



# 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](http://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

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 (NCCMC) 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 occasionally 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 rock 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



*A regular testing program of the harvested crop is recommended.*

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.

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 progressively 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.

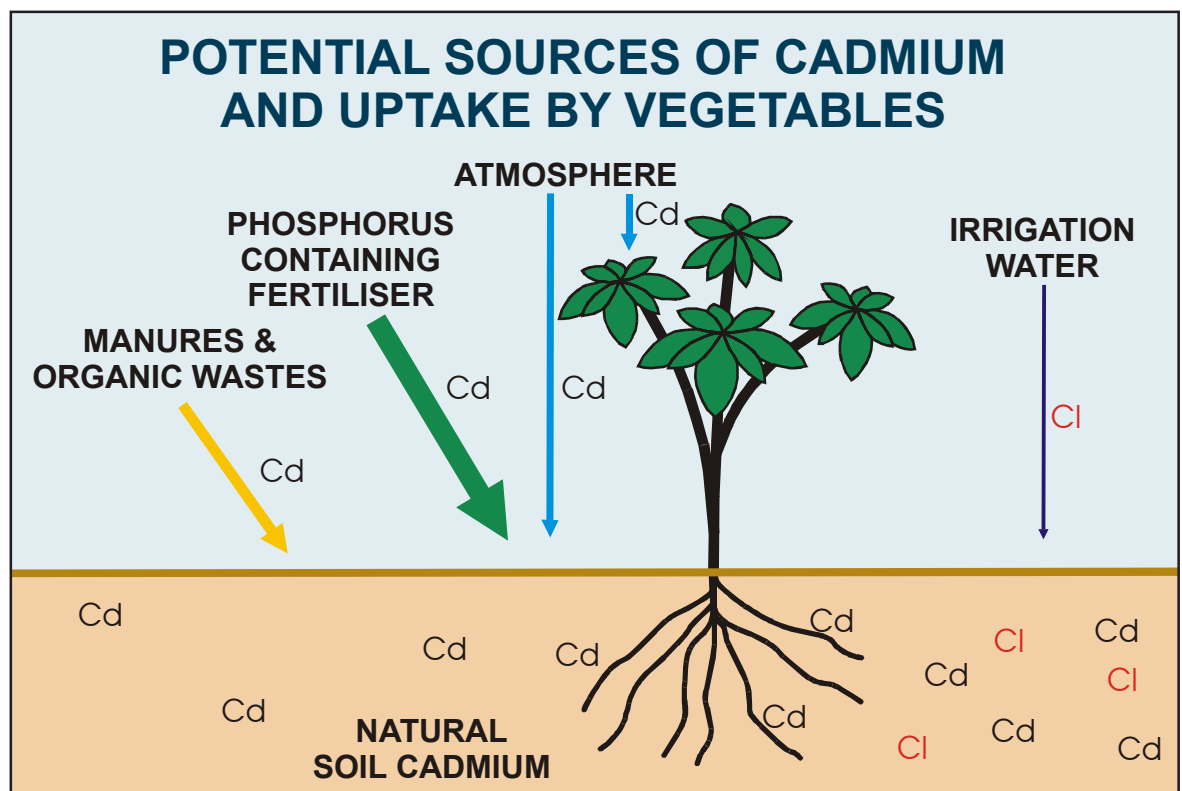
### Cadmium levels in Australian food and exports

- 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](http://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.

