (Sep 01 - Jun 06)	
DAFF Rep	Mr Stanford Harrison, (Jul 00 - Dec 00)	Mr Paul Ryan, (Dec 00 - Sep 01)	
NSW Rep	Dr Lindsay Cook, Dep Ag NSW (Jun 03 - Aug 04)	Dr Trevor Gibson, Dep Ag NSW (Aug 04 - Jul 05)	Dr Paul Milham, NSW DPI (Jul 05 - Jun 06)
FIFA Rep	Mr Doug McGuffog (Jul 00 - Sep 01)	Mr Nick Drew (Sep 01 - Jun 06)	
QLD Rep	Mr George Rayment, Qld DNR (Jul 00 - Jun 06)		
VIC Rep	Dr Bruce Shelley, DNRE (Jul 00 - Jun 06)		

Appendix Two - Meetings of the NCMC

During the six year term of the NCMC a total of ten in-person meetings, five teleconference meetings and two workshops have been held. Dates and locations of these are set out below.

Meeting No	Meeting type	Location	Date
1	In-person	Sydney	23 June 2000
2	Teleconference	-	17 August 2000
3	In-person	Melbourne	21 November 2000
4	Teleconference	-	20 March 2001
5	In-person	Melbourne	15 June 2001
6	Teleconference	-	11 October 2001
7	In-person	Melbourne	15 February 2002
8	Workshop	Melbourne	16 February 2002
9	Teleconference	-	18 October 2002
10	In-person	Adelaide	25 February 2003
11	In-person	Melbourne	30 June 2003
12	Teleconference	-	16 September 2003
13	In-person	Adelaide	19 March 2004
14	In-person	Couran Cove, Qld	5 August 2004
15	In-person	Adelaide	9 June 2005
16	In-person	Adelaide	20 June 2006
17	Workshop	Canberra	21 November 2006

Appendix Three - Best Management Practice Brochures

A copy of each of the best management practice (BMP) brochures are presented in the following order:

- Cadmium in potatoes: Managing the risk from saline irrigation water.
- Managing cadmium in potatoes for premium quality produce
- National Cadmium Strategy: Australian agriculture acts to reduce cadmium levels
- Managing cadmium in summer grain legumes
- Vege Notes: Managing cadmium in vegetables
- Vege Notes: Managing cadmium in vegetables (Vietnamese translation) and
- Managing for cadmium minimisation in Australian livestock.

Cadmium in potatoes

..managing the risk from saline irrigation water

Consumer demand for quality produce is increasing.

Potato tubers exceeding the Maximum Permitted Concentration (MPC) for cadmium set by the Australia New Zealand Food Authority (ANZFA) cannot be used in the domestic market and cause problems in international trading.

Predicting the risk of producing potato crops above the MPC is an important part of managing cadmium in your cropping system.

This leaflet considers the relationship between cadmium concentration of potato tubers and quality of irrigation water.

HRDC

Australian Potato Industry Council

CRC Australia Soil & Land Management

A joint venture

CSIRO

The University of Adelaide

SARDI

Primary Industries and Resources SA

Agriculture Victoria

The problem

In 1997 ANZFA revised limits for cadmium (a toxic heavy metal) in potatoes and other vegetables. The MPC is 0.1 mg cadmium/kg fresh weight, for root, tuber and leafy vegetables. The marketing of these vegetables in Australia with cadmium concentrations above this MPC is not permitted.

Elevated levels of chloride in water increases the solubility of cadmium and other elements present in soil, which increases their uptake by plants. In Australia, salinity in surface and ground-water is due mainly to chloride.

Research has confirmed increases in potato tuber cadmium levels with increasing chloride concentrations in irrigation water. The risk is higher in soils already high in cadmium, usually the result of past heavy applications of phosphate fertiliser containing high levels of cadmium as an impurity.

Cultural practices can help to reduce the risk of high cadmium concentration occuring in potato tubers. See the brochure 'Managing cadmium in potatoes for quality produce.'

Research results

The probability of cadmium exceeding the MPC of 0.1 mg/kg has been estimated from measurements of salinity of irrigation water at 130 irrigated potato sites in five states. See Figure 1.

Figure 1 shows that the probability of cadmium concentrations in tubers reaching the MPC is low when using irrigation water with a conductivity less than 2.0 dS/m. The probability then rapidly increases to above 50% as the salinity of the irrigation water increases above 3.0 dS/m.

Growers are advised to use water with a conductivity of less than 2.0 dS/m.

Research also indicated that the probability of cadmium levels of tubers reaching the MPC was increased if the soil contained more than 15 µg/kg cadmium extracted in 0.01M calcium chloride. Soil cadmium levels are likely to be high in paddocks with a history of heavy applications of phosphate fertiliser containing high levels of cadmium as an impurity.

If possible, avoid growing potatoes on these soils.

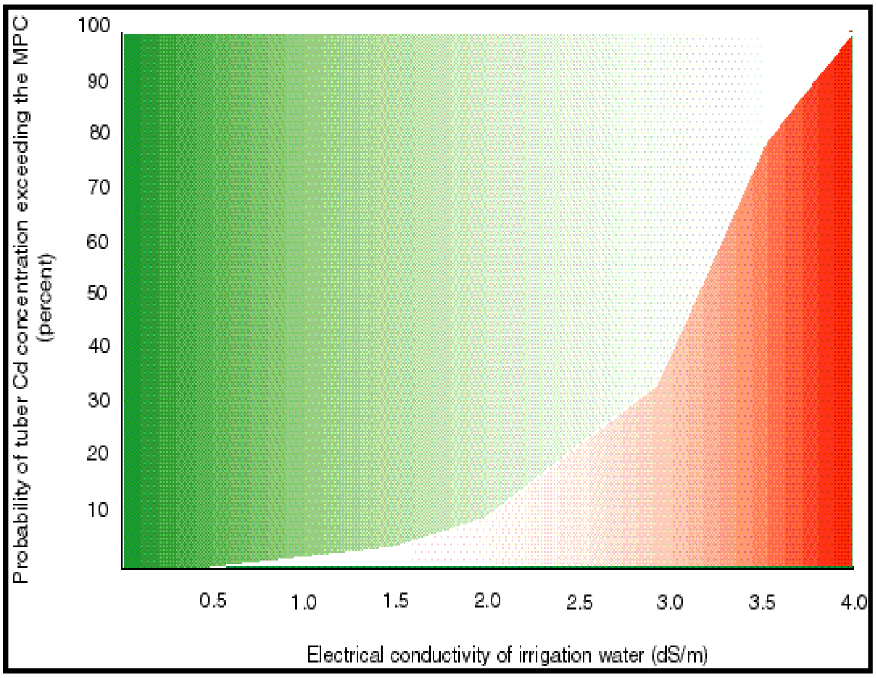


Figure 1. Probabilities of tuber cadmium levels at the MPC with varying levels of salinity of irrigation water

If irrigation water salinity is above 2.0 dS/m

- Chose an alternative irrigation water source with lower salinity.
- Select varieties with low or medium susceptibility to cadmium uptake including; Wilwash, Russet Burbank, Lemhi Russet, Ranger Russet, Winlock, Tarago, Pontiac, Atlantic, Desiree and Delaware.
- Use sulphate of potash rather than muriate of potash to supply potassium.
- Confirm possible problems in high risk situations with in-crop tuber testing. Test tubers early in the season as research has shown that, when water conductivity remains constant through the season, this gives a good indication of a potential problems.

Testing of irrigation water

Preplant

To minimise the risk of producing tubers with high levels of cadmium, measure the salinity of irrigation water. Where the water is high in salinity and there are no alternative sources, potatoes should not be grown.

Post planting

Water quality can change markedly during the irrigation season, with salinity often increasing late in the season. Monitoring the salinity level of irrigation water periodically during the season should be undertaken to determine the risk of higher levels of cadmium being taken up by tubers during part of the growing season.

Testing

Water samples can be sent to a laboratory, but cheap hand-held conductivity meters are now available to test your own samples in the field (see conductivity meters).

Sampling the irrigation water

- If ground water or dam water is used, ensure that the irrigation pump is run for sufficient time to obtain a sample representative of the water in the aquifer or dam.
- Using a clean plastic or glass 500 ml container, rinse it with the water to be tested prior to taking the sample.
- Fill the container with a sample of 500 ml of irrigation water.

Testing the irrigation water with a field meter

- Calibrate the small hand-held conductivity meter according to the manufacturers instructions. Wash the electrodes with rainwater or distilled water before and after each measurement.
- Measure the electrical conductivity (EC) of the water, in deciSiemens per metre (dS/m).
  Note: 1 dS/m=100 mS/m

Conductivity meters

If you cannot access a field meter, consider purchasing one for approximately $100.

Meters are electronic and require calibration. They need to be operated and stored with care (eg not in extremes of temperature).

Seek the advice of a reputable supplier of scientific equipment who will advise which meter best suits your requirements.

Figure 2. Measuring electrical conductivity with a hand-held meter.

Suppliers of conductivity meters include;

Crown Scientific Pty Ltd

NSW :	Toll Free: 008 449 115	Tel: 02 9602 7677
Vic :	Toll Free: 008 134 175	Tel: 03 9764 4722
Qld :	Toll Free: 008 773 442	Tel: 07 3252 1066
SA :	Tel: 08 8347 3310	
WA:	Tel: 08 9352 7000	
Tas :	Tel: 03 6229 7437	

Selby Biolab

Tel: 13 2991
Free Fax: 1800 067 639
Melbourne, Sydney, Brisbane, Perth, Adelaide, Darwin, Hobart, Newcastle, Townsville.

The Cooperative Research Centre for Soil and Land Management does not warrant or recommend any particular manufacturer supplier or model of meter.

Tuber sampling

- For each soil type, potato variety or management unit, take a representative sample of at least 25 small tubers about 50-70 days after planting.
- Sample the crop in at least five locations in the field, digging up about 2 metres of row in each location.
- Take at least 5 tubers (any size) from each of the five locations and bulk the tubers together. Ensure no damaged or diseased tubers are included in the sample.
- Brush off soil and store the tubers in a clean paper bag in a cool place. Send the sample to a laboratory within 3 days for analysis of cadmium concentration. Your state contact can provide details of a reputable laboratory.

Sampling of plant tops to estimate cadmium concentrations in tubers is not recommended, as levels vary with different stages of crop growth.

Figure 3. Sampling tubers for testing.

Acknowledgments

This brochure is based on research supervised by Dr Mike McLaughlin, Cooperative Research Centre for Soil & Land Management (CRCSLM) Adelaide, in collaboration with Norbert Maier from the South Australian Research and Development Institute, and representatives from state agencies in Western Australia, Tasmania, New South Wales and Victoria.

The brochure has been prepared by John Bourne and Mark Seeliger, CRCSLM, design and layout by Mary-Anne Fiebig, CRCSLM.Helpful comment was given by Leigh Walters, Manager, Australian Potato Industry, Technology Transfer Project.

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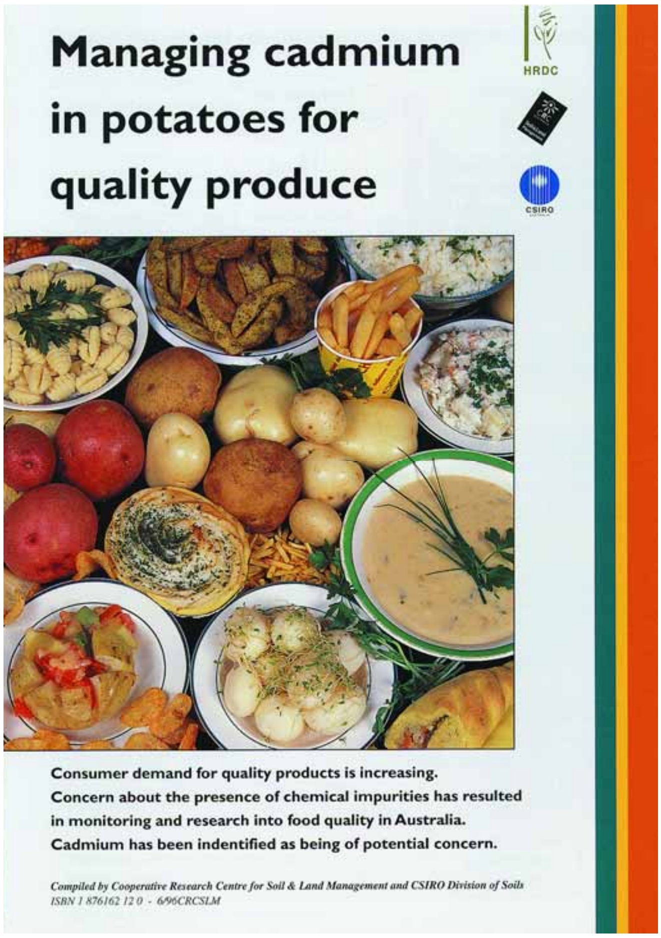
Further information:

Managing cadmium in potatoes for quality produce. CRC for Soil & Land Management, Adelaide. CRCSLM/6/96, available from your state contact.



