Magnesium is important to apply in serpentine and be fed in Solmin and a lot of information applies to both systems, so is in this one chapter. Animals need it in the body all day and more importantly to sleep well at night, but bodies don't have a storage area for Mg.

Cows drenched with magnesium chloride have suffered mouth ulcers and gut problems. More is known about animal effects than human ones. Oxides should not be fed to animals because it is a fertiliser form. Some animals dislike Mg oxide, so spreading it on pasture to graze is not useful in preventing milk fever. See Animal Health, Milk Fever.

Mg is best absorbed into animals when consumed evenly over 24 hours, as in correctly serpentine fertilised pastures and in Solmin in drinking water through a dispenser, rather than drenched or fed once or twice a day, or in soluble mineral mixes containing magnesium in forms other than sulphate, most of which are toxins.

This on the right is ryegrass low in Mg.

Mg Oxide (a fertiliser) spread on to pasture before grazing is the worst way to feed it, because animals don't like its bitter taste. Mg Chloride is about as bad because after a while, according to knowing vets, it damages their stomachs. Mg Oxide (a fertiliser) spread on to pasture before grazing is the worst way, because animals don't like its bitter taste.

Mg deficiency causes light yellow coloured stripes each side of the veins. This occurs more in the older leaves than in the new ones. Severe Mg deficiency can cause yellowing of leaves from the base of the plant upwards, with some of the lower leaves dying completely, which is the opposite to iron deficiency.

This is the same patch as the yellow one above on our lawn six weeks after applying the equivalent of 200 kg per hectare (2 mg per m2) of fine serpentine containing 23% Mg.

Ryegrass leaves and others lose their chlorophyll in stripes, so go yellow from the tips down. Grass leaf tips have lower Mg levels than the stems, so for accurate pasture analyses, take both from ryegrasses.

Many interpret the yellow signs as nitrogen deficiency so they apply it, which makes the grass greener, but not for long, then the Mg deficiency symptoms accentuate. Mg uptake is slower in cold and wet weather than in Read Soil > pH for how to adjust it.

This on the right is minor Mg deficiency.

Too much artificial nitrogen usually reduces Mg levels in clover based pastures, not only by lowering Mg uptake through fast growing pasture, but also by reducing the percentage of clover.

According to the National Institutes of Health, "Magnesium is needed for more than 300 biochemical reactions in bodies. It helps maintain normal muscle and nerve function, keeps heart rhythm steady, supports a healthy immune system, and keeps bones strong."

Deficiency symptoms in maize (left), tomatoes (right) citrus, and grasses are yellow stripes with green veins.

See Forage Crops > Maize, and Gardens, for more information.

High potassium level is a cause of low Mg uptake shown on the right. Repeated use of 0N, 6P, 15K, 8S, (New Zealand 30% Potassic Superphosphate is a major cause of low Mg. In most situations salt can replace half the potassium, with better pasture growth and vastly

improved animal health, and at a lower cost. (NZ$240 instead of $900 per tonne). Cultivation releases potassium, so fertilise new grasses with salt if necessary, not potash unless very low, and, if necessary, take precautions like feeding 1 kg of hay per grown animal per day when grazing newly sown pastures. Doing this also reduces the chances of grass tetany.

Even clover based pastures, which are higher in Mg than grass only, still can't supply the required amount of Mg needed by high producing milking cows, so supplementing is essential, and should be given all year, preferably in a Solmin mineral mix in the drinking water. Fertilising with serpentine which is finely ground with 24% magnesium. A coarse serpentine had only 6% of magnesium available. The coarse particles can take up to 20 years to become available. The same serpentine ground to as fine as pepper, tested at 22%. Feel it.

If grit can be felt, it is too coarse. It should feel fine like powder.

The magnesium levels in the drier, more mature summer and autumn pastures containing clovers give a grazing cow nearly a kilo more magnesium a day than shorter grasses.

Using other than sulphate, magnesiums are less advantageous because they have to be converted into chlorides in the body. Epsom salt is magnesium sulphate. Avoid feeding too much because it is a laxative. The amount in Solmin is OK.

Magnesium helps healthy bones & teeth in humans and animals.

