

# HEAVY METALS IN FERTILISERS & AGRICULTURE

## 1. HEAVY METALS – AN INTRODUCTION

Heavy metals occur naturally and are present at low concentrations in soils. They are also present as impurities in some fertilisers. Depending on the concentration of heavy metals in fertilisers and their rate of application, their use may add to background levels in the soil.

Of the various heavy metals, cadmium (Cd), lead (Pb), and mercury (Hg) are of greatest concern in fertilisers and agriculture. Of these, it is cadmium and its presence in phosphorus fertilisers that attracts the most attention. Lead may be present at relatively high concentrations in some metallic trace element fertilisers.

Heavy metals in fertilisers may be transferred to farm produce, either directly (fertiliser dust, foliar sprays, and ingestion of recently applied fertiliser by livestock), or indirectly from the soil by plant root uptake or soil and dust contamination of pasture and edible plant parts.

The presence of heavy metals in farm produce will not result in acute (sudden) poisoning, but potentially may result in chronic health effects over a long period of time, e.g. a lifetime, if continuously consumed in higher than normal amounts.

The health of Australians is not being affected by the heavy metals consumed in food, and dietary intake is within safe limits. However, there are instances where the Maximum Levels (MLs) specified in the Australia New Zealand Food Standards Code for cadmium in farm produce are exceeded. Violations of the Maximum Levels for lead and mercury in farm produce are rare.

MLs are set at the lowest level that is achievable with good farming practices, provided it will not result in an estimated intake of more than the PTWI (Provisional Tolerable Weekly Intake), i.e. they are set below the concentrations at which continued intake is likely to harm human health.

A violation of the ML does not indicate that consumption of the specific produce in question poses any short-term risk or is immediately detrimental to health. However, in the long term, it is desirable that the cadmium concentrations in food items be contained within the MLs, so that the combined intake of cadmium from all sources is within safe limits. Violations of MLs are usually used to indicate a need for investigation and action. Cultural and fertiliser practices may need to be changed.

Domestic food processors may reject produce from sources known to be high in cadmium. High cadmium concentrations in farm produce may also affect its acceptability on world markets.

## 2. HEAVY METALS IN SOILS

Heavy metals are naturally present in the soil, the amounts present depending on such factors as the parent material from which the soil was formed. Additions may come from various sources, e.g. atmospheric deposition (which is higher in industrialised areas) and the use of fertilisers, soil amendments and organic wastes, e.g. biosolids (sewage waste products).

In most Australian States, it is a legislative requirement that a Warning Statement be carried on fertiliser packs or tags if the heavy metal concentration in the fertiliser exceeds typical background levels present in agricultural soils. These concentrations are:

- Cadmium      1 mg/kg Cd
- Lead            20 mg/kg Pb
- Mercury       0.2 mg/kg Hg

Fertilizer Australia, an industry association representing Australia's major fertiliser suppliers, has developed its own "National Code of Practice for Fertilizer Description and Labelling". Incitec Pivot Fertilisers' labels comply with the Fertilizer Australia Labelling Code of Practice.

The Label Warning Statement required under the Fertilizer Australia Labelling Code, where cadmium, lead and mercury all exceed the above limits, is "*This product contains heavy metal impurities. Its use may result in accumulation of cadmium, lead and mercury in the soil. Depending on soil characteristics, irrigation water quality, plant species and variety, crop uptake of cadmium may lead to residue levels in plant and animal products in excess of the maximum level specified by the Australia New Zealand Food Standards Code. In pasture, the offal from grazing animals may also exceed these limits.*"

While fertilisers exceeding the above concentrations have the potential to increase soil concentrations of all three heavy metals, it is unlikely that fertilisers will significantly increase plant uptake of lead and mercury. Cadmium is taken up by plant roots and is therefore the heavy metal of greatest concern in fertiliser programs.

## 3. PLANT UPTAKE OF HEAVY METALS

As with other elements and nutrients in soils, heavy metals are mostly present in forms that are not available for plant uptake. This is particularly true for lead and mercury. Very little of either is taken up by plant roots.

Plant uptake of cadmium is low, but it may be high enough for farm produce to exceed MLs (Maximum Levels). This cadmium can be derived from that present in the soil (naturally and residual from past fertiliser applications) and from fertilisers or soil amendments applied for the crop being grown.