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Email: crcslm@adl.soils.csiro.au
WWW: http://www-crcslm.waite.adelaide.edu.au

Managing cadmium in potatoes for quality produce: 2nd edition

Consumer demand for quality products is increasing. Concern about the presence of chemical impurities has resulted in monitoring and research into food quality in Australia. Cadmium has been identified as being of potential concern.

Compiled by Cooperative Research Centre for Soil & Land Management and CSIRO Land and Water
ISBN 1 876162 12 0 - 6 /96CRCSLM - 2nd Edition 6/99

What is cadmium?

Cadmium is a widespread naturally occurring element, present in soils, rocks, waters, plants and animals. It occurs naturally with deposits of lead and zinc, but unlike zinc is not essential to life. Cadmium can accumulate in humans, and high levels can affect human health.

Why is cadmium a problem?

- There is a smaller safety margin in foods, between levels of cadmium and regulatory health limits, compared to other heavy metals such as lead and mercury.
- Cadmium is concentrated in particular parts of plants. Leaves contain the most, followed by storage roots and tubers, seeds or grain and fleshy fruits.
- Human intake of cadmium is through food consumption, smoking and occupational exposure.

Sources of cadmium

- Natural levels in soil range from less than 0.1 mg/kg to 0.5 mg/kg, or about 0.1 to 0.7 kg cadmium/hectare in the top 10 centimetres of soil.
- Rain and irrigation water generally have very low cadmium concentrations. Sewage sludges may contain cadmium as an impurity.
- Cadmium in the atmosphere may be high in the vicinity of industrial activities such as smelting, but in most agricultural regions the amounts added to the soil from the atmosphere are minimal.
- Phosphatic fertilisers can contain high levels of cadmium depending upon the source of rock phosphate. Trace element fertilisers and phosphogypsum also may contain high levels. Nitrogen and potassium fertilisers normally have a very low cadmium content.

The Fertiliser Industry Federation of Australia (FIFA) has agreed to progressively reduce the levels of cadmium in phosphate fertilisers by making greater use of rock phosphate with low cadmium content.

FIFA member companies are replacing the current voluntary limit of 250 mg cadmium per kg of phosphorus, for horticultural fertilisers, with a commitment to introduce an appropriate range of differentiated fertilisers with cadmium levels designed to meet defined needs. These products may vary in cadmium content but will generally be below 150 mg cadmium per kg of phosphorus. Horticultural fertilisers are generally applied at higher rates than fertilisers for pastures or other crops.

Greater use of rock phosphate from the United States, Africa and the Middle East has reduced cadmium inputs to soils.

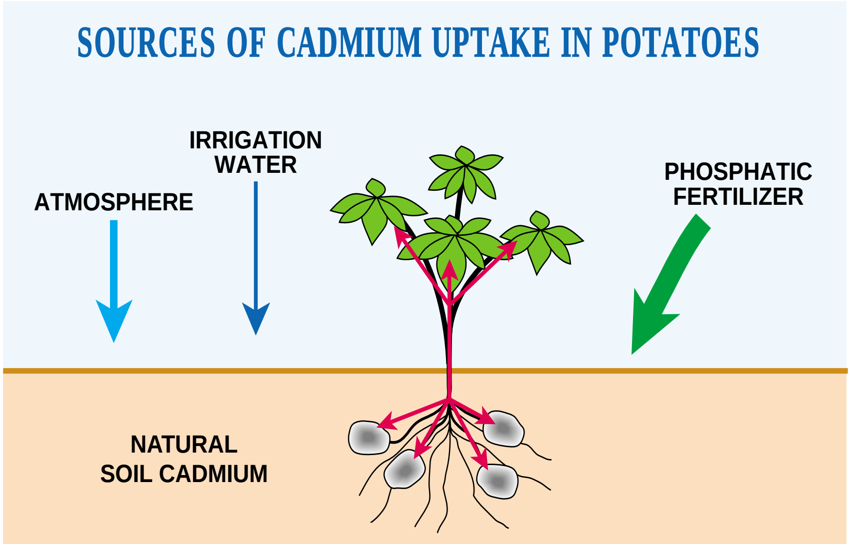
Cadmium levels in Australian food and exports

- Dietary intake of cadmium in Australia is low by world standards and our food exports have a “clean” reputation worldwide. To maintain this quality advantage we need to minimise any potential cadmium accumulation in food products.

How is cadmium taken up by plants ?

- Plants absorb most of their cadmium from soil through their roots.
- Cadmium in soil readily attaches to clay particles and organic matter, making it less available for uptake by plants. Sandy soils with low clay content and organic matter are likely to result in a higher uptake.
- The availability of cadmium to plants decreases as soil pH increases, or as soils become more alkaline.
- Zinc and cadmium uptake by plants occurs in a similar way, and it appears that if soil zinc levels are low then more cadmium will be taken up.
- Cadmium in soil tends to remain in the surface layers where it is available to plants. It can be removed by erosion or by leaching from very light sandy acid soils.

A regular testing program of the harvested crop is recommended.



- Higher concentrations of chloride in the soil appear to mobilise cadmium and increase uptake by plants. This could occur from irrigation with saline water, in areas subject to dryland salinisation, or from the intensive use of chloride based fertilisers.
- Uptake varies considerably between different plant species and between varieties or cultivars.
- Cadmium present in farm produce can also be as a result of soil or dust contamination either in the field or during processing, as well as by direct uptake from the soil.

How do you know you have a cadmium problem ?

In most cases you can not tell visually if a plant has high cadmium. A regular plant testing program is recommended for growers. Tuber samples of the harvested crop should be forwarded to accredited laboratories as cadmium analysis is a specialised service.

The Australia New Zealand Food Authority currently has set a limit for potatoes in the domestic market of 0.1 mg/kg cadmium on a fresh weight basis.

Research has indicated that the probability of cadmium levels of tubers reaching the MPC was increased if the soil contained more than 15mg/kg cadmium extracted in 0.01M calcium chloride. Soil cadmium levels are likely to be high in paddocks with a history of heavy applications of phosphate fertiliser containing high levels of cadmium as an impurity. If possible avoid growing potatoes on these soils.

There are no critical levels for cadmium in agricultural soils.

Management practices to minimise cadmium levels

Varietal selection

Data collected from CSIRO and state department trials have suggested the following variety ratings for susceptibility to cadmium uptake.

High

Toolangi Delight, Kennebec, Crystal, Nadine

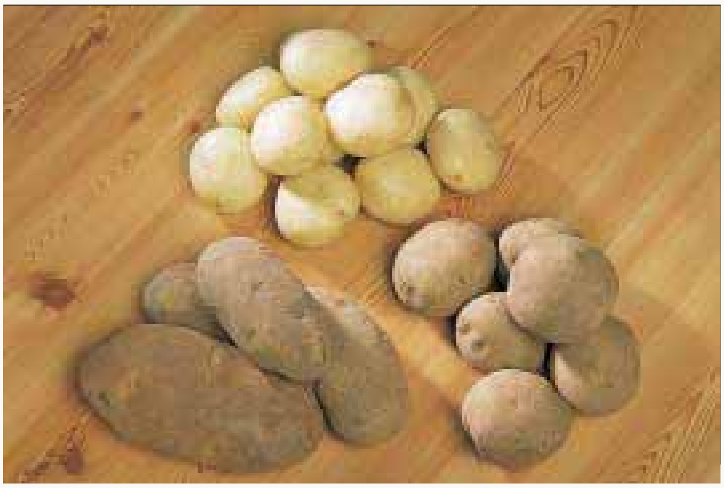
Medium

Wilcrisp, Sebago, Nooksack, Winlock, Tarago, Pontiac, Atlantic, Desiree, Delaware

Low

Wilwash, Russet Burbank, Lemhi Russet

Low or medium rated varieties are recommended where the likelihood of cadmium uptake is high.



Select varieties with low or medium susceptibility to cadmium uptake

Correction of soil pH.

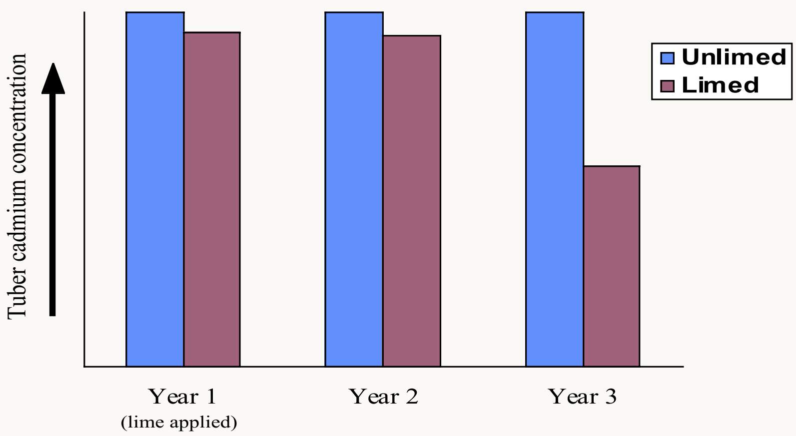
In highly acid soils (pH in water of less than 5.5, or pH in calcium chloride less than 4.8) a liming program should be initiated to increase soil pH. Aim to maintain soil pH (water) between 6.2 and 6.7, or pH (calcium chloride) between 5.5 and 6.0. Avoid overliming which can induce problems of micro-nutrient deficiency and the disease common scab.

A liming program is needed in highly acid soils

Field studies have shown that lime has had little or no effect on tuber cadmium concentrations in the year of application. However, reductions have occurred 2-3 years later.

Potatoes are tolerant of low pH values and so yield increases by liming are unlikely, but responses in crops and pasture during other phases of the rotation are possible.

Field experiments with gypsum were ineffective in reducing tuber cadmium levels and resulted in some small increases. Gypsum has little or no effect on soil pH, ie it is not a liming agent, but is used to reduce the effects of high sodicity in soil, such as hard setting surface crusts or waterlogging. Naturally occurring (mined) gypsum should be considered in place of phosphogypsum for the treatment of sodic soils to be used for potato production, particularly if cadmium uptake is already high. Phosphogypsum is a by-product from the manufacture of phosphatic fertilisers.



An example of tuber cadmium levels in response to liming an acid sandy loam soil

Management practices to minimise cadmium levels

Use of phosphatic fertilisers with low cadmium content

It is recommended that low cadmium fertilisers are used. The impact of this on reducing tuber cadmium levels at sites with a long phosphate fertiliser history is only likely to occur over the medium to long term.

Your supplier will be able to advise you on the cadmium content of fertilisers. Look for products of less than 150 mg cadmium per kg of phosphorus. Such products are commercially available. Where repeated high applications of phosphorus (that is greater than 100 kg per crop) are anticipated, fertilisers of less than 100 mg cadmium per kg of phosphorus are desirable.

Where a paddock has adequate soil phosphorus levels for potatoes (for critical levels consult your local agronomist) phosphorus rates can be reduced as yield response will be limited, and further cadmium will be added through the fertiliser application.

Maintain or increase soil organic matter

There is good evidence that organic matter helps to reduce cadmium availability to plants.

Soil organic matter is generally built up by:

- the retention of crop residues after harvest
- use of green manure crops
- pasture phases in crop rotations
- significantly reducing the number of crop cultivations

The build-up or breakdown of soil organic matter is a slow process and significant changes only occur in the medium to long term, unless organic matter is introduced from external sources such as manures.

Avoid use of irrigation water with high chloride levels

Field experiments have shown that increased chloride content in the topsoil will increase tuber cadmium levels.

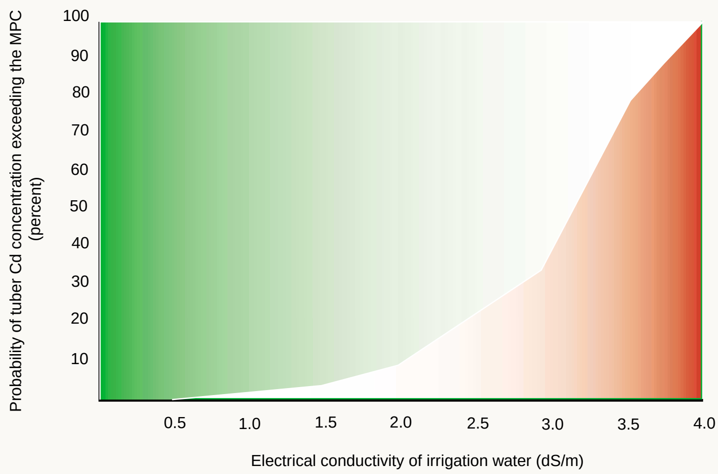
A major source of chloride is likely to be saline irrigation water. Experiments have confirmed increases in tuber cadmium levels with increasing chloride in irrigation water. This effect is less in a highly alkaline soil, that is pH (water) is greater than 8.0 or pH (calcium chloride) is greater than 7.3.

High soil chloride may also occur in areas subject to increasing dryland salinisation, due to rising groundwater levels.