Medical authorities, in their ignorance, claim that the widespread incidence of osteoporosis and tooth decay in western countries can be prevented with a high calcium intake. However, published evidence reveals that the opposite is true. Asian and African populations with a very low intake of about 300 mg of calcium daily have very little osteoporosis. Bantu women with an intake of 200 to 300 mg of calcium daily have the lowest incidence of osteoporosis in the world. In western countries with a high intake of dairy products the average calcium intake is about 1,000 mg. The higher the calcium intake, especially in the form of cows' milk products (except butter) the higher the incidence of osteoporosis.

If calcium goes up, magnesium goes down and vice versa. A high phosphorus intake without a high calcium and magnesium intake, causes calcium to leach from the bones and leave the body in urine.

Dr Barnett, an orthopaedic surgeon, practised in two different USA Counties with very different soil and water mineral levels. In Dallas County, with a high calcium and low magnesium concentrations, osteoporosis and hip fractures were very common, while in Hereford with high magnesium and low calcium these were nearly absent. In Dallas County the magnesium content of bones was 0.5% while in Hereford it was 1.76%.

The same applies for healthy teeth. In a New Zealand study it was found that caries-resistant teeth had on average twice the amount of magnesium as caries-prone teeth. The average concentration of magnesium phosphate in bones is given as about 1%, in teeth about 1.5%, in elephant tusks 2% and in the teeth of carnivorous animals made to crush bones it is 5%. In regard to the strength of bones and teeth think of calcium as chalk and magnesium as glue.

Cancer and Ageing

Many studies have shown an increased cancer rate in regions with low magnesium levels in soil and drinking water. The main difference was an extremely high magnesium intake of 2.5 to 3 g in these cancer-free populations, ten times more than in most western countries.

A similar decline in energy production takes place when we age. The great majority of enzymes involved in the production of energy require magnesium. A healthy cell has high magnesium and low calcium levels.

To relax the muscle, calcium is pumped out again. However, as we age, more and more calcium remains trapped in the muscles and these become more or less permanently contracted, leading to increasing muscle tension and spasms. Together with calcification of the joints, this is the typical rigidity and inflexibility of old age. The higher our intake of calcium relative to magnesium, the faster we calcify and age. Most of the excess calcium in our diet ends up in our soft tissues and around joints leading to calcification with arthritic deformations, cataracts, kidney stones and senility.

The Rejuvenating Mineral

Some chloride is required to produce a large quantity of gastric acid each day and is also needed to stimulate starch-digesting enzymes. Magnesium is the mineral of rejuvenation and prevents the calcification of our organs and tissues that is characteristic of the old-age related degeneration of our body.

Many ageing individuals, especially with chronic diseases who desperately need more magnesium

cannot produce sufficient hydrochloric acid and then cannot absorb the oxide or carbonate. Epsom salts is magnesium sulphate. Magnesium can reverse the age-related degenerative calcification of our body structure and with this, help us to rejuvenate.

As we age, and this is most pronounced in old men and post-menopausal women, we become more and more inflexible. Calcification occurs in the eyes which causes cataracts and even the skin hardens, becoming tough and wrinkled.

CAUTION Magnesium supplementation should be avoided if there are kidney problems (severe renal insufficiency if on dialysis). Be careful with severe adrenal weakness or with low blood pressure. Too much magnesium can cause muscle weakness, if this happens temporarily, use more calcium. Signs of excess magnesium (hypermagnesia) can be similar to magnesium deficiency and include changes in mental status, nausea, diarrhoea, appetite loss, muscle weakness, difficulty breathing, extremely low blood pressure, and irregular heartbeat.

With a low magnesium intake, calcium goes out of the bones to increase tissue levels, while a high magnesium intake causes calcium to go out of the tissues into the bones. A high phosphorus intake without calcium or magnesium intake causes calcium to leach from the bones and leave the body with the urine.

Magnesium Osteoporosis

This is a disease where increased bone weakness increases the risk of a broken bone. It is the most common reason for a broken bone among the elderly. Bones that commonly break include the back bones, the forearms, and the hip. Until a broken bone occurs there are no symptoms. Bones may weaken to such a degree that a break may occur with minor stress. Mg regulates the whole calcium metabolism. It fixes the calcium where it should be, for example, on osteopenia and osteoporosis, and removes the calcium from where it should not be, from arteries and joints. Mg removes calcium oxalate stones from kidneys. It removes the excess calcium when it is in the wrong place and fixes the calcium where there is a deficiency provided that at the same time the person has a diet rich in calcium, so for those who take magnesium chloride there is no risk at all of taking excess calcium.