The application of phosphorus fertilisers can increase plant uptake of cadmium in two ways. Firstly, cadmium is added to the soil with the fertiliser, and may be taken up directly by plant roots. Secondly, by stimulating root growth and plant vigour, the uptake of cadmium inherently present in the soil may be increased.

Many factors affect the availability of cadmium in the soil, and its uptake by plants.

### **Salinity**

Australian research shows that salinity is one of the major factors affecting cadmium uptake. High soil chloride (Cl<sup>-</sup>) concentrations, either from irrigation with saline water and/or dryland salinization, will enhance cadmium uptake by crops. Chloride mobilises cadmium in the soil, increasing cadmium concentrations in the soil solution. CdCl<sup>+</sup> is more available for plant uptake than Cd<sup>2+</sup>.

### **Acidity**

Plant uptake of cadmium is often greater under acid soil conditions (low pH). The application of lime to correct soil acidity may help reduce the availability of cadmium in the soil for uptake by plants.

### **Soil Type**

Applied cadmium (as fertiliser) will be more available on light-textured sandy soils low in organic matter than on soils with a high cation exchange capacity. Heavy-textured (clay) soils, and those with a high organic matter content tend to bind cadmium strongly and reduce plant uptake of cadmium.

### **Zinc**

Cadmium and zinc uptake by plants occurs in a similar way, and if zinc is low, more cadmium will be taken up. Where soil zinc is low, the application of zinc may provide two benefits. Firstly, it will correct any deficiency of zinc, and secondly it may depress plant uptake of cadmium. However, the application of zinc at rates over and above that required to correct any deficiency of this element is not advocated.

### **Plant Species and Cultivar**

Plants differ markedly in their ability to absorb cadmium. For example, Capeweed (also known as Cape Dandelion and African Daisy), an important seasonal weed in South Australia and Western Australia, contains about five times more cadmium than Subterranean Clover.

In agricultural produce, the highest cadmium concentrations are found in tuber and root crops (potatoes, carrots), leafy vegetables (spinach, lettuce), tobacco, oilseeds (safflower, sunflower), grain legumes and peanuts.

Durum wheat takes up more cadmium than other cereals.

## 4. GRAZING ANIMALS

In livestock, as with crops, the focus is on cadmium. Cadmium may be ingested by animals in the forage, either that which has been taken up by plant roots, or through soil and fertiliser dust contamination of forage and feed.

The health of grazing animals will not be affected by heavy metals present in fertilisers applied to the soil in pasture and forage crops, nor are the Maximum Levels in meat and dairy products likely to be exceeded. The marketability of offal from animals after slaughter, however, may be.

Most of the cadmium consumed by animals is excreted. The cadmium that is retained in the body tends to accumulate in the kidneys and liver. Kidneys have higher levels than liver while much lower levels are found in muscle (meat). Not surprisingly, given the short time it takes to be produced, cadmium is not found in detectable amounts in milk.

Kidney cadmium concentrations tend to increase with age, and higher levels are found in females than in males. Breeding females are culled at an older age than males raised for meat. Sheep tend to have higher kidney concentrations of cadmium than cattle, probably attributable to their grazing closer to the soil surface, thereby ingesting more soil.

Higher levels of cadmium are often detected in kidneys of sheep and cattle on improved pasture from southern and western Australia than from New South Wales and Queensland. This reflects regional variations in such factors as:

- i. Soil type - plant uptake of cadmium is higher on acid sandy soils;
- ii. Rainfall - the higher incidence of summer rainfall in the eastern states allows more uniform pasture growth throughout the year. Stock are therefore not forced to graze as close to the soil surface, and are therefore less likely to ingest soil (and freshly applied fertiliser) with pasture, seed, burr and supplementary feed;
- iii. Pasture species - greater use is made of perennial pasture species in the east, while annual species are commonly used in the winter-dominant rainfall areas of South Australia and the southwest of Western Australia. Soil acidification does not occur as rapidly with perennials and they tend to take up less cadmium than annual species;
- iv. The prevalence of Capeweed in pastures in the west;
- v. Dryland salinity; and
- vi. Fertiliser use – little use is made of fertiliser on beef and sheep pastures in Queensland.

As a safeguard, authorities withhold the offal of aged cattle and sheep, e.g. culled breeders and wethers, from the agricultural region of Western Australia for sale for human consumption.

