Zinc (Zn) Version 2.6 12 june 2016

Zinc is essential for soils, plants, animals and people.

Zinc is a very powerful antioxidant able to prevent hoof problems and liver damage caused by facial eczema, and help livers repair after facial eczema damage has occurred. Not many things can repair damaged livers. However, facial eczema **prevention** with LimePlus, earthworms and summer forage crops are far better and more certain than zinc treatment. One can only wonder whether zinc control would ever have been discovered if the late Gladys Reid had not done so. See below. However, LimePlus did a far better job and improved the soil and pasture yields on ours and other farms since 1959 and is working for GrazingInfo readers. It is by having correct calcium and other levels in soils to keep earthworms at optimum levels and healthy. They consume the dead pasture (thatch) on which facial eczema spores breed, so reduce spore numbers. See Soils > Earthworms for other essential ways to keep earthworm numbers up where they should be at 30 or more per spade spit on grazed pastures. 'Grazed', because caliginosa earthworms (the main and most active ones in grazed pastures) thrive on animal manure. Longa and Terrestris earthworms can do well on good soils with organic matter without animal manure.

Zinc's antioxidants reduce free radicals in soils and bodies. For Zn to work as an antioxidant, copper in the body must be adequate, although **excess** copper reduces Zn absorption so can cause a zinc deficiency. **Excess** Zn reduces copper.

Very high selenium (Se) can suppress zinc absorption, while low zinc can reduce selenium absorption, so analyse ryegrass to ensure that pasture mineral levels and supplement contents are correct.

Benefits of Zn

Zn fed to fast growing, thin animals helps to produce meat rather than fat. It also helps to protect the liver from manganese toxicity, carbon tetrachloride poisoning, copper poisoning, facial eczema sporidesmin poisoning (Gladys Reid), ragwort poisoning, and from a fungus poison on lupins in Australia. It also hardens hooves when fed and when used in a Hoofmat, which cows walk over when entering farm dairies to reduce hoof problems. See Animal Health > Hooves > Footrot.

Zinc supresses manganese toxicity. Zn has stopped calves from scouring when they were getting milk powder mixed with water which was high in iron.

Zn is not affected by iodine or salt, but low zinc accentuates the bad effects of low iodine intake.

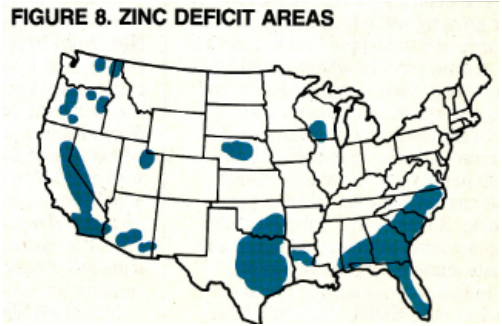
Optimum Levels

Ryegrass should have 50 mg/kg, white clover 40, red clover 45, cocksfoot (Orchard grass) 48 and lucerne (alfalfa) 40 mg/kg.

On range land, supplying Zn to animals can be difficult, but if pasture levels are below 25 mg/kg animal deficiencies can occur. I've seen animals with severe Zn deficiency in some of North America, Australia and New Zealand and it probably occurs elsewhere. In South Africa the government adds zinc oxide to the maize meal porridge flour, which is strange because the **oxide** form is a fertiliser and is inorganic and virtually insoluble, so only about half is absorbed. I know of one case where a vet stated to clients that "The faecal zinc levels in your herd are higher than in the other herds we have sampled – is it possible your cows are receiving zinc in a feed supplement?" They were getting it in Solmin at 0.006% of liveweight.

Zn intake by animals and people is much lower now than in the past, because galvanised pipes and reservoirs have been replaced by plastic ones.

USA zinc deficient areas.



Animal deficiency symptoms

A deficiency of Zn causes reduced weight gain, decreased feed intake and utilisation, a rough hair coat, decreased testicular growth, listlessness, swollen feet with open, scaly lesions, bone deformities, cracked or blemished

hooves (nails in humans), impaired night vision through low vitamin A, scaling of the skin and dermatitis on the legs, neck, head and nostrils.