There is a risk of excess calcium, arteries and joints calcification for those who are not taking magnesium, which regulates the distribution of calcium.

Many people think that those who have arteriosclerosis cannot take calcium because it will harden the arteries. It will, if it is not taken with Mg, but if taken along with Mg, no, because the calcium is only going to fix where it should be. Mg is a regulator of calcium.

Serpentine

When Solmin minerals are not fed in the drinking water and a good serpentine is not applied with fertilisers, some form of Mg may be necessary for at least four days prior to and four days after animal transport, to avoid metabolic problems.

Magnesium aids digestion and calcium absorption, and increases iodine absorption by the thyroid. Cows and ewes can die of metabolic diseases and cows and ewes can suffer so badly from low Mg, that feeding it for a month before and three months after giving birth can increase milk production by 15%, worth NZ$400 per cow. This was shown by AgResearch trials in the 1970's after which the extensive use of magnesium was recommended in New Zealand, so we added serpentine to fertilisers twice a year and had almost no metabolic problems. Some still don't know about serpentine, which is a naturally mined marine product that releases Mg slowly, and, where it is deficient, which is most of NZ, gives higher pasture yields, and doesn't require frequent applications of Mg.

Sulphate in the above sulphate elements makes Solmin safe and palatable. All are non-toxic and sulphate helps reduce milk fever, so in USA it is added to totally mixed rations prior to calving. Mg oxide and chloride forms of minerals are toxic to animals so should not be fed. In USA some feed extra Mg sulphate (Epsom salts) in their concentrates to reduce milk fever. It is less toxic. Some worry about it causing scours, but this takes more than 100 grams per cow per day, not the 8 grams per cow in Solmin, or 16 grams in HiMag Solmin.

Farms that have been getting LimeMag, which has serpentine (the Mag), over decades have higher Mg levels in pastures and animals, with fewer metabolic problems than neighbours not applying it.

Many of my trials showed that heavy metal levels decreased after LimePlus, but increased after superphosphate mixes were applied.

Pasture analyses of trials I did on an equal cost basis (using NZ North Island dolomite price) per hectare on Pukeroro loam soil of the late Bill Chynoweth, and on Atiamuri pumice ash on Maurice

Thomas's farm, both with pH 6, but low Ca and low Mg levels in pastures, showed that applying a lime and Serpentine mix worked well.

One farmer who had very Ca and Mg deficient soils felt magnesium had not risen enough after applying the much more costly (in the Waikato North Island) dolomite. MAF in about 1950, and two of my trials in the 1970s described in this chapter, showed that the same cost of serpentine achieved far better results in total production of pasture and kg per hectare of magnesium. The farmer didn't know that Mg needs Ca to be increased first to make the Mg respond. The farmer reported that the earthworms had increased with an improvement in soil structure which LimePlus does faster than any other mix. Fast growing grasses stimulated by optimum calcium levels have lower Mg levels than slow growing grasses lacking Ca. Nitrogen stimulated pasture, reduces Mg levels.

Dolomite is very hard, so takes longer to become available, and for the same reason is not the best when fed or taken by humans. See Human Health Minerals > Magnesium. There are much better forms for humans such as Thompson's Organic Magnesium, which contains four different mild magnesiums to reduce allergy effects that some magnesiums can cause.

If spreading Mg oxide for pasture dusting, wear a mask to avoid the oxide bad effects. Cows don't like oxides so eat less, and their milk quality drops.

Fine serpentine is the best Mg fertiliser, but is not water soluble so should not be fed or consumed.

The Dolomite promotion I've seen and been given doesn't show equal cost comparisons with other Mg sources. I've seen dolomite demonstration farms and been disappointed.

Don't buy dolomite if it is more expensive per kg of Ca (24%) and Mg (12%), which it is in the North Island of New Zealand and the South Island where serpentine is mined in Marlborough and Southland.

Dolomites vary and some have lead and other impurities so, even if cheap, get a complete current analysis with a date on it before buying any.

Usually faster growing grass has less Mg and other important elements.

When cultivating to crop or resow, 5,000 kg per hectare on some mineral soils, and more on most peats, may be needed, depending on the calcium level, soil type, depth of chisel ploughing to be done, and the previous liming history. (Read Peat Part 1.) Excess lime without Mg can suppress it so check levels in the herbage. If in your area you have a choice of limes, get analyses, and, if Mg is needed, choose one with serpentine. Graymont has 2.14% Mg worth $6/tonne, bringing its price down to $19/tonne.

