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.

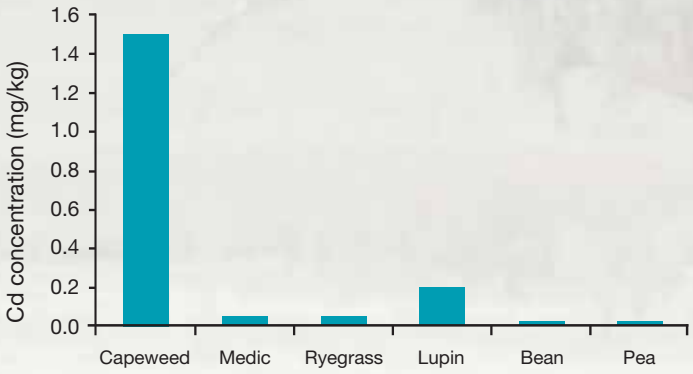
Higher soil chloride concentrations increase the release of cadmium from soil and uptake by plants (see table 2).

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

Jim Derrick
Meat Manager –
National Residue Survey
Ph: 02 6272 4019
Fax: 02 6272 4023
Email: jimderrick@daff.gov.au

Published on behalf of SAFEMEAT by Meat & Livestock Australia (MLA)