If below 15 mg/kg in feed, loss of appetite, severe hair and wool loss and even skin lesions will occur so animal production can drop substantially.

Scaly, itchy skin causing animals to rub themselves a lot, even if they don't have lice, mange or ringworm, but still check for them.

Decreased appetite, so animals nibble just sufficient to satisfy immediate needs, especially around calving time when cow zinc levels decrease.

Cracked horns, ill thrift and slow healing of wounds are also common symptoms.

Eyes run, although low cobalt can also cause runny eyes.

Hair is dry, stiff and long, especially over the crown (top of head). Bare areas can also be caused by a fungus which a wipe with iodine can cure.

High somatic cell counts in milk and sometimes increased mastitis.

Hooves lengthen and can crack, and foot problems increase.

Scald where the hoof joins causing a lack of hair there, as shown.

Poor Vit A absorption causing runny eyes and poor night vision, so animals walk into and break through electric fences at night. Hair loss around eyes.

Scabs can form on teats.

Weakened muscles, so giving birth takes longer.

If low, supplement with Zn sulphate in fertilisers at 6 kg per hectare and/or in the drinking water through a dispenser at 20 grams per 500 kg cow. Start it gradually over a week and reduce it gradually once an improvement is seen.

Dr Neale Towers or Ruakura who opposed Gladys Reid's findings for about six years, wrote in the Waikato Times on 21 October 1992, "I know of no trial work that proves the existence of a zinc deficiency in cattle in New Zealand."

All that means is that he didn't search for any, and/or that researchers had been idle in not identifying and publicising deficiencies.

NZ Ministry of Agriculture veterinary investigating officer, Gary Clark, said that zinc deficiencies in animals are common, and I agree, while some still claim there are not.

I've seen plenty, with the worst one at Ruakura Animal Research Centre shown here. Many cows and calves with North American blood don't thrive because they are incapable of absorbing enough minerals from grazing pastures. They were selected and developed in North America on Total Mixed Rations (TMR), called TMF (Feed) in the UK, which have concentrates and optimum minerals added, whereas New Zealand cows have been selected and developed on mineral deficient pastures.

Animal excesses symptoms

Toxicity of Zn is rare and difficult to produce. Animals can tolerate excess zinc, but supplemented in excess it lowers Cu, Se & Ca in animal blood and/or liver. Surplus Zn is excreted in the urine.

According to AgResearch, there is evidence that excess zinc may interfere with the enzymes that protect red blood cells, contributing to mild anaemia and poor clotting of blood. Animals that have had eczema-damaged livers may be anaemic and their blood may not clot well because of a lack of clotting factors normally made by the liver.

De-horning yearlings in autumn after having had facial eczema and/or large amounts of zinc to prevent facial eczema, have been fatal.

Low zinc encourages the growth of fat rather than meat.

Causes of low zinc levels

High calcium levels reduce Zn absorption by ruminants.

Animals fed an excess of brassica crops.

Excess molybdenum, sulphur and copper, and excess iron from consuming it in soil from pugged pastures, or through overgrazing. However, iron when low can induce Zn deficiencies in plants.

Nitrogen fertiliser used in excess lowers the percentage of Zn in pasture. Sulphate of ammonia doesn't do this as much as urea.

P in excess lowers the availability of Zn.

pH above 7 lowers Zn availability, so severe Zn deficiency is often seen in animals in the dry, high pH areas of USA. The same areas are usually high in selenium, which also lowers Zn absorption.

Low sulphur levels inhibit the uptake of Zn (as does high S).

Low temperatures can inhibit Zn uptake by plants.

Zn levels decrease in lambs exposed to severe cold.

If buying supplements such as lucerne, get them from zinc adequate areas or spread zinc and molasses over the lucerne or other feed.

There is no Zn storage system in an animal, so Zn is needed daily in the feed or as a supplement.

If livers become damaged for any reason (eczema or poisoning) Zn is excreted in larger quantities, so needs to be replaced.