A Te Awamutu vet organisation in the 1970s found that cows getting winter brassica crops suffered a lot fewer metabolic problems than those on mainly pasture. Brassicas have about 1% sulphur which is more than twice what is in pastures. In North America they proved that sulphate before calving reduces milk fever. Solmin has sulphate elements which also helps reduce milk fever.

Serpentine needs to be finely ground and soils slightly acid (under pH 6.5) to make it available. Serpentine superphosphate (5% Mg), when used regularly, maintains adequate Mg levels in pastures on many soils, including peat, which has none to start with. Calcined magnesite (30 to 50% Mg) at 40 kg with fertiliser has increased pasture levels within three months.

800 kg per ha of Sechura RP provides 2.4 kg of elemental Mg per hectare.

Serpentine is a hard rock, so the coarse particles would take decades to become available. Some of Quinphos phosphate was coarse and MAF figures showed that it would take 40 to 50 years for all to become available.

Obviously lime was applied because it is the first essential and works better with serpentine. It gave better soil, pasture and animal health, and contributed to our 30% higher milk production than the neighbours who used 30% potassic super (0-6-15-7-0). We also grew and grazed forage crops, and fed some hay and/or silage as required. Our metabolic problems were rare, while neighbours' were high.

Some of the best farmers in New Zealand have been fertilising with Mg silicate from serpentine since 1955 that I know of, to prevent milk fever and grass tetany, and to satisfy the earthworms. They are animals and need the same minerals. See Soils > Earthworms. Unfortunately the NZ Ministry of Agriculture criticised those fertilising with serpentine until the 1980's which was 25 years for them to learn that the best farmers were right - again.

The October 2005 New Zealand Journal of Agricultural Research, 2005, Vol. 48, showed that magnesium fertilisers, such as Mg Oxide and Mg Sulphate, increase pasture tissue mineral levels quickly, but had to be applied frequently to maintain pasture levels, and about 50% soon leached to

below 150 mm so was lost, wasted, and caused pollution. Serpentine was slower at lifting pasture levels, but almost none leached, because figures showed that over time, 95% of Mg in serpentine was taken up by the pasture. As usual they didn't compare costs, but in the NZ Central North Island serpentine is a third the cost of others, so more can be applied to raise levels more quickly, knowing that it won't leach. Acidity speeds its release so, if S is needed, adding elemental sulphur helps. Adequate S helps prevent milk fever.

Because of the ignorance of most fertiliser companies, and their greed, and AgResearch, most farmers in New Zealand waste money on too much potassium (K) which suppresses Mg, when they should put that money into serpentine, lime and coarse agricultural salt. The latter two improve pasture palatability and animal health and reduce K leaching, so applying them is not a cost, but a profit.

High K, especially in Muriate of Potash, has a bad effect on soils, seedlings and animals. Some old time farmers claimed that bloat in NZ started after they started applying Muriate of Potash in the 1950s in place of Sulphate of Potash.

Magnesium is a cation necessary for the development of chlorophyll, the green pigment in plants, and photosynthesis, and in animals for Ca absorption, bone structure, health and growth.

A Mg grass mineral tissue level of at least 0.28% should be aimed for by fertilising with serpentine, but the higher the pasture potassium level, the more Mg, Na, B and Ca needed for animal health. White clover has 0.31%, red clover 0.35%, lucerne (alfalfa) and chicory 0.4%. Animals need it more than soils and pastures, so, if necessary, it is economical in winter to supply it in High Magnesium Feedtech soluble minerals in the drinking water.

Magnesium levels in many NZ pastures are decreasing, as more potassium, nitrogen and fast release fertilisers and less lime are applied. Cow requirements can be met with dusting pasture, or making a slurry and pouring Mg over hay and/or silage, drenching and through in-line soluble mineral dispensers, but it is important to have pasture levels at the optimum so that animals get Mg all day and night as they graze.

Some parts of the Hauraki Plains and Whakatane in NZ, and Wisconsin and surrounding states in the USA, have excessively high Mg levels in soils, which makes soils very tight and hard.