The figure below shows that the probability of cadmium concentrations in tubers reaching the MPC is low when using irrigation water with a conductivity less than 2.0 dS/m. The probability then rapidly increases to above 50% as the salinity of the irrigation water increases above 3.0 dS/m.

Note: 1 dS/m = 100 mS/m = 1 mS/cm

Growers are advised to use water with a conductivity of less then 2.0 dS/m.



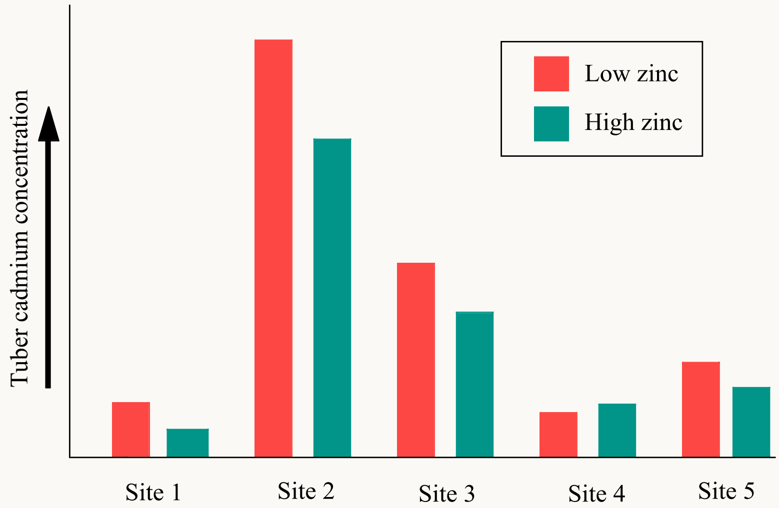
Probabilities of tuber cadmium levels at the MPC with varying levels of salinity of irrigation water

Testing of irrigation water for salinity is recommended - see brochure 'Cadmium in potatoes - managing the risk from saline irrigation water' CRCSLM/CTT01/99 available from your state contact.

Management practices to minimise cadmium levels

Selection of nitrogen and potassium fertilisers to minimise cadmium uptake

Glasshouse and field experiments have shown that changing nitrogen fertiliser has little impact on tuber cadmium concentrations. Changing from potassium chloride to potassium sulphate has decreased tuber cadmium by up to 30% in areas where chloride in soil and irrigation water is low. However potassium sulphate costs more.



Effect of zinc on tuber cadmium

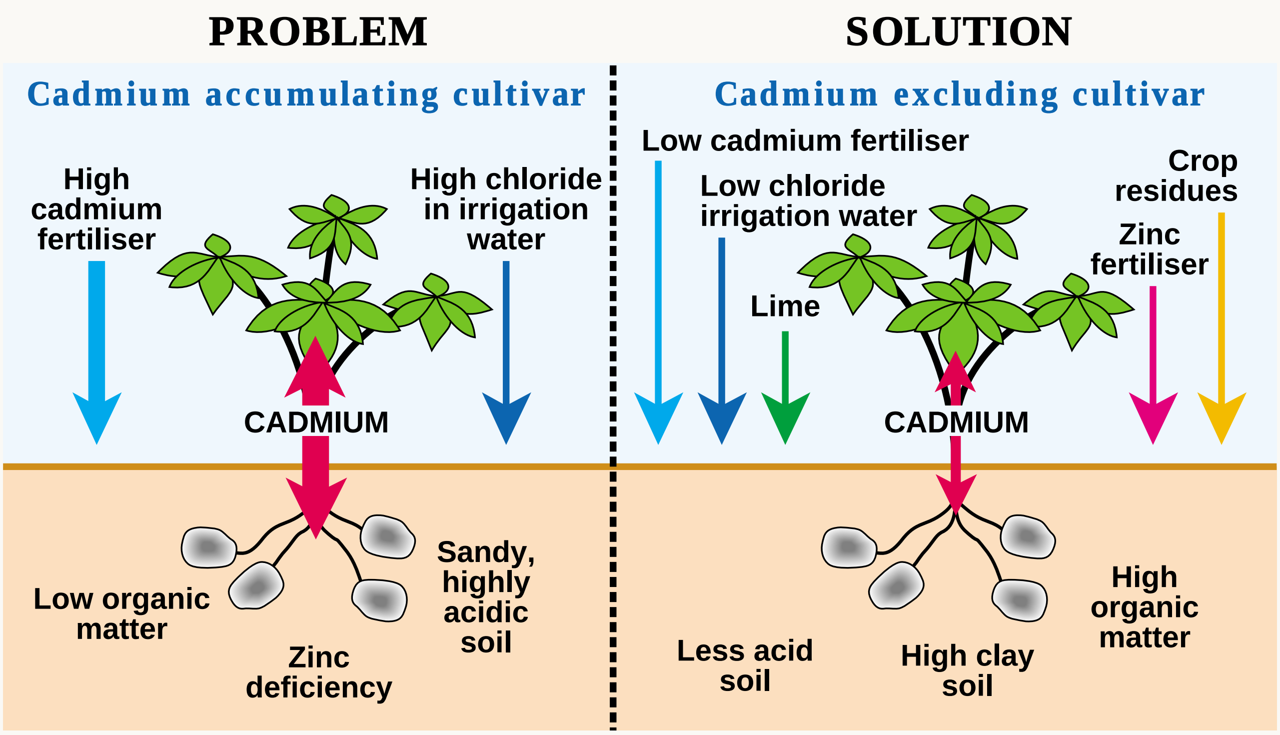
Addition of zinc

Banding 50-100 kg zinc/ha as zinc sulphate at planting has significantly reduced tuber cadmium concentrations at some trial sites. These rates are more than is usually applied to treat zinc deficiency in potatoes.

Zinc broadcast and incorporated into the soil is suggested as a trial where the concentration of EDTA zinc in the soil is less than 6 mg/kg. Rates of 30-100 kg zinc sulphate/ha could be used (consult your agronomist).

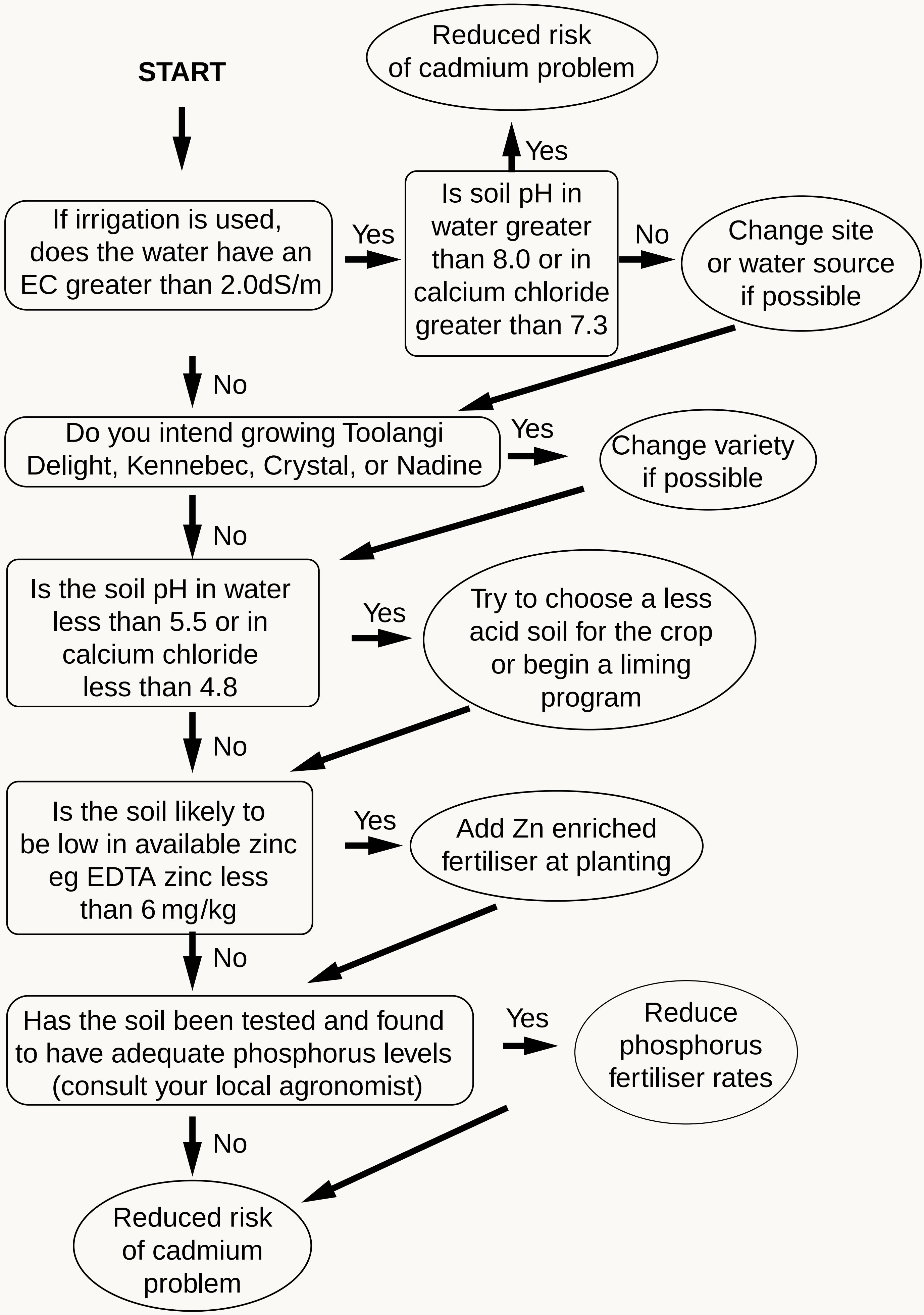
Zinc deficiency has not been widely observed in Australia, so it is unlikely that the zinc will increase potato yields. Any effect of zinc on tuber cadmium should last several years.

Cadmium content of the zinc fertiliser should be checked before using, as the cadmium content of trace element products is normally higher than standard NPK fertilisers.



Managing cadmium effectively means implementing a range of practices as a total system. In paddocks where tuber cadmium concentrations are already high, the impact may be small in the short term, but sound management will be essential to assist control of long term cadmium levels.

Grower checks if tuber cadmium levels are high



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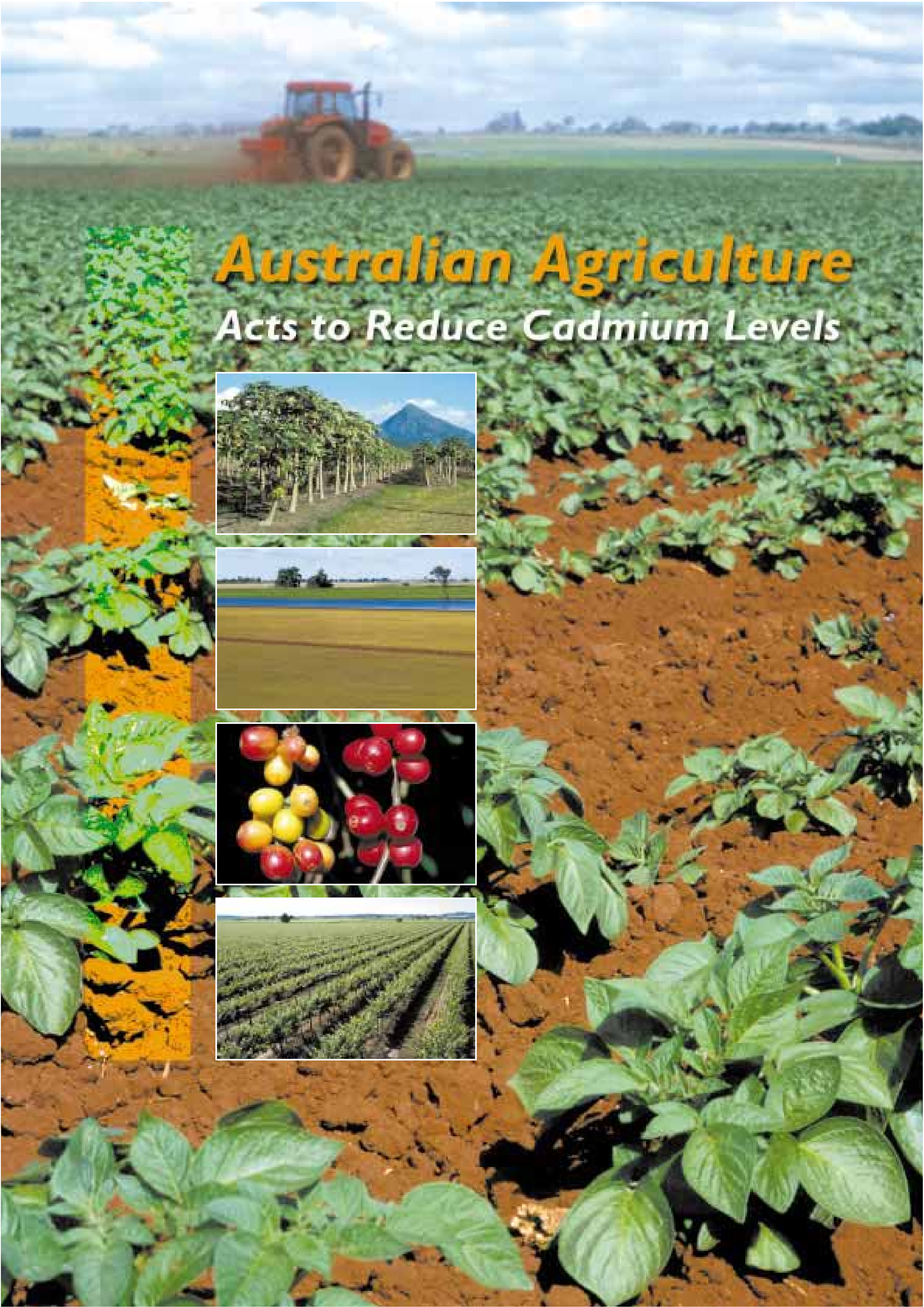
Australian Agriculture

Acts to Reduce Cadmium Levels



Australian Agriculture

Acts to Reduce Cadmium Levels

Australia has adopted a strategy to maintain safe levels of cadmium in its agricultural soils and produce: an important move in ensuring safe food for Australians and a competitive edge for our agricultural exports.