Cows in most conditions need at least 0.75 grams a day of pure Zn per day. Pasture with 45 mg/kg will provide this, but some animals will still benefit from more.

British feed formulations aim at about 50 mg/kg of Zn in the feed for lactating cows. Animals grazing soil contaminated pasture under wet or dusty conditions may be eating a ration with iron in the thousands of mg/kg and manganese in the hundreds, both of which decrease Zn absorption.

For facial eczema prevention, zinc sulphate should be administered through the drinking water, or zinc oxide agitated and drenched at the following levels -

Grams	Zinc Sulphate	Zinc Oxide
NZ 500 kg Friesian cow	34	11
NZ Friesian cross	30	10
NZ Jersey	28	9

Zinc All Year

Regular amounts of Zn are beneficial to animals in deficient areas. It is easy to supply through an on-line dispensing system using Solmin.

500 tonnes of Zn is supplemented to animals in New Zealand each year. Zn with high cadmium (Cd) levels should not be used. Only pharmaceutical grade zincs should be used.

Soil & Plant Deficiencies

Low Zn levels can reduce the production of N by some legumes and reduce seed production in some plants, but requirements of different plants vary widely.

This runner bean is low in zinc. Zinc sulphate at 10 kg per hectare or 0.01 kg or 10 grams per m2 fixed it. The maintenance rate is half that.

The potato at the top got zinc, below didn't.

The left potato below needed zinc. The right one got some.

Low Zn can delay silking and tassling in maize and reduce chlorophyll activity, resulting in yellowish or white blotches between the veins on leaves. Stems can be stunted with bunched up leaves.

Gladys Reid who has studied Zn perhaps more than anyone, found that Zn helps plants to cope with the strong sunlight in New Zealand.

Zn availability in soils increases as the pH rises to above 7, then it decreases. Zn uptake can be deficient in poorly aerated and low organic matter soils.

Five kg per ha (4.5 lbs per acre) of zinc sulphate spread with fertiliser or lime as carriers, usually increases pasture levels to above 30 mg/kg.

Yellowing of pastures which can occur in waterlogged soils, can sometimes be aggravated by a Zn deficiency.

Soil & Pasture Excesses

I've seen very high levels (200 g/kg) in a pasture analysis because the collector had touched a galvanised gate or wire before collecting the sample. One analysis I saw had an impossibly high zinc figure, showing that the sampler (a CPAg Member of the Institute of Professional Soil Scientists), must have touched a new galvanised gate before collecting the pasture. One I took a year later showed Zn to be at the optimum level of 45 mg/kg.

I don't know of any issues with soil and pasture Zn excesses, but too much of anything can cause a problem.

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The New Zealand facial eczema story

Waikato dairy farmer, Gladys Reid, conscious of the ill health of the average Waikato dairy cow, noticed in the 1959 USA Yearbook that niacin and Zn could have a beneficial effect on animals suffering from liver damage and muscle weakness. She started using Zn on a trial basis on one of her dairy herds at Shaftesbury in the Eastern Waikato. In the autumn of 1960 she was astounded when her one herd being treated with Zn not only had no facial eczema, but also during the facial eczema period produced about 30% more milk than her other herd, which she used as a control. Even the tanker driver asked why her one herd had not dropped in production, while others in the area had dropped.

She also observed that the Zn deficient animals had weaker muscles, including the tail muscles, which resulted in dung covering their tails because the muscles weren't strong enough to lift their tails out of the way. Later she found that low Zn levels weakened cows to the degree that calving took longer, also that Zn levels in the blood of cows at calving dropped drastically.

Salmonella has occurred on some sheep and cattle farms after drenching with large amounts of zinc, and more so when two to three weeks' facial eczema zinc requirements are given in one drench.

See Animal Health > Facial Eczema for full information on drenching with zinc to control it.

Zinc is used in the diet of young pigs to control post-weaning diarrhoea.

Calving Problems by Gladys Reid, Te Aroha, NZ.