Some deep rooted plants, including legumes (especially lucerne) and some weeds, have a higher Mg content than ryegrasses in the same soil, because they draw Mg from below the grass root depth, so can increase the Mg content of the topsoil slightly. Earthworms can also bring up some.

Absorption of magnesium occurs in the rumen and abomasum and varies from 7 to 33% in dairy cows to 70% in milk-fed calves.

Animal health

Dry cows getting 8 kg of pasture dry and cows before calving get only half the minerals of milkers eating 16 kg.

Calves can suffer from insufficient Mg, so feed them a good soluble mineral mix from after the first week or ensure that the muesli or pellets have enough Mg. All-milk diets without Mg in some form cause calf body reserves to become depleted.

Some have written that fertilising with Mg doesn't increase Mg levels. I disagree. Were they measuring soils or pastures? Soil measurements can take a long time to rise, as with P, because of the soil measuring systems. Hill Laboratories repeatedly refer to the inadequacies of soils tests in their Newsletters. The much more accurate pasture levels move sooner, and are what the animals are eating. Also, some have kept applying K, so what do they expect, because K lowers Mg levels and causes some of the problems that Mg helps prevent.

When pastures are NOT forced with high levels of N (worst), K (second worst) and water-soluble P, and when pastures are allowed to grow a little longer before grazing, Mg levels can be adequate. Short grass has less than long grass, but levels decline in seeding grass as minerals go to seed.

The New Zealand human health authorities (who are far from authorities on minerals) still recommend calcium for osteoporosis prevention, when more magnesium (and zinc) are what bones need. Ca can suppress Mg and increase osteoporosis.

Mg pasture levels on farms where serpentine has been applied for a few years are usually adequate, and low Mg animal health problems are fewer, provided potassium is not applied unless shown to be needed in a pasture analysis.

However, Mg supplementation to animals is still necessary for high milk production.

Ruakura Animal Research Centre reported in 2000 that 98% of dairy farmers supplemented pasture

diets with Mg to prevent milk fever.

A high crude protein content in pasture from excess artificial nitrogen use causes excessive ammonia production in the rumen and lowers the animal's absorption of Mg. Pasture with a low sodium content has less Mg absorbed by the animal, especially if the animal is not fed a sodium based mineral supplement like Solmin which has 88% salt, because its saliva will contain less sodium.

Some NZ agricultural scientists have expressed concern about the decreasing Mg levels in pastures in some areas, however, farms using correct fertilisers (no urea) with adequate serpentine and salt have no problem, and some farmers' cows grow bigger. See GrazingInfo > Testimonials.

Mike Templer then of Ngahinapouri, Waikato, a top farmer, who had applied serpentine for decades and didn't use artificial nitrogen, had his vet test his cows for Mg. The vet reported that levels were optimum and wrote, "Keep feeding the same supplements." Mike was not feeding any.

Animal deficiency symptoms

O'Connor et al. (1987), hypomagnesaemia is a major cause of lowered milk production, affecting about 30-50% of dairy herds.

Cows can suffer from sub clinical grass tetany even when body reserves of magnesium are not depleted. Symptoms of minor Mg deficiency can be any one, or more, of the following - sunken sleepy staring eyes, heads held low, walking stiffly, lethargy, staggering and hind leg weakness and nervousness.

Farm dairy nervousness can also be caused by many other problems. See Animal Health > Grass Tetany and Animals > Stress.

A major deficiency causes muscle twitching, staggering and not eating, convulsions, teeth grinding, frothing at the mouth, rapid heart beat and respiration, grass tetany and milk fever, all of which can be followed by death within a day.

Low magnesium levels increase hot weather stress in animals, so where necessary it should be supplemented. In USA Mg has been found to reduce summer production slump problems (salt does too) and encourage increased feed intake, which is important on pasture, because high consumption achieves higher animal production, especially in summer heat.

Animals' ability to use Mg is decreased by high fluorine levels.

A fatty liver in a fat cow, or in one fed incorrectly, can reduce Mg levels, which, with oestrogen, can impede calcium uptake.

Both cold and hot weather lower blood Mg levels. Cloudy periods are worse and short sappy grass has less Mg than is in more mature grass.

In some cases, the use of nitrogen can actually increase the Mg (and sodium unless very low) content of herbage, but when potassium is high and nitrogen is applied, metabolic problems frequently occur, especially if sodium levels are low.