## 5. HEAVY METALS IN FARM PRODUCE

The levels of cadmium, lead and mercury in food was surveyed by Food Standards Australia New Zealand and reported on in the 23<sup>rd</sup> Australian Total Diet Survey (2011).

The Report found that dietary exposures to cadmium and inorganic mercury were below the respective reference health standards. On this basis, there are no public health and safety issues regarding current intakes of cadmium or inorganic mercury by Australian consumers. The report also found it re-assuring that over the decade from the 19th Australian Total Diet Survey in 2001 to the 23<sup>rd</sup> survey in 2011, that dietary exposure to lead from food for the Australian population had been reduced approximately sevenfold as a result of a range of effective risk management strategies.

### Cadmium

In our foodstuffs, the highest cadmium concentration is found in offal, particularly the kidneys. Leafy vegetables such as silver beet or spinach, and root crops such as carrots can accumulate high levels of cadmium from that applied in fertiliser and/or if grown in soils containing a lot of cadmium and/or where other conditions favour its uptake. Potatoes, because of the quantity consumed, represent the biggest single source of cadmium in our diets.

The Maximum Levels (MLs) for cadmium in food for Australia and New Zealand are shown in the table below. These standards are amongst the most stringent in the world.

**Maximum Levels for Cadmium in Farm Produce (March 2016)**

FOOD	mg/kg Cd
Kidney *	2.5
Liver *	1.25
Peanuts	0.5
Leafy vegetables, root and tuber vegetables, wheat, rice.	0.1
Meat (excluding offal)*,	0.05

\* Cattle, sheep, pig.

### Lead

Violations of the MLs for lead in farm produce are rare. Apart from that present at harvest, lead concentrations in food can increase during handling, storage, and food processing.

Changes in canning technology, i.e. the use of welded cans in place of soldered cans, have greatly reduced the amount of lead consumed in food.

### **Mercury**

Seafood is by far the most significant source of mercury in the diet. By comparison, the mercury levels in farm produce are low. Dietary intake of mercury depends mainly on the concentration of mercury in fish and the amount of fish consumed.

## **6. HUMAN HEALTH**

### **Cadmium**

In Australia, dietary intake of cadmium is within the PTWI (Provisional Tolerable Weekly Intake) and there is very little risk of cadmium toxicity. The PTWI provides a safety margin before health is affected. However, because cadmium intake (as a percentage of the PTWI) is higher than for other heavy metals, it is treated with greater concern by health authorities.

Cadmium can accumulate in the liver and kidneys, particularly the renal cortex, and at toxic levels impairs the function of these organs. Levels in the body tend to increase slowly with age, up to about 50, as normal intake and absorption into the body is a slow process. Tobacco smoking adds significantly to the body's burden.

### **Lead**

In Australia, it is the health of children in urban and industrial environments and their exposure to lead that is the primary cause of concern. Infants and children are considered particularly vulnerable to lead exposure. Small but significant decreases in intellectual development have been associated with blood lead levels formerly thought of as safe. Measures are being sought which will reduce the lead intake of children from air and soil and dust.

Leaded petrol emissions were once a major contributor to lead concentrations in air in urban areas. This was addressed by the introduction of unleaded petrol in 1985, and the subsequent phasing out of leaded petrol. The accidental ingestion of soil by children while playing, and the ingestion and inhalation of dust are other ways in which humans consume lead. Since lead is stable, lead deposited onto soil (from petrol emissions, paint, and industrial sources) becomes a long-term source of lead exposure.

### **Mercury**

Mercury is found in various forms (elemental, inorganic and organic), all of which have different toxicological properties. The most toxic to humans is the organic form, with the most common organic form being methyl mercury. Methyl mercury is largely produced from the methylation of inorganic mercury by microbial activity. This is most likely to occur in marine and freshwater sediments. Methyl mercury is rapidly taken up and concentrated by

filter-feeding organisms upon which fish feed. Hence seafood contains much higher levels of mercury than most other foods and is the main source of mercury in the diet.

High levels of mercury can produce toxic effects in humans, primarily in damage to the central nervous system. In the past, mercury was used in the processing of felts to make hats. Prolonged exposure resulted in chronic poisoning and madness, hence the saying "As Mad as a Hatter".