The National Cadmium Minimisation Strategy recently commissioned by the Standing Committee on Agriculture and Resource Management (SCARM) will provide a consistent and coordinated program to address issues related to the control of cadmium in soils and crops. A Coordinator will manage implementation of the strategy and monitor its success.

Why is Cadmium found in Australian soils and plants?

Cadmium is a naturally occurring element. Although cadmium is present at low concentrations in all soils, its accumulation in soil and hence through the food chain may lead to a health risk in humans.

In Australia, natural levels of cadmium in the soil are low by world standards. The average intake of cadmium in the Australian diet is also well within safe limits set by health authorities.

Phosphate fertiliser has been a major source of cadmium additions to agricultural soil in Australia. The Australian fertiliser industry has made significant reductions in the cadmium contents in fertilisers over the last 10 years. It now uses rock phosphate with lower cadmium concentrations for local manufacture. Imported

phosphatic and trace element fertilisers low in cadmium have also been targeted.

In recent years, the practice of adding sewage biosolids and green wastes to soils in Australia through recycling has also contributed to cadmium levels. Together with the effects of long-term fertiliser use, this has the potential to increase the level of cadmium in Australian food above the maximum concentrations acceptable to health authorities, with consequent implications for human health and international trade.

Despite the inherently low levels of cadmium in Australian soils, plant and animal products from Australian agriculture contain cadmium concentrations similar to other countries. This is due to the chemical processes involved in the uptake of cadmium by plants and the management practices applied to soils, crops and livestock in Australia.

Many soil and management factors influence the extent to which agricultural crops take up cadmium. These include crop type and variety, soil acidity and salinity, irrigation water quality, fertiliser history and management. For crops such as potatoes, guidelines are available to farmers to assist in minimising cadmium uptake. Avoiding soils and waters with high salinity is one example.

What has been done to manage Cadmium in soils?

Cadmium concentrations in fertilisers are regulated in all states in Australia, and steps are underway to harmonise these standards and to lower maximum permitted concentrations in fertilisers.

Most states have guidelines for use of sewage biosolids on soil, but regulatory levels vary around Australia. National guidelines for biosolids management are being developed as part of the National Water Quality Management Strategy.

The Australia New Zealand Food Authority regulates cadmium concentrations in foods. Cadmium concentrations in crops are monitored by various government surveys as well as through industry quality assurance programs.

What potential human health problems are related to Cadmium?

Cadmium can cause health problems in humans after long-term exposure. It accumulates in the body, principally in the kidneys, leading to gradual renal dysfunction if exposure is high over a long period. While cadmium can induce effects on organs other than the kidneys, the effects generally occur at doses higher than those associated with renal effects. Population-based studies in Japan and Belgium have shown a clear relationship between indicators of renal dysfunction and environmental and occupational exposure to cadmium.

While it is anticipated that the Australian population is unlikely to experience cadmium-related health problems, the potential for any increased health risk should be addressed. Cadmium is recognised internationally as a potential health risk and guidelines for a 'tolerable' level of intake have been established by the World Health Organization.

Non-tariff trade barriers

Cadmium is likely to become an increasing factor in international trade negotiations as countries establish standards to control cadmium residues in food. If a country's standards are low compared to the international norm, they may be perceived as a non-tariff trade barrier. Many countries now have strict regulations to limit human intake of cadmium in the diet, and are applying them to food imports.

The National Cadmium Minimisation Strategy

The issue of cadmium in agricultural soils and produce in Australia has been of concern to the former Standing Committee on Agriculture and its successor, SCARM, for some time.

A Cadmium in Agriculture Task Force was established by SCARM in 1997 to consider the situation and report back on any further action required. All State Governments, the Commonwealth, CSIRO, the National Farmers' Federation and the Fertilizer Industry Federation of Australia were represented on the Task Force. The result is a National Cadmium Minimisation Strategy.

The key elements of the Strategy are:

- development of Best Management Practices for the production and processing of agricultural produce for those industries and/or areas which have an existing or potential problem with cadmium levels in their produce
- development of a Code of Practice by the fertiliser industry to target low cadmium fertiliser to those areas/industries which have an existing or potential cadmium problem
- continued commitment by all states to reduce the regulated maximum level of cadmium (Cd) in phosphatic fertilisers to a practical minimum
- all states to consider the labeling of fertilisers and soil ameliorants, to alert growers to their cadmium content.

The Strategy is coordinated by a National Cadmium Coordinator whose role will include the collection and analysis of data and information on cadmium in fertilisers, soils and produce; its impact on trade, and to monitor the implementation and success of the strategy.

The National Coordinator operates under the direction of a National Cadmium Management Committee comprising representatives of all States, the Commonwealth, CSIRO, the National Farmers' Federation and the Fertilizer Industry Federation of Australia. The Committee will report regularly to SCARM on the success of the strategy.

Dr Mike McLaughlin from CSIRO Land and Water has been appointed National Coordinator to oversee the Strategy: a position funded for five years by the Fertilizer Industry Federation of Australia, the Horticultural Research and Development Corporation and the Grains Research and Development Corporation.

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Managing Cadmium in Vegetables

Consumer demand for quality products is increasing.

Concern about the presence of chemical impurities has resulted in monitoring and research into food quality in Australia.

Cadmium has been identified as a potential concern.

This publication is an initiative of the National Cadmium Minimisation Committee

www.cadmium-management.org.au

The bottom line

- Cadmium is a potential problem for horticultural growers
- Crops should be monitored for cadmium
- Cadmium can be managed by reducing inputs or by using sound agronomic practices

July 2003

The Australian Vegetable Industry is the largest section of the horticulture industry and is vital to the national economy. In 1999-2000 it produced more than three million tonnes of product, which had a gross value of $1.8 billion.

To protect this industry Australia's National Cadmium Minimisation Committee (NCMC) was established in 2000 to oversee a strategy to minimise cadmium concentrations and inputs into agricultural soils and crops.

What is cadmium?

Cadmium is a widespread, naturally occurring, element that is present in soils, rocks, waters, plants and animals. The chemical symbol for cadmium is Cd. It occurs naturally with deposits of zinc and phosphorus but, unlike these nutrients, it is not considered essential for life.

Cadmium can accumulate in humans and high levels can affect human health, through bone disease and kidney damage. Therefore, it is crucial to limit our long-term exposure.

Why is cadmium a problem?

Increased daily intake of cadmium can lead to health problems.

Human intake of cadmium is through food consumption, smoking and occupational (workplace) exposure.

Cadmium is concentrated in particular parts of plants. As a general rule, leaves contain the most, followed by storage roots and tubers, seeds or grain and fleshy fruits.

Surveys have shown that the levels of cadmium in some foods have occassionaly approached regulatory health limits.

Sources of cadmium

- Natural levels in Australian soils range from less than 0.1 to 0.5 milligrams per kilogram, or about 0.1 to 0.7 kg cadmium per hectare in the top 10 centimetres of soil.
- Rain and irrigation water generally have very low cadmium concentrations.
- Some sewage sludges (biosolids) may contain a significant amount of cadmium as an impurity. However, phosphorus, nitrogen, copper and zinc concentrations are generally the rate limiting factors in the application of biosolids to soils for beneficial use.

Greater use of rocl phosphate from the united states, Africa and the Middle East has reduced cadmium inputs to soil.

Consequently, there are comprehensive state guidelines governing the application of biosolids to soil. Contact your state Environmental Protection Agency for more details.

- Other organic wastes and manures may also contain cadmium.
- Cadmium in the atmosphere may be high in the vicinity of industrial activities such as smelting. In most agricultural regions the amounts added to the soil from the atmosphere are minimal.

- Phosphorus containing fertilisers can contain high levels of cadmium depending upon the source of rock phosphate used in manufacturing.
- Trace element fertilisers and phosphogypsum may also contain high cadmium levels. Consequently, these fertilisers can be a major source of cadmium in horticultural soils. The maximum permitted concentration of cadmium, in trace element fertilisers, ranges from 50 - 80 mg per kg and in phosphogypsum it ranges from 10 - 80 mg per kg (check with your local fertiliser representative for state standards).

  Normally, nitrogen and potassium fertilisers have very low cadmium contents.

A regular testing program of the harvested crop is recommended.

Currently all states are aiming for a Maximum Permitted Concentration (MPC) of cadmium in phosphatic fertilisers of 300 mg cadmium per kg phosphorus .

The concentrated phosphatic fertilisers currently used in Australia, i.e. DAP, MAP and TSP are generally low in cadmium (less than 100 mg cadmium per kg phosphorus). It is recommended that fertilisers used have cadmium concentrations as low as possible.

Pasture grades of single superphosphate are generally higher in cadmium, typically containing less than 250 mg cadmium per kg phosphorus. Premium grades developed for horticulture contain less than 100 mg cadmium per kg phosphorus and are available in some states.

The Fertiliser Industry Federation of Australia Inc. (FIFA) initiated a program in the early 1990s to progresssively reduce the levels of cadmium in phosphatic fertilisers. They achieved this by using low cadmium phosphate rock in the manufacturing of superphosphate and importing low cadmium, high phosphorus analysis fertilisers.

FIFA member companies are replacing the voluntary limit, of 300 or 350 mg cadmium per kg of phosphorus for horticultural fertilisers, with products generally containing less than 100 mg cadmium per kg of phosphorus.

High phosphorus users, like horticulturists, could apply as much as 35 grams of cadmium per hectare annually, if they are using fertilisers with a high cadmium concentration. This is equivalent to approximately 0.01 to 0.03 mg per kg soil.

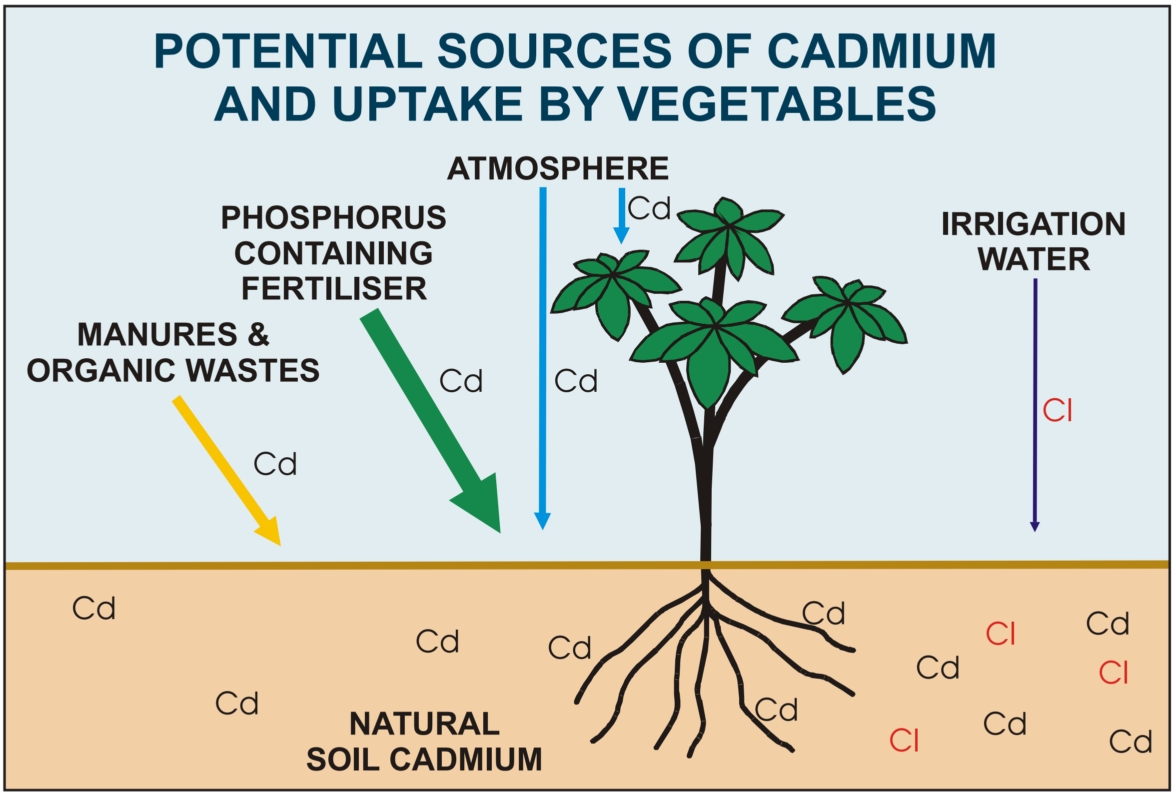
Cadmium levels in Australian food and exports

- Dietary intake of cadmium in Australia is low in comparison to world standards and our food exports have a “clean” reputation worldwide. To maintain this quality advantage we need to minimise any potential cadmium accumulation in food products.
- Food Standards Australia New Zealand (FSANZ) sets the maximum levels of cadmium in various food products by considering public health, food safety and consistency between domestic and international food standards.