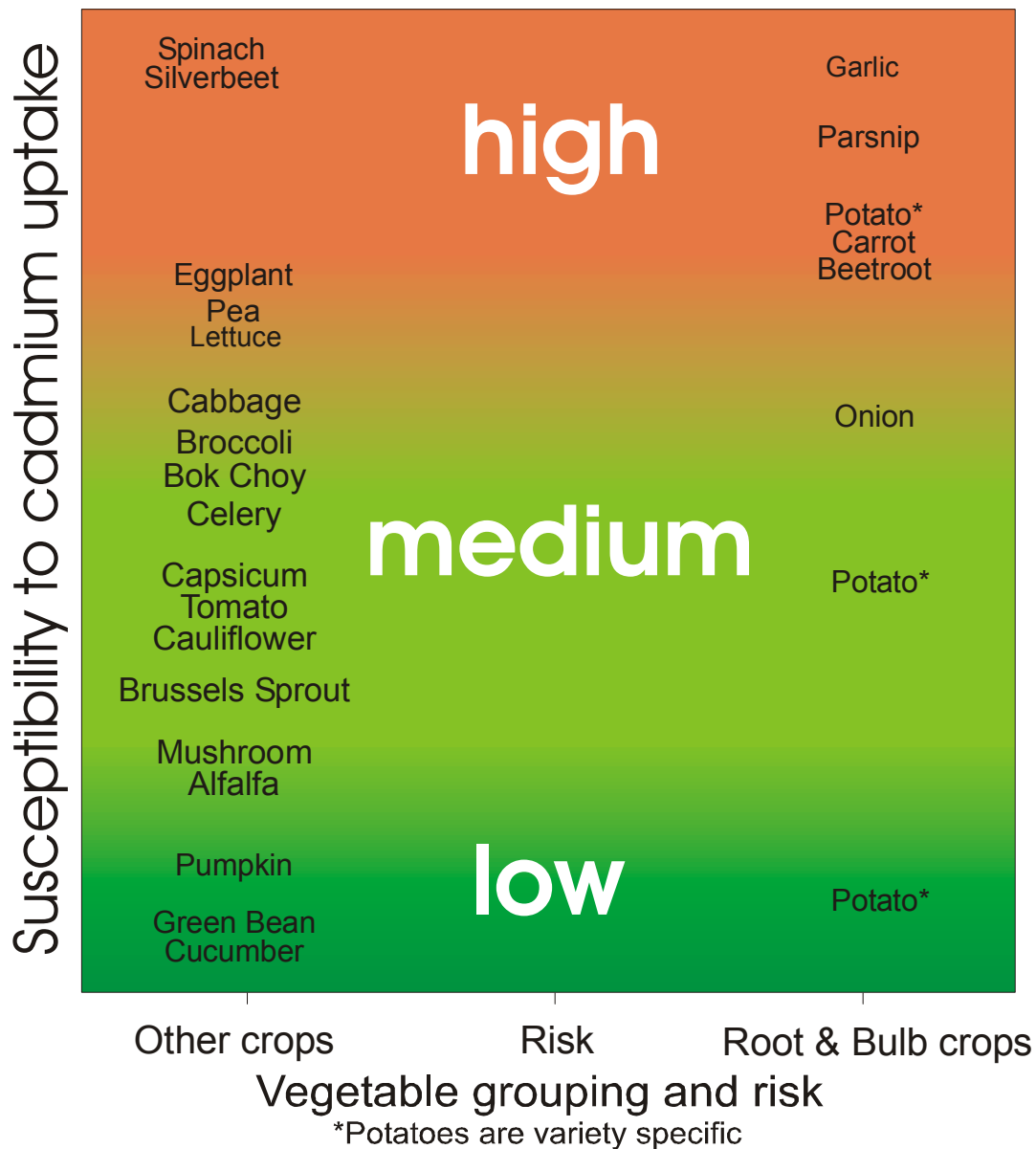
• Australia has several residue survey programs which include cadmium. Some of these programs have detected a very small number of samples exceeding the ML.

### 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. potassium 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](http://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 availability 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

**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.

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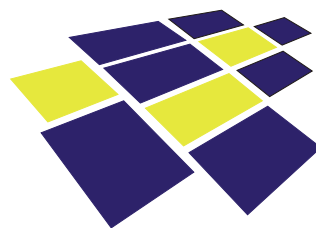
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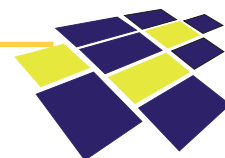
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