## 7. PERMITTED CONCENTRATIONS FOR HEAVY METALS IN FERTILISERS

Maximum concentrations for cadmium, lead and mercury, as specified in State Fertiliser Acts and the Fertilizer Australia "National Code of Practice for Fertilizer Description and Labelling" are detailed in the table below.

Nitrogen and potassium fertilisers are typically low in heavy metals. Their use will not normally add to soil concentrations or contribute to violations of MLs in farm produce.

Phosphorus fertilisers are usually higher in heavy metals, these being derived from the raw materials (phosphate rock and acids) used in their manufacture. Lead and mercury are usually of little concern. Cadmium concentrations are variable and are typically higher than those found in the soil. In risk situations, fertilisers with a low cadmium content may need to be used.

Micronutrient (trace element) fertilisers may also be high in cadmium and lead. This particularly applies to the metallic trace elements, e.g. copper and zinc. The addition of trace elements to NPK fertilisers usually adds to the lead content of the finished fertiliser. While the use of soil-applied trace element fertilisers with a high lead content is unlikely to increase root uptake of lead, it will increase soil concentrations of lead, and should soil or dust contamination occur, indirectly increase lead concentrations in farm produce.

The maximum concentrations of cadmium, lead and mercury in Incitec Pivot products are declared on the product label, which is copied onto the pack or bag tag for custom blends, bulk bags and bulk deliveries.

Heavy metal specifications (Maximum Concentrations) for various Incitec Pivot products are also detailed in the table at the end of this Agritopic. The heavy metal content of blended fertilisers will reflect that of the ingredients.

The lowest maxima declared on Incitec Pivot labels are 1 mg/kg Cd (cadmium), 1 mg/kg Pb (lead) and 0.2 mg/kg Hg (mercury), even though some nitrogen and potassium fertilisers contain well below these figures. At these levels, Label Warnings are not required, and there is no need for concern about the use of the product. These figures are close to the limits of detection for some laboratory equipment. It becomes more difficult and costly to measure and report lower concentrations.

### Maximum Concentrations for Cadmium, Lead and Mercury in Fertiliser

Heavy Metal Impurity	Fertiliser	Maximum Concentration
Cadmium (Cd)	Phosphorus Fertilisers (> 2% P)	300 mg Cd/kg P
	Other Fertilisers, e.g. N, K.	10 mg/kg Cd
	Trace Element Fertilisers	50 mg/kg Cd
Lead (Pb)	NPK Fertilisers	100 mg/kg Pb
	NPK Fertilisers with added Trace Elements	500 mg/kg Pb
	Trace Element Fertilisers for Foliar Application	500 mg/kg Pb
	Trace Element Fertilisers for Soil Application	2 000 mg/kg Pb
Mercury (Hg)	All Fertilisers (including Trace Elements)	5 mg/kg Hg

## 8. CADMIUM CONCENTRATIONS IN PHOSPHORUS FERTILISERS

Because the phosphorus (P) content of fertilisers vary, the cadmium (Cd) content is often expressed in terms of mg of cadmium per kg of phosphorus (mg Cd/kg P), rather than mg of cadmium per kg of product (mg/kg Cd). This allows easier comparisons to be made between products with different phosphorus contents.

Incitec Pivot declares the maximum cadmium concentration in the product (mg/kg Cd) as well as per kg of phosphorus (mg Cd/kg P) on the label for products containing more than 2% P.

Cadmium occurs naturally, and is present as an impurity in phosphate rock, the ore from which phosphorus fertilisers are manufactured. Phosphate rock varies in its cadmium content, depending on the source. For many years, Australia was largely dependent on nearby ocean sources of phosphate rock such as Banaba (Ocean Island), Christmas Island and Nauru for domestic manufacture of phosphorus fertilisers. These rocks had a relatively high cadmium content. Nauru phosphate rock, for example, contains 500 – 600 mg Cd/kg P. It can no longer be used on its own to manufacture phosphorus fertilisers for the Australian market, given that the maximum cadmium content allowed in phosphorus fertilisers under Australian legislation is 300 mg Cd/kg P. Boucraa phosphate rock (from Morocco), which is imported into Australia to manufacture superphosphate, contains 200 – 250 mg Cd/kg P. Florida phosphate rock, from which much of the MAP and DAP that is imported into Australia is made, contains 30 – 80 mg Cd/kg P. The Duchess deposits in north-west Queensland,



from which MAP and DAP are manufactured locally by Incitec Pivot, are comparatively low in cadmium, containing 20 – 30 mg Cd/kg P.