Some researchers have suggested that low sodium (a digestive juice in saliva) impede the transport of Mg through the intestinal wall. Sodium in a soluble mineral mix should be fed all year, ideally through a dispenser to the drinking water.

When putting animals out to pasture from confinement, special care should be taken by making the change gradual. Feed them hay and/or silage, then only 20 minutes of pasture the first day, increasing gradually up to three hours after 10 days. An animal can be full and lying down within three hours on adequate good pasture. If it is necessary to give more than what they can get in 20 minutes, give them two 20 minute breaks about 12 hours apart with other feed in between. This slow change of diet should be carried out even if GT is not a problem.

Upset or stressed cows will show low Mg in blood samples, so when taking samples don't leave cows in the yard for hours, have them in a close reasonable sized paddock, control the dog, get them in slowly and quietly, just ahead of the vet arriving, and slow down yourself. Take the blood samples before any other treatment, and in the morning before they get any Mg supplement. As with all animals, don't look them in the eye, because to them it is threatening, and it stresses some.

The Mg level in the blood of animals about to go down with GT is low. Once down, the blood Mg level can increase as Mg is drawn from the rest of the body, especially from muscles. If unsure, measure the blood levels of other cows. Long term deficiency lowers Mg levels in bones. Calcium needs Mg to go into bones.

Dry feeds need only about half the recommended levels to maintain healthy cows, possibly because it moves through the digestive tract more slowly, or possibly because more saliva (the first digestive

juice) is taken down with dry feed. Animals on lush pasture don't produce enough saliva, especially if low in sodium. The person who produces an artificial saliva that can go in the drinking water through a dispenser will make a fortune and help animal health, certainly reducing bloat.

Supplementing with Mg

It is not a good practice to recommend exact dose rates in a book or from afar, but there are so many mistakes made with Mg supplementation that it will be explained here. DairyNZ recommend that dry cows have a Mg requirement of 0.35% of diet, and lactating cows 0.28%, but typically doesn't say which magnesium, and there are big differences.

The reason for the different percentages is that dry cows get only 8 or 9 kg DM, less than half as much pasture dry matter as milkers so only half the minerals.

If, despite using Mg according to the instructions, milk fever and/or GT occur, try changing the brand. Some are not finely enough ground, not pure enough, not soft or palatable enough, not easily digested, or are too diluted. Australian Causmag XLM is a better Mg oxide containing 55% soluble Mg and no toxins I know of. Many on farm trials show that it gives the best results in New Zealand, because it is fine, soft and gets results. Some Mg oxides can have the same analysis, but not achieve such good results. Mg oxide must be finely ground like fine powder. There is plenty of evidence of poor quality Mg products. A dairy farmer using another brand had nervous heifers during milking. He changed to Australian Causmag XLM and they settled down. Another farmer had several cows die while on another brand and changed to the same amount of Causmag, and health in all animals improved. Another farmer changed from a Mg oxide to Australian Causmag and improved from two cows going down per day to one a week in a 300 cow herd calving about eight a day. Another had low Mg in blood and stressed cows, that improved after changing.

I recommended that 340 cow dairy farmers Brendan and Tania Fernyhough getting 10% milk fever change from chelated minerals to applying LimePlus, and feeding Solmin, and milk fever almost disappeared in a few weeks.

In the 1980s, a good 500 cow client had only one (the same cow) get milk fever each year. His son changed from Solmin to chelated minerals, concentrates and palm kernel extract (PKE) with grains, and applied less lime and less boron and soon his cows showed deficiency symptoms and had more metabolic problems.

The percentage of elements absorbed by animals can be low and can vary depending on the level of deficiency in the animal. Mg deficient animals can absorb as much as 50% of what is consumed, while those with adequate levels may absorb as little as 10%.

Mg is not stored in the body so must be supplied every day. If not it will be taken from muscles (causing cramps, strokes, or heart attacks in humans). Insufficient sodium which does many things, is a digestive aid increasing Mg absorption.

Low Mg reduces zinc levels in some animals, impairs vitamin D absorption and increases cold and hot temperature sensitivity and their ill effects.

Most soluble mineral mixes (SMMs) don't supply enough magnesium for milk fever and grass staggers control before and after calving. All animals should be supplemented with the best soluble mineral mix of nine essential elements all year. This and correct fertilising gives larger stronger animals. See Free Ashford Testimonial.