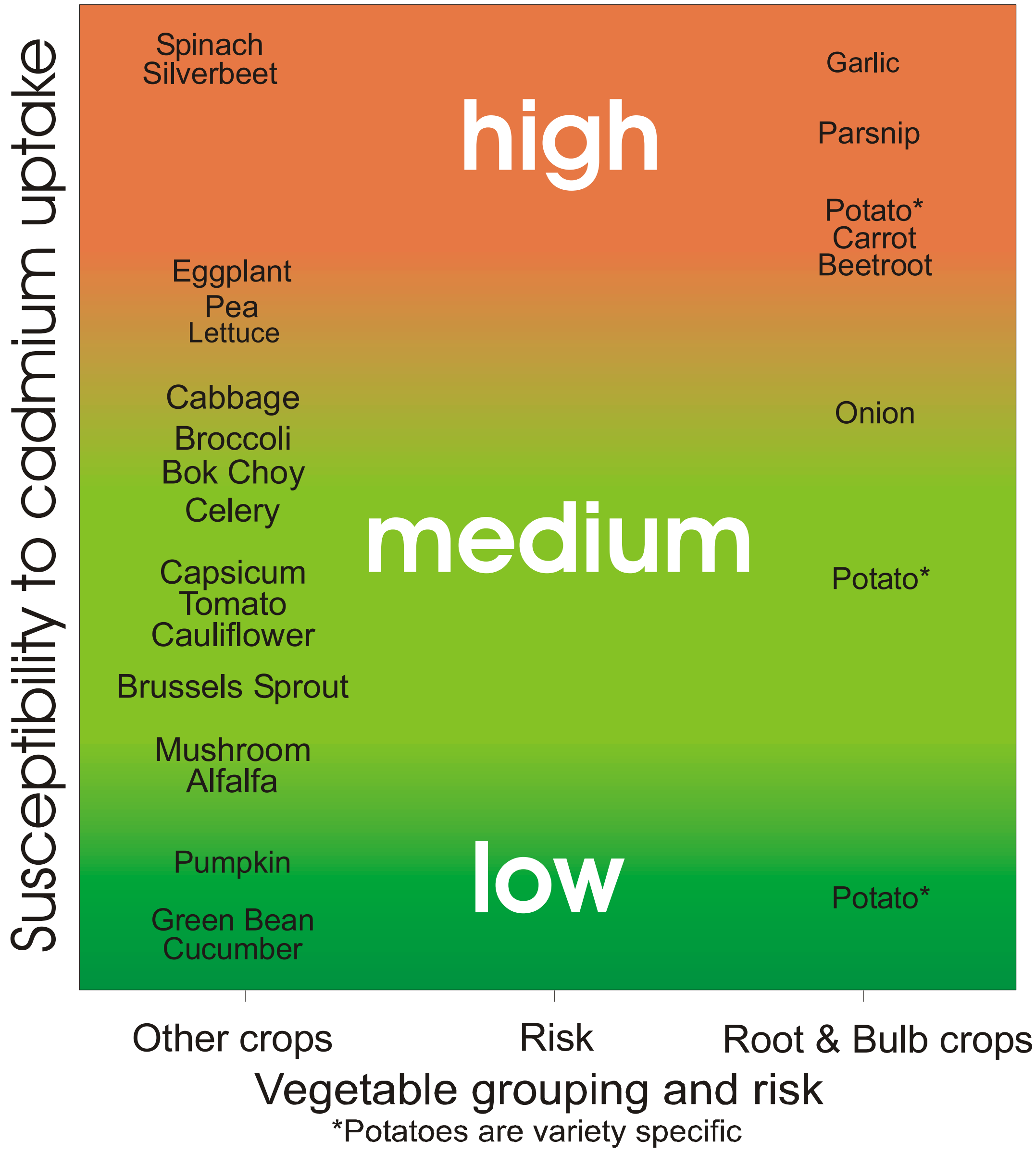
  The Maximum Level (ML) of cadmium for leafy (including leafy Brassicas), root and tuber vegetables, as set by FSANZ (www.foodstandards.gov.au), is currently 0.1 mg per kg, on an ‘as consumed’ basis. However, the ML is a good guide for all vegetables to manage cadmium.
- If State, Territory and New Zealand Health Departments enforce the standards contained in the Food Standards Code. Where an ML for cadmium is exceeded in vegetables, they would take action to alert the supplier and have the product removed from the market.
- Australia has several residue survey programs which include cadmium. Some of these programs have detected a very small number of samples exceeding the ML.

How plants take up cadmium

- Plants absorb most of their cadmium from soil through their roots.
- Cadmium in soil readily attaches to clay particles and organic matter, making it less available for uptake by plants. Sandy soils, with low clay content, and organic matter are likely to result in a higher uptake of cadmium.
- The availability of cadmium to plants decreases as soil pH increases - as soils become more alkaline.
- Zinc and cadmium uptake by plants occurs in a similar way and research suggests that if soil zinc levels are low then more cadmium will be taken up.
- Cadmium in soil tends to remain in the cultivated layers, where it is potentially available to plants. It can be removed from soils by erosion, or from very light sandy acid soils, by leaching.
- Higher concentrations of chloride in the soil appear to mobilise cadmium and increase uptake by plants. Soil chloride can be high after irrigation with saline water, (eg. in areas subject to dryland salinisation) or after the intensive use of chloride based fertilisers (eg. potasium chloride or muriate of potash).



Generally, vegetables are very low in cadmium. If your vegetables are high in cadmium, other plant species can be grown that take up less cadmium. The chart below will assist in the selection of crops that will minimise the risk of cadmium uptake.



- Uptake varies considerably between different plant species and between varieties or cultivars. Refer to the diagram above.
- Cadmium present in farm produce can also be as a result of soil or dust contamination, either in the field or during processing.

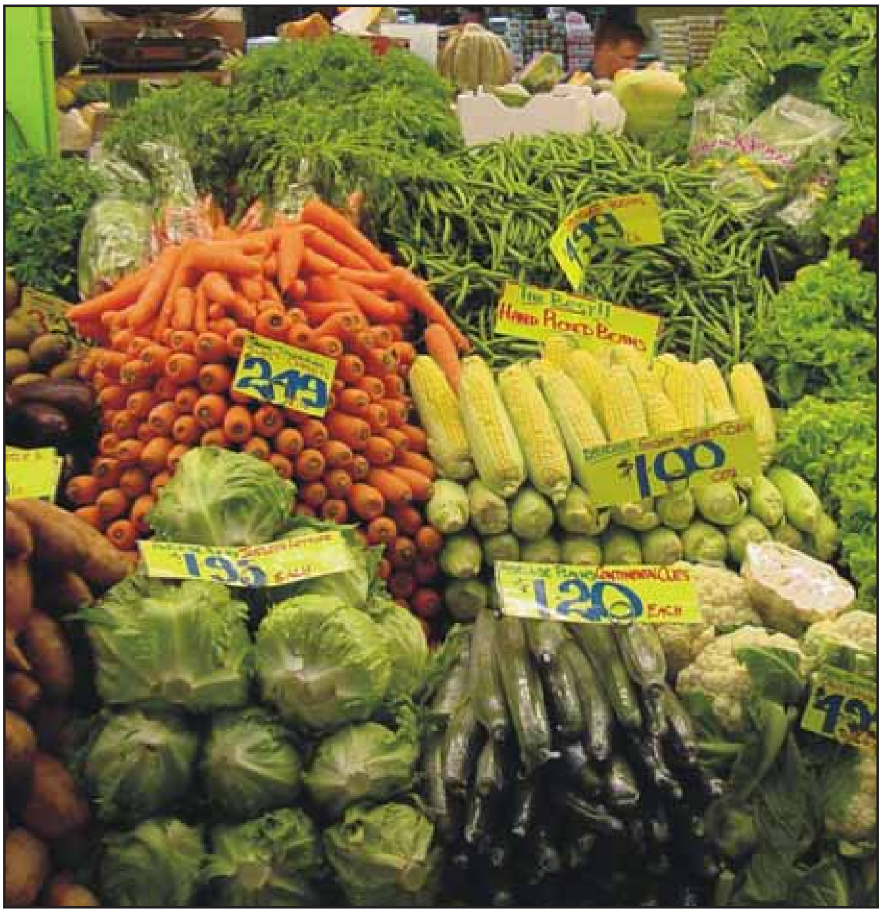
How to recognise a cadmium problem

Visual symptoms can be evident when plants are grown in grossly contaminated soils in industrial or urban areas. However, you cannot tell visually if a plant has high cadmium when grown in normal agricultural soils - the concentration needs to be measured. This is because the level of cadmium in plant tissues that may affect human health could be well below the level that may damage the plant.

A regular plant analysis program is recommended for growers. Edible samples of the harvested crop should be forwarded to accredited laboratories, as cadmium analysis is a specialised service. You can find accredited laboratories listed on the National Cadmium Minimisation Strategy website: **www.cadmium-management.org.au**

Conventional soil tests are also of value in soil and crop management. Soil tests for pH, organic carbon, salinity, phosphorus and zinc provide valuable information in managing cadmium accumulation by plants (consult with your local agricultural adviser).

Irrigation water should be checked for its salinity as chloride stimulates plant uptake of cadmium (see table page 7). Plant tissue tests for cadmium are best performed on the marketable or edible portion of the produce and are reported on a fresh weight basis.



Managing cadmium in produce

There are three approaches to reducing the cadmium content of produce:

1. **Reducing the input of cadmium into soil.**
2. **Using agronomic practices that minimise plant uptake of cadmium.**
3. **Monitoring cadmium concentrations in produce to assess the impact of cadmium minimisation strategies.**

Reducing inputs

- As discussed previously, superphosphate fertilisers can be a major contributor of cadmium inputs in horticultural soils. Growers need to be aware of cadmium impurities in specific fertilisers and should use fertilisers low in cadmium.
- Ensure you have a soil test performed and only add phosphorus to soil when the test indicates a deficiency, increasing the likelihood of a crop response.
- Organic wastes (e.g. biosolids) and manures may also contain cadmium. If these are used, check that cadmium concentrations are below acceptable limits.

Agronomic practices

- Reduce chloride additions to soils through the use of irrigation water and fertilisers with low chloride concentrations. Elevated soil chloride concentrations increase the plant availability of soil cadmium. See table, page 7.
- If high chloride concentrations are present in irrigation water, it is recommended that cadmium concentration in the edible portions (e.g. tubers for potatoes, leaves for leafy vegetables, etc) be tested more frequently.

- Choose low risk crops or varieties (if known). Certain crops are more susceptible to cadmium uptake and selection of crops and varieties (if known) which minimise cadmium accumulation in the edible portion can be used if unacceptable cadmium levels in produce are detected (See risk graph, page 5).
- Soil pH affects the uptake of cadmium by crops. Soil pH of less than 5.5 (measured in water) or 4.8 (measured in calcium chloride) should be amended upwards to pH levels of between 6.2 - 6.7 (measured in water) and 5.5 - 6.0 (measured in calcium chloride), through the addition of lime.

  As a **guide**, lime rates of high quality agricultural lime needed to raise soil pH by one unit in the top 15 cm of soil are:

Sand	1.5 - 3 tonnes of lime/ha
Loam	3 - 4.5 tonnes of lime/ha
Clay	4.5 - 6 tonnes of lime/ha

A liming program is needed in highly acidic soils.