The maximum cadmium concentrations in Incitec Pivot's most commonly used phosphorus fertilisers are tabulated below.

#### Maximum Cadmium Concentrations in Incitec Pivot Phosphorus Fertilisers

Product	Analysis (%)			Maximum Cadmium Concentration	
	% N	% P	% S	mg/kg Cd	mg Cd/kg P
SuPerfect		8.8	11	25	300
MAP	10.0	21.9	1.5	15	75
DAP	17.7	20.0	1.6	10	50

At the present time, the only control over cadmium inputs into agriculture from fertiliser is to use products that are made from phosphate rock with a low cadmium content. Fertilisers from which cadmium has been further reduced or removed are not commercially available.

Details on the cadmium content of the major phosphorus fertilisers marketed by Incitec Pivot are discussed below.

### SuPerfect

Incitec Pivot SuPerfect is Single Superphosphate (SSP). It is manufactured from a range of imported phosphate rocks. The resultant product contains a maximum of 300 mg Cd/kg P. This (300 mg Cd/kg P) is the maximum cadmium concentration allowed in phosphorus fertilisers in Australia. This is satisfactory for use on pasture, which is the primary use of SuPerfect.

SuPerfect is not recommended for use on its own, i.e. as the sole source of phosphorus, in vegetables.

Vegetable crops typically receive much higher rates of phosphorus than pasture, so the cadmium loading to the soil will be higher. Root, tuber and leafy vegetable crops also tend to take up cadmium in higher concentrations than other crop and pasture species. Fertilisers with a lower cadmium content than SuPerfect should be chosen when growing vegetables.

### MAP and DAP

Incitec Pivot DAP and MAP have a maximum specification of 50 and 75 mg Cd/kg P respectively. They are mostly the same (less than 50 mg Cd/kg P), being manufactured from the same rocks or being imported from the same sources. The higher specification for MAP

allows for the occasional import of MAP with a cadmium content between 50 and 75 mg Cd/kg P.

## CADMIUM MANAGEMENT

While the cadmium in our food does not harm the health of Australians and our exports have a "clean" reputation, there are instances where the Maximum Levels (MLs) for cadmium in farm produce are exceeded. Fertilisers can contribute, in part, to these violations.

Phosphorus fertilisers contain higher concentrations of cadmium as an impurity than that present in the soil. Their application can, over many years, increase soil cadmium concentrations. To help contain such increases, low cadmium fertilisers should be chosen in risk situations, e.g. where phosphorus is applied at high rates, where cadmium concentrations in farm produce are elevated, or future land use may change, and today's practices may restrict the choice of crops that can be grown.

Important factors which, individually or combined, can indicate a need to choose phosphorus fertilisers with a low cadmium content are:

- Soils which are naturally high in cadmium, or in which the cadmium content has been increased through fertiliser use to the extent that cadmium concentrations in farm produce are approaching or exceed the ML for cadmium.
- Where cadmium inputs from other sources are high, e.g. disposal of biosolids (sewage waste) high in cadmium.
- Where high rates of phosphorus are applied on a regular basis, such as in growing potatoes and other vegetable crops.
- Where the soil is cropped or is likely to be cropped in the future to vegetables.
- Saline soils, and/or where poor quality irrigation water is used.
- Sandy soils.
- Acid (low pH) soils.

It is recommended that potato (and other vegetable) growers choose phosphorus fertilisers containing less than 150 mg Cd/kg P. If repeated applications of phosphorus are made at high rates, e.g. more than 100 kg/ha P per crop, it is desirable that fertilisers containing less than 100 mg Cd/kg P be used.

The cadmium concentration in phosphorus fertilisers will be less of a consideration where phosphorus is applied irregularly and/or at low rates, on neutral and alkaline (high pH) soils, on land used exclusively for crops in which cadmium does not normally accumulate, or is typically present in low amounts, e.g. sugarcane, cereals (Durum wheat may be an exception), tree crops, and in non-food crops, e.g. cotton.

In grazing animals, violations of the ML for cadmium may occur in offal, e.g. kidney, but are not likely in muscle (meat). Phosphorus application rates in pasture are typically much lower than those used in vegetable crops.