Avoid using rates higher than necessary. Every farm varies in its requirements, depending on pasture analyses, but cows will indicate the amounts required. Watch for staggering and sluggishness from too much, and ill-thrift and milk fever from too little.

Minerals and other supplements help animals more when sunshine hours are low. Remember how poorly cows milk in springs when sunshine is lacking.

Animal excesses

Too much Mg oxide (calcined magnesite) can raise the rumen pH, decrease fermentation if above neutral (pH7), cause scouring through poor digestion, and cause milk fever type symptoms. Animals become sleepy, sluggish and difficult to move, with staggering, and symptoms similar to milk fever, but they don't respond to treatment. Dung can contain large bubbles and blood can be nearly black in colour. Small fine bubbles can be excess molybdenum or copper deficiency, and if smelly, can be salmonella.

Feeding excessive amounts (50 grams per cow per day) of magnesium reduces the manganese and phosphorus levels in the blood, and iodine uptake is inhibited.

An excess of Mg, manganese and/or Fe lowers the absorption of P. Get the whole diet right, after which less Mg will be needed.

Soil & plant deficiencies

Good pasture (75% grasses and 25% clovers) should have at least 0.29% Mg in summer and at least 0.25% in winter. Pure ryegrass should have between 0.22% and 0.24% Mg in winter. Levels decrease in prolonged overcast weather, especially in young sappy pasture. Mg levels increase with maturity, then decrease at seeding as elements move to the seed, because the leaves have finished their job and are ready to die.

When levels of elements antagonistic to magnesium (nitrogen, potassium, aluminium and iron) are decreased or increased to optimum levels, pasture uptake of Mg can increase without applying more to the soil. Excess aluminium or iron leach Mg. High potassium levels lower the uptake of Mg more than anything else. Pasture levels are lower in winter and higher in summer. See the Element > Interactions spreadsheet. Low Mg levels in pasture analyses quite often show up soils deficient in Ca, because calcium influences the translocation of elements. Liming neutralises aluminium toxicity, so ryegrass roots go deeper and source the previously untapped Mg. In Missouri, USA, it was found that after applying phosphate to fescue pastures the Mg levels rose. This, and other evidence of it happening show that Mg and P work together, but it could be aided by the added phosphorus encouraging root growth into previously aluminium toxic areas, that then give roots access to more Mg. Low Mg reduces the uptake of phosphorus and reduces legume nitrogen fixation.

High nitrate levels lower pasture Mg levels. Animal effluent, calcium, potash, nitrogen, aluminium and some other elements depress Mg levels. Where effluent is applied repeatedly, Ca, Na and Mg decrease, so should be applied regularly.

Applying magnesium reduces aluminium toxicity, as does applying lime and phosphorus, which at the correct levels also increase magnesium availability. Analysing pasture tissue minerals helps decide the optimum lime and fertiliser to maintain a balance.

Soils that don't have optimum Mg levels will become deficient when large amounts of water soluble fertilisers are applied, which give higher pasture production.

Mg soil levels depend on the parent material, but oxygen is needed in soils for its uptake. Wet soils lower the plant uptake of Mg.

Pastures in acid soils take up more manganese (Mn) and aluminium because they are dissolved more in acid soils, at the expense of Mg. Mg is more available in close neutral soils, but 3,000 kg per hectare of agricultural lime can reduce Mg levels, so if Mg is even a little low, apply LimeMag which is 97% CaCO2 agricultural lime and the chosen percentage of serpentine (23% Mg) required.

Prolonged lack of sun can lower pasture Mg levels. If the pasture growth rate is reduced, cows will be grazing more fresh pasture regrowth, which has a very unfavourable levels of high N & K and low Mg & Ca.

A clover dominant pasture has more Mg than a grass dominant one, because clover has 50% more Mg and 15% less K than perennial ryegrass in the same paddock. High K decreases both plant uptake and animal absorption, but Mg and Na help pastures take up K out of the soils, which without Mg and Na, don't release K as well.

When pastures grow faster, their magnesium level decrease, and when nitrogen is used the percentage of clover decreases, which also lowers magnesium levels in the overall pasture. Pasture grown without sunshine is also low in Mg. When grown on the high magnesium soils of Wisconsin and adjacent states, mixed pasture levels can have 0.35% which is good for animal health when levels of other elements are optimum. However, even at high levels today's high producing cows can still need extra Mg, especially if N is high, partly because lush high N pasture travels through the gut very quickly. When scouring occurs, mineral absorption is lower.