"I was first attracted to the role of zinc in reproduction when reading a USA Department of Agriculture publication, 'Towards the New'. Then I was on the mailing list of the Superintendent of Documents USA for agricultural research publications. The title "Towards the New" attracted me because I felt that the facial eczema problem would not be solved by current knowledge here.

In this publication Dr Jean Apgar described problems in reproduction in the rat. (Dr Apgar was previously a member of the Professor Halley team when she was awarded a Nobel Prize for identifying

the structure of a t-RNA molecule, which was a seven year project.)

When Dr Apgar tried to breed rats on a soyabean meal they failed to survive (as with pigs), and the rat pups born to these females died shortly after birth. The females underwent excessive stress during labour. They took up to 24 hours to deliver the young (normal two hours) and they rarely survived.

The problem was that the Zn in soyabean meal was in an unavailable form, according to the article. Thus started a 20 year association, and the recognition by Dr Apgar that there was scientific information to back up my observation that Zn in the water troughs was protecting the livers of our cows in autumn. It was Dr Apgar who sent me the research material which showed that Zn dosing at about 20 times greater than normal protected the liver from certain poisons. This was the research of Professor Chvapil, who was investigating the liver rejection pathways in liver transplants. The Professor and Dr Apgar subsequently visited me, and I stayed with both of them in USA.

Dr Apgar's first paper on the effect of Zn deficiency at parturition was published in 1968. The Zn deficient female rats stopped eating a couple of days before going into prolonged labour. The stressed rats bled excessively, failed to groom themselves and their newborn, and failed to nurse them. The afterbirths were left in the cage. All this activity was monitored on closed circuit TV. It was subsequently found that the prolonged labour sent the female rats into shock with seriously subnormal body temperatures.

Food consumption and weight gains were recorded during the whole of pregnancy. Only five rat pups were reared to weaning out of 93 born in the Zn deficient group, but 112 out of 140 were reared in the Zn supplemented group. Zn was administered in the diet or in drinking water, or by stomach tube.

The fact emerged that Zn depletion could develop with surprising speed. It was apparent that Zn could not be mobilised fast enough from body stores for body needs under conditions of stress (similar to calcium and magnesium in stress). Under these conditions, outside sources of Zn are needed for body requirements.

It was not a case of a dietary deficiency in the true sense, as there was Zn in the body tissues. It was a case of supply not meeting the demands of stressful labour.

I pointed out to Dr Apgar that her stressed rats reminded me of stressed cows at calving, when they stood all day eating nothing, particularly in storms, and when many afterbirths were left uneaten in the paddock.

So I put zinc sulphate in the water troughs of the maternity paddocks at 20 grams per cow, per day, to replicate what Dr Apgar had done with her rats. I then had cows chewing their cud right until calving, and calves up and sucking in no time. A farmer friend told me that he had an old cow being supplemented with Zn, who was so full of energy that she was trying to decide whether to scoff more grass, chase the dog, or get on with calving.

At this time (1973) a CSIRO veterinarian in Australia was studying difficult calving. He acknowledged my comments and observations in a CSIRO report on Zn levels during calving, which he acknowledged I had initiated. He found Zn levels fell markedly during prolonged labour, and remained low after stillbirths. See the graph below.

The point needs to be made again that the crash in available Zn in the blood plasma has nothing to do with soils, fertilisers or grass levels. It is simply that stressful and prolonged calving increases the short term Zn needs, which can’t be mobilised fast enough from bone and other tissues. The same demands for calcium and magnesium also may not be met at calving, bringing on milk fever.

We had a cow that didn’t get up after all the normal treatments, so I suggested to our vet they it could be low in zinc, which he denied. I put a small handful in her mouth and she got up an hour later and outlived the vet.

This graph shows why zinc sulphate in the drinking water may be useful to keep cows eating on the day of calving. Cow sodium requirement also rises in late pregnancy, because of the increased blood volume. DeLaval FeedTech minerals contain zinc, and sodium.

This information was published in Australia and New Zealand in the 80s, and should be common knowledge, but it is not.