Cadmium may also be present in other fertilisers and soil amendments, e.g., biosolids (sewage waste products). Where used, consideration needs to be given to the heavy metal content and the rate and frequency of application of these products as well to keep cadmium loadings to agricultural soils at acceptable levels.

## 9. SUMMARY

Of the three heavy metals (cadmium, lead and mercury) for which maximum concentrations are prescribed in Australian fertiliser legislation, and for which label information and warnings are required in some States, it is cadmium and its presence in phosphorus fertilisers that warrants the most attention.

Incitec Pivot SuPerfect (Single Superphosphate), which is manufactured at Geelong and Portland in Victoria, contains up to 300 mg Cd/kg P, the maximum allowed under Australian legislation.

Efforts to reduce the cadmium content of Single Superphosphate by using phosphate rocks low in cadmium have not proven successful, either due to difficulty in procuring a reliable supply of competitively priced phosphate rock in sufficient quantity, or difficulties with the operation of the factories. Jordan phosphate rock was used for a time, and then discontinued, due to ongoing problems with odour emissions during the manufacturing process.

Incitec Pivot SuPerfect is primarily intended for use on pasture. It should not be used as the sole source of phosphorus in vegetable crops.

It is recommended that potato (and other vegetable) growers choose phosphorus fertilisers containing less than 150 mg Cd/kg P. If repeated applications of phosphorus are made at high rates, e.g. more than 100 kg/ha P per crop, it is desirable that fertilisers containing less than 100 mg Cd/kg P be used.

Incitec Pivot high analysis phosphorus fertilisers, i.e. DAP and MAP, are comparatively low in cadmium. Incitec Pivot DAP a maximum of 50 mg Cd/kg P, and Incitec Pivot MAP a maximum of 75 mg Cd/kg P. These products should be used rather than SuPerfect where vegetables are to be grown.

Incitec Pivot NPK blends for the horticultural segment are formulated so as to contain no more than 150 mg Cd/kg P. Many contain less, i.e. those based on MAP and DAP, with no phosphorus in other forms.

## INCITEC PIVOT HEAVY METAL SPECIFICATIONS

### Maximum Concentrations as at July 2017

These specifications are correct at the time of preparation of this Agritopic but are subject to periodic review and change.

PRODUCT	CADMIUM (Cd)		LEAD (Pb)	MERCURY (Hg)
	mg/kg	mg Cd/kg P	mg/kg	mg/kg
Big N® (Anhydrous Ammonia)	1		1	0.2
Granular Urea				
Prilled Urea / Stockfeed Urea				
Liquifert® N / Liquifert® Lo-Bi				
Easy N (UAN Solution)				
Cal-Am				
Muriate of Potash				
Sulfate of Potash				
Sulfur Bentonite				
YaraLiva® Tropicote	1		10	0.2
Magnesium Oxide				
Kieserite				
Gran-am®	1		10	1
Granubor®	1		20	0.2
DAP	10	50	20	1
Granulock® SS	5	50	100	1
MAP	15	75	100	1
Granulock® Z	20	100	20	1
Nitrophoska® Special	7	150	20	0.2
SuPerfect®	25	300	100	5
Iron Granules	15		20	0.5
Manganese Sulfate Granular	20		20	1
Zinc Sulfate Monohydrate	20		100	0.2
Copper Granules	20		500	1

## 10. FURTHER READING

A separate abridged Incitec Pivot Agritopic is available on “Managing Cadmium in Vegetables”.

Several publications are also available from the “Australian Cadmium Minimisation Strategy” website: [www.cadmium-management.org.au](http://www.cadmium-management.org.au)

- Managing Cadmium in Vegetables (2003)
- Managing Cadmium in Potatoes for Quality Produce: 2<sup>nd</sup> edition (1999)
- Cadmium in Potatoes: Managing the Risk from Saline Irrigation Water (1999)
- Managing Cadmium in Summer Grain Legumes (2001)
- Managing for Cadmium Minimisation in Australian Livestock (2007)

## 11. WARNING

The information and guidelines in this publication summarise existing knowledge and are presented to help farmers and graziers in their decision making process.

Many variables affect cadmium uptake. It cannot be predicted in advance what the effect of fertiliser on soil concentrations of plant-available cadmium and crop or pasture uptake will be. District advice may need to be sought from local Departmental Advisers and others.

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