The above recommended pasture (feed) levels are higher than the NRC suggested level. This could be necessary because of the high K and N levels in typical NZ pastures and the fact that NZ pasture is usually grazed in a more lush condition, which causes it to pass through the digestive system more quickly, so all the magnesium is not absorbed. Feeding as little as 1 kg (2.2 lb) a day of good hay with short lush pasture can improve digestion and reduce metabolic problems in cows.

Between 1985 and 1995 the average magnesium levels of Waikato dairy pastures decreased by 33%. Those applying enough serpentine in LimeMag lost little or none. Levels remained high in the few high magnesium soils in the Hauraki Plains, southern Bay of Plenty and other high Mg soils.

Applying too much agricultural lime to soils low in Mg can reduce its level, so only apply lime if ryegrass Ca tissue is below 0.7%, then apply serpentine to aim for 0.27% Mg in ryegrass tissue. It can be higher in high Mg soils. In most soils Mg should be applied with lime. In most soils Mg is low so should be applied with lime. Graymont lime near Otorohanga, contains % Mg.

Soil & plant excesses - see the Interactions spreadsheet

Feeding too much Mg to cows on high Mg soils can worsen metabolic health problems. Excess Mg lowers Ca, P, K, Co, Cu, I, Se and Zn uptake by plants, and absorption by animals. High Mg levels can make pastures have high N levels and be unpalatable. Soils from old estuaries can be tight from high Mg and sometimes have high Na and a high pH. To improve soil structure and give 54 benefits, Ca levels must be adequate.

OrganiBOR slow release is best (see Boron). Salt and/or sulphur may also help if deficient. A pasture tissue analyses of minerals show element levels. A magnesium deficiency accentuates the ill effects of low boron. Don't apply either before analysing herbage boron and magnesium levels, because excess Mg can worsen the problem and suppress calcium and phosphorus uptake, make the soil go tight (compact) and increase the loss of soil nitrogen into the air. See the free spreadsheet called Pasture Mineral Analysis Excess Mg (or sodium or calcium) can reduce the osmotic action (the movement of water) in soils, lowering the amount of moisture some plants can take up, so they wilt sooner. Insufficient Mg can have the same effect. Organic matter and lime help improve it, but they don't change it. Shallow spinner ditches 20 to 30 metres apart help by allowing excess rainfall to run away, rather than lie on the pasture and make it too wet to be grazed. See Drainage.

Where Mg oxide has been spread on pastures for animals to eat for the control of metabolic diseases, and some has been left uneaten, it has slowed pasture growth, is a waste and not achieving its aim.

Mixing 20 grams of Solmin with each 40 grams of Causmag oxide helps it to stick to the pasture, and encourages cows to eat the Mg oxide, which is very bitter, so more is eaten and less wasted. Soil excesses in patches are then less likely and better animal health is achieved. The remaining 10 to 20 grams of Solmin can then be fed in the drinking water through a dispenser.

If cows get sluggish, reduce the magnesium. If a metabolic problem occurs, increase it.

Reducing high Mg levels in soils is difficult. Sulphate sulphur, in Single Superphosphate if P is required, in Sulphate of Ammonia if N is required, and in Gypsum (23% Ca, 18% S) if Ca is required, all help leach Mg.

Sources of magnesium fertilisers

Don't fertilise with Mg without first analysing pasture tissue. If soil levels get too high they get tight and imbalances occur.

Water soluble fast release Mg fertilisers in high rainfall areas leach to below the root zone.

Slow release magnesium fertilisers such as serpentine must be finely ground to become available to plants within a reasonable time.

Serpentine is found in Aria (near Taranaki) and the north and south of the South Island, New Zealand, China, Afghanistan, South Africa, USA, and England.

Sources for feeding

Some fertiliser-grade imported magnesiums can have high levels of lead, cadmium and/or arsenic, so don't feed them without checking with suppliers. For feeding, buy only Agricultural Compounds & Veterinary Medicines Group approved feed-magnesiums with a complete analysis on the bag, and buy from reputable companies and sources. Some of this has been published in the NZ Veterinary Journal, but many farmers still feed it.

If all pasture levels are correct and pre-winter feeding of HiMag Solmin, no other Mg supplements should be needed.