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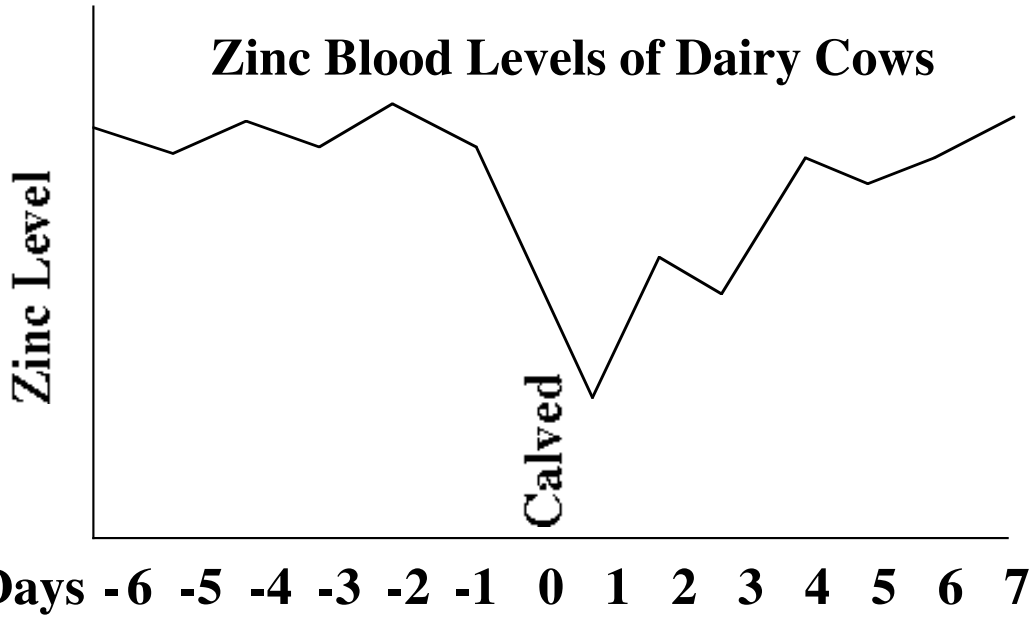

This chart shows how zinc levels drop during calving, as described by Gladys Reid.

information above shows how important it is to not allow zinc levels to get too low. Something AgResearch could research is what happens to blood Zn levels if facial eczema Zn is suddenly stopped. It is known that consuming excesses makes bodies absorb less, for example with calcium before calving, so it could happen when farmers suddenly stop supplying Zn for facial eczema control.

All changes in diets of animals and humans should be done gradually over a few days, or with bulky food, a few weeks. See Feeds & Feeding.

Sources (imported to New Zealand)

Zinc sulphate (35% Zn) is soluble in water. If low in pasture, it can be applied at 6 kg per hectare (6 lb per acre) per annum, with fertiliser.

Zn oxide (50-80% Zn) is insoluble in water.

Zn chelate (14% Zn).

Make sure they have minimum toxic elements such as cadmium.

Based on the British Pharmacopoeia (the world's drug reference) 1980 STD's, from the NZ Animal Remedies Board, the following should apply -

Zinc oxide should contain not less than 99% ZnO, not more than 10 mg/kg arsenic, 200 mg/kg iron, 100 mg/kg lead and 10 mg/kg cadmium.

Zinc sulphate should contain not less than 99% and not more than the 10 mg/kg arsenic, 100 mg/kg iron, 10 mg/kg cadmium and 25 mg/kg lead.

However, the analyses of Zinc Sulphate Heptahydrate on the NZ market in 1988 was -

	Source 1	**Source 2**
Zinc Sulphate Heptahydrate	99%	92%
Available Zn as Zn	22.4%	20%
Cadmium	1180 mg/kg	1 mg/kg
Iron	14 mg/kg	8,000 mg/kg

The analyses show that neither product is suitable for administering to animals. Avoid companies that sell poor quality items. Unfortunately, there can be variations within consignments. Ask for an analysis.

Cadmium is a toxic heavy metal, which like mercury, is hard to get rid of so should be avoided in fertilisers and supplements. Excess cadmium apparently upsets male hormones and can cause kidney damage.