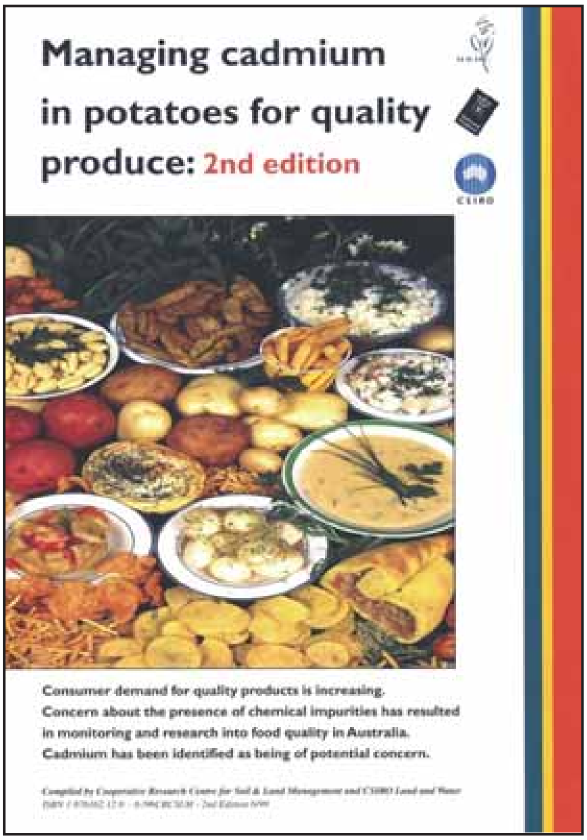
Interaction between chloride in irrigation water and cadmium in soil

Irrigation water chloride concentration (mg/L)	Risk of increasing crop cadmium concentrations
0-350	Low
350-750	Medium
>750	High

For best results, use finely ground, high quality lime and incorporate it into the soil.

- Maintain or increase soil organic matter, which is thought to reduce the availablity of cadmium in plants, therefore reducing plant uptake of cadmium. If you do this by importing compost or other off-farm organic material, use only high quality (low cadmium) sources.
- Addition of zinc at nutritional rates to overcome zinc deficiency, at planting, has been found to reduce cadmium levels in crops in some field trials.
- Cadmium is generally more available to plants grown in sandy soils than in soils with high clay content. Therefore, the risk of high cadmium levels in produce is greater for sandy soils in comparison with clay soils.

Further information can be found in the 'Managing



cadmium in potatoes for quality produce; 2nd edition' at:

www.cadmium-management.org.au/publications.html

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Horticulture Australia

Managing Cadmium in Vegetables

Nhu cầu người tiêu dùng cần sản phẩm chất lượng cao ngày càng tăng.

Lo lắng về sự hiện diện của hoá chất độc đã dẫn đến việc theo dõi và nghiên cứu chất lượng thực phẩm ở Úc.

Cadmium đã được đánh giá là chất có tiềm năng đáng lo ngại.

This publication is an initiative of the National Cadmium Minimisation Committee

www.cadmium-management.org.au

Những điểm nhấn mạnh

- **Cadmium là một vấn đề tiềm năng đối với nông gia trồng vườn.**
- **Cây trồng cần được theo dõi về hàm lượng cadmium.**
- **Cadmium có thể điều chỉnh bằng cách giảm lượng bón vào đất hoặc bằng biện pháp nông học hữu hiệu.**

Spring 2003

Trồng rau là lĩnh vực lớn nhất trong ngành trồng vườn của Úc và có vai trò quan trọng trong nền kinh tế quốc dân. Trong năm 1999-2000, ngành đã sản xuất được 3 triệu tấn sản phẩm với tổng giá trị là 1.8 tỷ Úc kim.

Để bảo vệ ngành, Uỷ ban quốc gia về việc giảm thiểu lượng Cadmium (Australia's National Cadmium Minimisation Committee (NCMC) đã được thành lập trong năm 2000 để xem xét một kế hoạch giảm thiểu hàm lượng và sự nhiễm cadmium vào đất nông nghiệp và cây trồng.

Cadmium là gì?

Cadmium là một nguyên tố phổ biến trong thiên nhiên: trong đất, đá, nước, thực vật và động vât. Công thức hoá học của cadmium là Cd. Nó có mặt trong thiên nhiên cùng với các hợp chất tự nhiên của kẽm và photpho, nhưng không giống các dưỡng chất này, cadmium được cho là chất không cần thiết cho sự sống.

Cadmium có thể tích tụ trong cơ thể người, và nếu đạt tới nồng độ cao, nó có thể ảnh hưởng đến sức khoẻ như gây bệnh về xương, làm tổn hại thận. Cho nên, hạn chế việc tiếp xúc lâu dài với cadmium là điều cực kỳ quan trọng.

Cadmium gây ra vấn đề gì?

Lượng cadmium đi vào cơ thể hàng ngày tăng cao có thể làm tổn hại sức khoẻ.

Cadmium đi vào cơ thể qua việc ăn uống, hút thuốc lá và qua tiếp xúc trong khi làm việc.

Cadmium tích tụ trong các phần đặc biệt của thực vật. Theo nguyên tắc chung, lá chứa nhiều cadmium nhất, sau đó là các loại củ, hạt và các loại trái cây nhiều phần mềm (thịt)

Các nghiên cứu cho thấy rằng lượng cadmium trong một số thức ăn đôi khi lên tới giới hạn được cơ quan quản lý sức khoẻ cho phép.

Tăng sử dụng đá phosphat nhập từ Mỹ, Nam phi và Trung đông đã làm giảm lượng cadmium bón vào đất.

Nguồn cadmium

- Hàm lượng cadmium tự nhiên có trong đất của Úc từ dưới 0.1 đến 0.5 mg /kg, hay khoảng 0.1 đến 0.7 kg/ha trong lớp đất dầy 10cm trên cùng
- Nước tưới và nước mưa nói chung có hàm lượng cadmium thấp.
- Một số loại bùn cống thải (biosolids) có thể chứa một lượng cadmium đáng kể do bị nhiễm bẩn. Tuy nhiên, nói chung, để đánh giá lợi ích sử dụng của các loại bùn này khi dùng bón cho đất người ta chỉ tính mức giới hạn của các nhân tố phốt pho, nitơ, đồng và kẽm.

  Vì vậy, người ta đã đưa ra nguyên tắc chung cho toàn tiểu bang để chỉ đạo việc bón phân bùn cho đất. Xin liên hệ với Cơ quan Bảo vệ Môi trường tiểu bang để biết thêm chi tiết.
- Một số chất thải hữu cơ và phân gia xúc cũng có thể chứa cadmium.
- Lượng cadmium trong không khí ở các vùng sản xuất công nghiệp cũng có thể đạt mức cao, như xung quanh lò luyện kim. Trong đa số các vùng nông nghiệp, lượng cadmium từ không khí nhiễm vào đất là rất nhỏ.

Một chương trình bón vôi là cần thiết cho đất có độ axit cao (đất chua nhiều - ND).

- Các loại phân bón có chứa phốt pho (lân) có thể chứa nhiều cadmium, điếu này phụ thuộc vào nguồn đá phốt phát được sử dụng trong sản xuất phân.
- Các loại phân vi lượng và lân thạch cao (phosphogypsum) cũng chứa nhiều cadmium. Do vậy, các loại phân này là nguồn cadmium chính trong đất nông nghiệp. Nồng độ cho phép tối đa của cadmium trong phân vi lượng giao động từ 50-80mg/kg và trong lân thạch cao là từ 10 đến 80 mg/kg (xin quí vị hỏi chuyên viên phân bón ở địa phương để biết tiêu chuẩn của tiểu bang).

  Thông thường, phân đạm (nitơ) và phân kali (potassium) chứa ít cadmium.

Hiện nay tất cả các tiểu bang đang nhắm tới việc qui định Nồng độ Cho phép Tối đa (Maximum Permitted Concentration - MPC) của cadmium trong các loại phân lân (phosphatic) là 300mg/kg.

Các loại phân lân đậm đặc đang được sử dụng ở Úc, như DAP,MAP và TSP nói chung có chứa ít cadmium (dưới mức 100 mg/kg). Người ta đề nghị nên sử dụng các loại phân lân có lượng cadmium càng ít càng tốt.

Nói chung, loại super lân dùng bón cho đồng cỏ có lượng cadmium cao hơn, thường là dưới 250 mg cadmium/ kg lân.

Loại phân lân cao cấp dùng cho ngành trồng vườn chứa ít hơn 100 mg cadmium/kg và sẵn có ở một số tiểu bang.

Hiệp hội sản xuất phân bón của Úc (Fertiliser Industry Federation of Australia Inc.- FIFA) đã đưa ra một chương trình vào đầu thập niên 90' nhằm giảm bớt nhanh chóng lượng cadmium trong phân lân. Họ đã đạt được việc này bằng cách sử dụng đá photphat có hàm lượng cadmium thấp để sản xuất phân super lân và nhập khẩu các loại phân lân có hàm lượng phốtpho cao và hàm lượng cadmium thấp.

Các công ty thành viên của hiệp hội này đã tự nguyện thay các loại phân lân dùng trong nghề vườn mà có hàm lượng cadmium cao ở mức 300 hoặc 350 mg /kg phân lân bằng các loại phân có chứa dưới 100 mg Cd/kg phân lân.

Những người dùng nhiều phân lân, như người trồng vườn, có thể bón một lượng cadmium nhiều đến 35 gam trên một hecta một năm nếu họ dùng các loại phân lân có hàm lượng cadmium cao. Lượng này tương đương với khoảng 0.01 đến 0.03 mg Cd /kg đất.

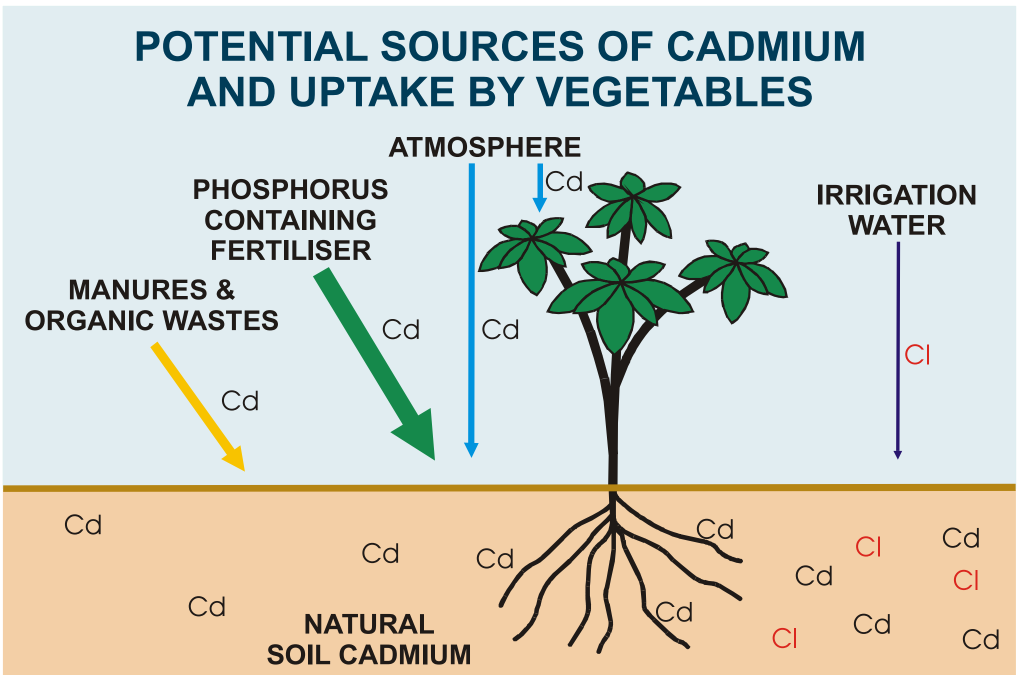
Lượng cadmium trong thực phẩm trong nước và xuấu khẩu của Úc.

- Lượng Cd trong khẩu phần ăn ở Úc thấp hơn so với tiêu chuẩn thế giới và thực phẩm xuất khẩu của chúng ta nổi tiếng là "sạch" trên thế giới. Để giữ được ưu thế chất lượng này, chúng ta cần giảm thiểu khả năng tích luỹ cadmium trong thực phẩm.
- Cơ quan Tiêu chuẩn Thực phẩm Úc và New Zealand (Food Standards Australia New Zealand -FSANZ) qui định mức Cd tối đa trong các loại thực phẩm dựa trên việc xem xét sức khoẻ cộng đồng, việc an toàn thực phẩm và sự nhất quán giữa tiêu chuẩn thực phẩm nội địa và quốc tế.

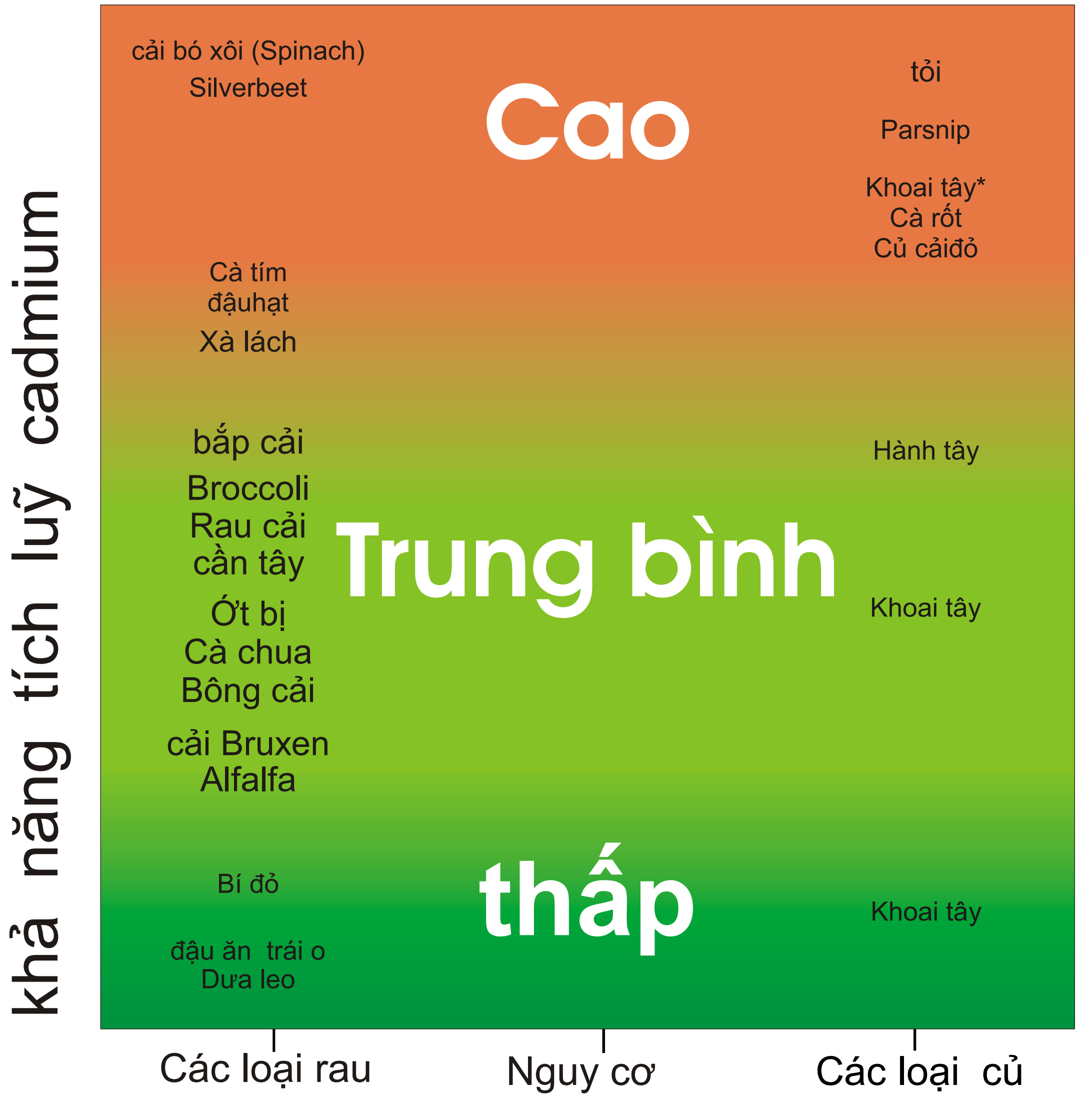
  Lượng Tối đa (Maximum level - ML) của cadmium trong rau ăn lá (kể cả các loại rau cải), rau lấy củ, như đã được FSANZ (WWW.foodstandards.gov.au) qui định hiện nay là 0.1mg/kg nông sản ở dạng " để dùng". Tuy nhiên, ML là chỉ số tốt để điều chỉnh lượng cadmium trong tất cả các loại rau.
- Nếu lượng cadmium trong rau vượt quá múc cho phép, Sở Sức khoẻ của các tiểu bang, khu vực lãnh thổ và New Zealand có quyền thi hành Qui định về Tiêu chuẩn Thực phẩm. Các sở sẽ thông báo cảnh cáo người cung cấp và buộc họ phải thu hồi sản phẩm trên thị trường.
- Úc có một số chương trình kiểm tra lượng tồn dư hoá chất trong đó có cadmium. Một số chương trình đã phát hiện một số lượng nhỏ của mẫu thực phẩm có lượng cadmium vượt quá MứcTối đa.

Cây hút cadmium như thế nào?

- Cây hấp thụ phần lớn cadmium từ đất qua rễ.
- Trong đất, cadmium dễ dàng liên kết với các hạt đất sét và vật chất hữu cơ. Việc này làm cho cây khó hút được cadmium hơn. Đất cát có thành phần sét và vật chất hữu cơ ít hơn, và kết qủa là cây hút nhiều cadmium hơn.
- Khi độ pH của đất tăng thì lượng cadmium tự do cho cây hút sẽ giảm đi - do đât trở lên kiềm hơn
- Cây hút cadmium và kẽm theo cách giống nhau và các nghiên cứu cho rằng nếu lượng kẽm trong đất thấp thì cây sẽ hút nhiều cadmium hơn.
- Cadmium thường nằm trong tầng đất canh tác, nơi mà cây dễ hút. Cadmium có thể rửa khỏi đất do bị xói mòn, hoặc bị rửa trôi từ đất cát rất nhẹ và chua.
- Nồng độ clorua cao trong đất có thể làm cho cadmium năng động hơn và cây hút dễ dàng hơn. Hàm lượng clorua trong đất có thể cao sau khi đất được tưới bằng nước mặn (ví dụ như ở các vùng bị mặn do hạn) hoặc sau khi sử dụng nhiều các loại phân bón có chứa clorua (ví dụ như phân clorua kali hoặc muriat bồ tạt).



Nói chung, rau củ chứa rất ít cadmium. Nếu rau của quí vị chứa nhiều cadmium, có thể trồng loại rau tích luỹ ít Cadmium hơn. Sơ đồ dưới đây giúp quí vị chọn lựa loại rau Có khả năng giảm thiểu nguy cơ tích luỹ nhiều cadmium.



PHÂN NHÓM RAU VÀ NGUY CƠ TÍCH LUỸ CADMIUM

*** Khoai tây có các giống riêng biệt**

- Khả năng hấp thu cadmium của các loại cây, các giống và các loại cây trồng là khác nhau. Xin tham khảo sơ đồ trên đây.
- Cadmium có trong nông sản còn có thể là do bụi và đất bị nhiễm độc, cả trên đất vườn cũng như trong quá trình chế biến.

Làm sao có thể nhận biết được vấn đề về cadmium?

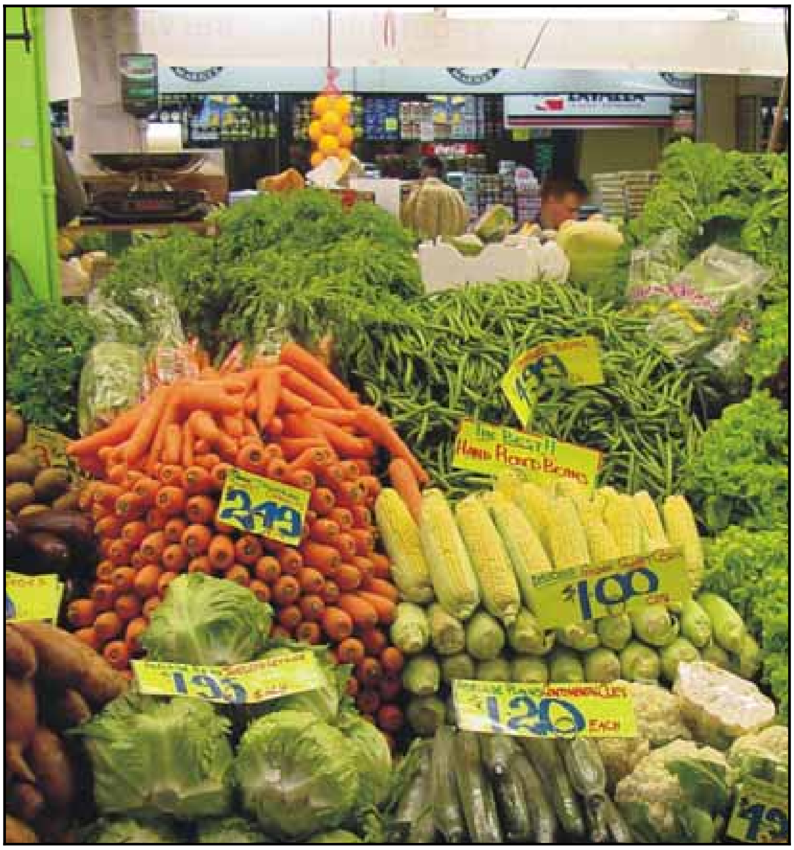
Các triệu chứng nhìn thấy thể hiện rõ khi cây được trồng trên đất bị nhiễm độc nặng trong các vùng công nghiệp hay vùng đô thị. Tuy nhiên, người ta không thể nhìn thấy các chứng cớ nếu cây có hàm lượng cadmium cao khi cây được trồng ở đất nông nghiệp bình thường - Người ta cần phải đo hàm lượng cadmium. Đó là do lượng cadmium trong cây có thể ảnh hưởng tới sức khoẻ con người nhưng còn xa mới tới mức gây hại cho cây.

Các nông gia nên có một chương trình phân tích cây trồng thường xuyên. Những mẫu nông sản của các vụ thu hoạch nên được gửi tới các phòng thí nghiệm được công nhận, vì phân tích lượng cadmium là một nghiệp vụ chuyên môn. Quí vị có thể tìm thấy các phòng thí nghiệm được công nhận trong danh mục trên trang web của chương trình Chiến lược Quốc gia về giảm lượng cadmium (National Cadmium Minimisation Strategy website):

www.cadmium-management.org.au

Các xét nghiệm đất thông thường cũng có giá trị trong quản lý đất và cây trồng. Các xét nghiệm kiểm tra độ pH, lượng cácbon hữu cơ, độ mặn, lân và kẽm cung cấp các thông tin có giá trị trong việc tìm cách giảm bớt lượng cadmium tích tụ trong cây trồng. (hãy tham khảo ý kiến chuyên viên nông nghiệp địa phương).

Nước tưới cần được kiểm tra độ mặn vì clorua kích thích cây trồng hấp thụ cadmium (xem bảng 7). Các xét nghiệm về hàm lượng cadmium trong mô cây nên đươc thực hiện trên các phần ăn được hoặc bán được của nông sản và được báo cáo theo trọng lượng tươi.



Quản lý cadmium trong nông sản
Có ba cách làm giảm lượng cadmium trong nông sản:

1. Giảm lượng cadmium được bón vào đất.
2. Sử dụng các biện pháp nông học làm giảm việc hút cadmium của cây trồng.
3. Theo dõi nồng độ cadmium trong nông sản để đánh giá ảnh hưởng của chương trình giảm thiểu cadmium.

Giảm lượng bón

- Như đã nói ở phần trên, phân super lân có thể là nguồn chủ yếu để đưa cadmium vào đât vườn. Nông gia cần biết các loại phân đặc biệt có lẫn nhiều cadmium và nên sử dụng các loại phân chứa ít cadmium.
- Cần bảo đảm rằng quí vị có làm xét nghiệm phân tích đất và chỉ bón lân cho đất khi xét nghiệm cho thấy đất thiếu lân và việc bón lân có khả năng làm cây trồng tốt hơn.
- Các chất thải hữu cơ (như bùn cống thải) và phân gia súc có thể cũng chứa cadmium. Nếu sử dụng chúng, quí vị hãy kiểm tra để biết rằng hàm lượng cadmium trong phân này ở dưới giới hạn chấp nhận được.

Biện pháp nông học

- Giảm lượng clorua được đưa vào đất bằng cách dùng nước tưới và phân bón có nồng độ clorua thấp. Nồng độ clorua trong đất cao sẽ làm tăng lượng cadmium tự do cho cây hút. Hãy xem bảng ở trang 7.
- Nếu nước tưới có hàm lượng clorua cao, người ta khuyên nên nên kiểm tra hàm lượng cadmium trong các phần ăn được của cây (ví dụ như củ của khoai tây, lá của các loại rau ăn lá v.v) thường xuyên hơn.

- Một số cây trồng hấp thụ cadmium dễ dàng hơn các cây khác . Nếu phát hiện thấy hàm lượng cadmium trong nông sản cao ở mức không chấp nhận được, hãy chọn loại cây trồng và giống (nếu biết) tích luỹ ít cadmium hơn trong các phần ăn được (hãy xem đồ thị về nguy cơ, trang 5).
- Độ pH của đất ảnh hưởng đến việc hấp thụ cadmium của cây trồng. pH đất nhỏ hơn 5.5 (đo trong nước) hoặc 4.8 (đo trong clorua canxi) nên được điều chỉnh lên tới mức pH 6.2 - 6.7 (đo trong nước) và 5.5-6.0 (đo trong clorua canxi) bằng việc bón thêm vôi.

Sau đây là **chỉ dẫn** về cách tính lượng vôi nông nghiệp chất lượng cao cần thiết để tăng pH của đất lên một đơn vị trong tầng đất 15 cm trên cùng:

đất cát	1.5 - 3 tấn vôi/ha
đất mùn	3 - 4.5 tấn vôi/ha
đất thịt	4.5 - 6 tấn vôi/ha

Để đạt kết qủa tốt nhất, hãy sử dụng vôi nghiền nhỏ chất lượng cao và trộn vào đất.

Một chương trình kiểm định nông sản mới thu hoạch đã được đề nghị.

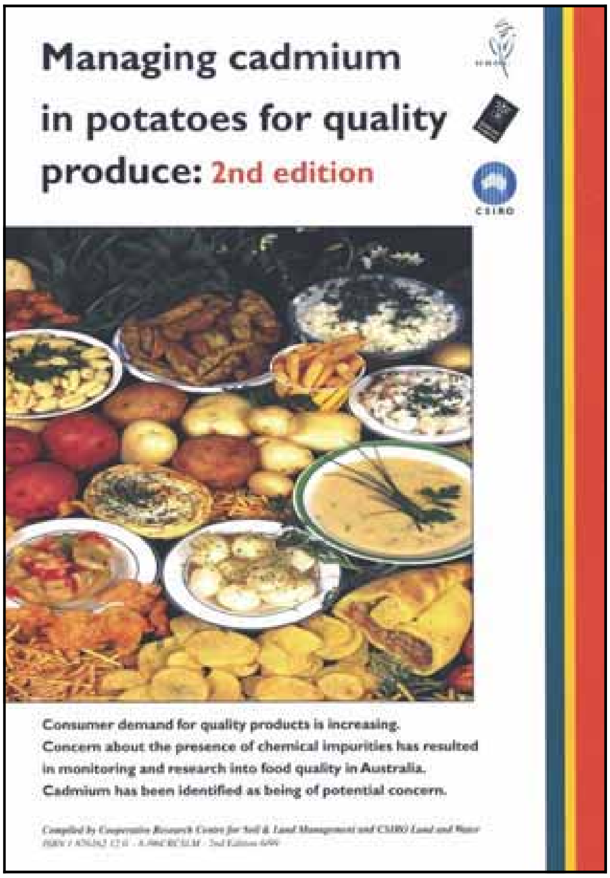
Tương tác giữa ciorua trong nước tưới và lượng cadmium trong đất

Nước tưới Hàm lượng chlorua (mg/L)	Nguy cơ tăng hàm lượng cadmium trong cây trồng
0-350	Thấp
350-750	Trung bình
>750	Cao

- Duy trì và tăng các vật chất hữu cơ trong đất. Người ta nghĩ rằng chúng sẽ làm giảm cadmium tự do cho cây, và như vậy cây trồng sẽ hút được ít cadmium hơn. Nếu quí vị làm việc này bằng cách bón thêm phân cây ủ (compost) hoặc những vật chất hữu cơ từ bên ngoài vào thì chỉ nên dùng những loại phân có chất lượng cao (ít cadmium).
- Một số thử nghiệm ngoài đồng cho thấy việc bón kẽm vào lúc trồng, ở liều lượng bồi bổ cho cây thiếu kẽm sẽ làm giảm lượng cadmium trong cây trồng.
- Nói chung, trong đất cát có nhiều cadmium tự do để cây hút hơn là trong đất có thành phần đất thịt cao. Do vậy, nông sản trồng trên đất cát có nguy cơ chứa nhiều cadmium hơn so với nông sản trồng trên đất thịt.

Quí vị có thể tìm thêm thông tin trong " Quản lý cadmium trong khoai tây để có chất lượng cao"(Managing cadmium in potatoes for quality produce); Xuất bản lần thứ 2, trên địa chỉ mạng:

www.cadmium-management.org.au/publications.html



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Horticulture Australia

Managing for cadmium minimisation in Australian livestock

The toxic heavy metal cadmium occurs in soil, water, plants and animals. Excessive levels of cadmium will cause health problems for humans and animals. Its concentration in different meat products used for human consumption is regulated and regularly monitored.

Cadmium – at a glance

- Food quality is a growing issue both nationally and internationally.
- Excessive daily intake of cadmium can lead to health problems in humans and animals, causing kidney and bone disease in humans.
- Surveys have shown that the level of cadmium in some Australian foods has occasionally exceeded regulatory health limits; cadmium has been detected at high levels in offal in some parts of Australia.
- Cadmium can infiltrate pastures and livestock via fertilisers; soil or water, especially downstream from mining; and compost or manure.
- Cadmium in pastures and animal products should be monitored, and can be managed by using sound agronomic practices.
- The only way to be sure if there is a cadmium problem is to measure its concentration in plants and livestock.

Why is cadmium a problem in grazing systems?

Cadmium accumulates in soil, where it can then be transferred to plants, animals and humans. Cadmium is concentrated in the kidney and liver (and, to a much lesser extent, muscle and milk) of livestock and humans. In plants, leaves generally contain the most cadmium.

Excessive daily intake of cadmium can lead to health problems in animals and humans. In livestock, the ability to metabolise copper is reduced, while in humans, cadmium increases the risk of kidney and bone disease.

It is important to minimise cadmium intake to protect livestock health and limit the potential for human exposure through animal products.

How to recognise a cadmium problem

Only plants grown in grossly contaminated soils in industrial or urban areas show visual signs of cadmium toxicity. Livestock rarely display any visual symptoms when their kidney and liver cadmium concentrations only just exceed the maxiumum levels (MLs) for human consumption. The only way to know if there is a cadmium problem is to measure its concentration.

For the grazing animal, it is important to be aware of previous land use, fertiliser history and general health of stock.

Sources of cadmium

- *Soil* – natural levels of cadmium in Australian soils fall predominantly within the range of less than 0.1mg to 0.5mg per kg, or about 0.1kg to 0.7kg cadmium per hectare in the top 10cm of soil. Cadmium remains in surface soil layers for long periods of time, unless there is erosion loss. Pastures and crops grown on river flats can have very high cadmium concentrations originating from contaminated sediments from mining activities. Soil dust particles containing cadmium can also coat the surface of farm produce, either in the field or during processing.

- *Water* – rain and irrigation water generally have very low cadmium concentrations. Care should be exercised if water from a mine, or river water downstream of mining, is being used as stock water. If such water contains high copper and sulfur levels it may protect livestock from the effects of cadmium.

- *Sewage sludges* (*biosolids*), *composts and manures* – these may contain cadmium as an impurity. There are comprehensive national and state guidelines governing the application of biosolids to soil. Contact your state Environmental Protection Agency for more details.

- *Atmosphere* – cadmium levels can be high near industrial activities such as smelting. In most other agricultural regions contamination from the atmosphere is minimal.
- *Miscellaneous* – farm rubbish tips and discarded metallic objects such as galvanised iron may be a source of cadmium if animals have access to these materials.
- *Fertilisers* – cadmium levels can vary in fertilisers containing phosphorus.

The concentrated phosphatic fertilisers currently used in Australia, ie DAP, MAP and TSP, are generally low in cadmium (less than 100mg cadmium per kg phosphorus). It is recommended that fertilisers used have cadmium concentrations as low as possible.

Pasture grades of single superphosphate are generally higher in cadmium, typically containing less than 250mg cadmium per kg phosphorus. Premium grades developed for horticulture contain less than 100mg cadmium per kg phosphorus and are available in some states.

Most Australian states have established a maximum permitted concentration (MPC) for cadmium in phosphatic fertilisers of 300mg cadmium per kg phosphorus. Member companies of the Fertiliser Industry Federation of Australia currently provide horticultural fertilisers that contain less than 100mg cadmium per kg of phosphorus (ie well below the proposed MPC).

Trace element fertilisers and phosphogypsum may also contain high cadmium levels. The maximum permitted concentration of cadmium ranges from 50–80mg per kg in trace element fertilisers and 10–80mg per kg in phosphogypsum. Check with your local fertiliser representative for the standards of your state.

Normally, nitrogen and potassium fertilisers and limes and natural gypsum have very low cadmium levels.

Managing for low cadmium in grazing systems

There are several approaches to reducing cadmium input and uptake in grazing systems:

1. Reducing inputs to soil

Fertilisers and soil ameliorants and conditioners can add cadmium to pasture soils. Be aware of cadmium impurities in these products and use those with the lowest concentrations of cadmium that still meet your needs.

Ensure you test your soil prior to adding any phosphorus-containing product. Do not add excessive phosphorus, in whatever form, to the soil.

2. Reducing ingestion of contaminated soil and water

Grazing livestock may consume more than 50kg of soil a year. Where possible, minimise the risk of animals ingesting soil by:

- not overgrazing
- not feeding grain or other supplements on the bare soil surface

Prevent stock from having access to cadmium-contaminated water or dumps. Do not use water with high concentrations of cadmium or chloride for irrigating crops or watering livestock.

3. Reducing inputs via feed

Obtain information on the cadmium concentration of feeds, grains and mineral supplements and use those with the lowest possible cadmium concentrations that meet your needs. Occasional monitoring of feed inputs may be required.

4. Improving pasture composition

Control the plants in your pasture to minimise the presence of weeds, such as capeweed, that accumulate high concentrations of cadmium.

5. Improving soil conditions

Soil pH of less than 5.5 (measured in water) or 4.8 (measured in calcium chloride) should be increased to pH values of 6.0–7.0 (measured in water) or 5.5–6.0 (measured in calcium chloride) through the addition of lime. This will reduce the release of cadmium from soil and uptake by plants and animals.

Approximate amounts of high quality agricultural lime needed to raise soil pH by one unit in the top 15cm of soil are:

Sand	1.5–3 tonnes of lime/ha
Loam	3–4.5 tonnes of lime/ha
Clay	4.5–6 tonnes of lime/ha

For best results, use finely ground, high quality lime and incorporate it into the soil.

Maintain or increase soil organic matter, which reduces the availablity of cadmium to plants. If you do this by importing compost or other off-farm organic material, use only material with low cadmium concentrations.

In sandy soils the practice of clay spreading should help decrease cadmium uptake by plants, especially if the clay is alkaline.

Reduce chloride additions to soil by using irrigation water and fertilisers with low chloride concentrations.

6. Preventing trace element deficiencies

Correction of deficiencies in zinc, copper, sulphur and molybdenum in animals and grazing pastures is likely to reduce cadmium uptake by animals.

Cadmium levels in Australian food and exports

Dietary intake of cadmium in Australia is low by world standards and our food exports have a ‘clean’ reputation worldwide. To maintain this advantage we need to minimise any potential cadmium accumulation in food products.

Food Standards Australia New Zealand (FSANZ) sets the MLs of cadmium in various food products. The FSANZ MLs for cadmium in animal products are shown in table 1.

Products found to contain cadmium residues that exceed the FSANZ MLs are condemned as they cannot legally be sold for human consumption.

Australia has several chemical residue survey programs which include cadmium. These have detected a very small number of samples exceeding the MLs.

Table 1

Animal product	Maximum level (mg/kg)
Kidney of cattle, sheep and pig	2.50
Liver of cattle, sheep and pig	1.25
Meat of cattle, sheep and pig (excluding offal)	0.05

Factors that control cadmium uptake by plants

Cadmium added to soil tends to remain in the topsoil, where it is potentially available to plants. However, it binds to clay particles and organic matter, making it less available for uptake by plants and animals. Sandy soils with low clay content and organic matter are likely to result in a higher uptake of cadmium.

It can be removed from soils by erosion or by leaching from very light, sandy, acid soils.

Plants mostly take up cadmium through their roots. The availability of cadmium to pasture plants other than grasses decreases as soil pH increases – ie as soils become more alkaline. The availability of cadmium to pasture grasses is less affected by soil pH.

Research suggests that if soil zinc levels are low then more cadmium will be taken up by plants.

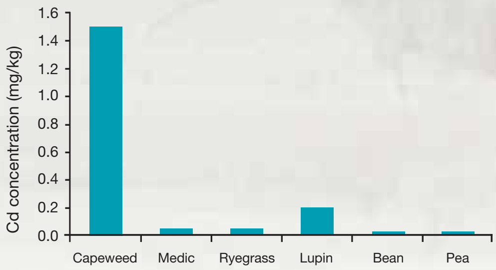
Higher soil chloride concentrations increase the release of cadmium from soil and uptake by plants (see table 2).

Table 2

Interaction between chloride in water and cadmium in plants	
Water chloride concentration (mg/L)	Risk of increasing crop cadmium concentration
0–350	Low
350–750	Medium
> 750	High

Uptake of cadmium varies considerably among different plant species and among varieties or cultivars (refer to the diagram below). Some weeds, notably capeweed, and some plants belonging to the cabbage family (eg broccoli, chinese broccoli, brussels sprouts, cabbage, cauliflower and kohlrabi) accumulate cadmium to a much greater extent than legumes, which in turn accumulate more than grasses (see figure 1).

Figure 1



Merry (1988), *Cadmium Accumulations in Australia Agriculture* (Editors J. Simpson and W. J. Curnow.) pp.62-79.

Further information

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