Calcium (Ca) Version 9.7 4 December 2016

Limestone is the remains of sedimentary rock composed largely of calcium carbonate - CaCo3. I and many farmers in many parts of New Zealand and the world have done lime trials in paddocks by spreading optimum rates of finely ground lime or LimePlus (lime with deficient elements) over small trial areas, and pasture or crop growth has been more than they had ever seen before. Graymont Aglime (was McDonald's) near Otorohanga averaged 2.4% magnesium (Mg) in their standard lime in early 2016, so it is a true LimeMag, whereas Rorisons call theirs LimeMag, but it has no mg which has to be added in serpentine at a high cost.

Rorisons claimed that their quarry plant enables the production of ultra fine lime particles. This is untrue. It is the most coarse lime I have ever see. McDonald's lime in late 2015 was like powder, far finer that most. Graymont bought them. Their available calcium level in 2016 was 20%, with 2.4% Mg worth $6 per tonne for the Mg, reducing the total cost to $19/tonne while Rorison's at the same time was only 13% Ca because lumps are not available and won't be for decades, so can not be measured. There are other very fine limes in New Zealand at about $25 per tonne.

One Testimonial says that pasture production increased three times after LimePlus. Many have been amazed when their animals have grazed the limed areas down to the soil, and left pasture in the 'no lime areas' ungrazed.

These show how smart animals are, to find and eat the better limed pasture, and how dumb some people, scientists, researchers and even some top farmers have been and many still are, by not applying sufficient lime that costs only about $25/tonne, as opposed to often unnecessary potash (K) at $800/tonne being applied. Excess K kills red clovers and if more, kills white clovers.

Pasture land is expensive, but many farmers buy large areas of land, then find that they can't afford to feed it all correctly, and then complain when it doesn't grow much so they make no profit. In many cases half the farm correctly fed makes a lot more profit, and grows as much as the whole farm poorly fed. Some farmers encouraged by some vets and other sales people, buy grains and other feeds, which make no profit. Trials in many countries, including USA and Canada have shown that bought feeds fed to cows make no profits, while grazing pasture makes a profit even when milk payouts are low.

In 1955 we bought a 40 ha poor pastured two metre deep peat runoff for £4,500 and limed it all and chisel ploughed and correctly fertilised four hectares every year, which was all we could afford to do.

In 1956 we bought 20 ha of Manuka covered 6 metre deep raw peat, and chisel ploughed in 13 tonnes/ha of lime and applied 1 t/ha more lime on the surface and harrowed it in with one tonne/ha of fertiliser, to 2/ha each year, which was all we could afford. After two years each hectare carried two cows, which was close to what the best Waikato land was carrying then.

I was ridiculed and called the 'Lime king' but won the NZ Dairy Board's Most Improved Dairy Farm in the Waikato in 1959, and was written up by the NZ Dairy Board Exporter magazine and NZ Herald, but not in the Waikato Times, which is now one of 94 Fairfax, Australia, owned negative publications, that reports bad farming showing their envy of New Zealand farmers.

The importance of adequate calcium for high yields

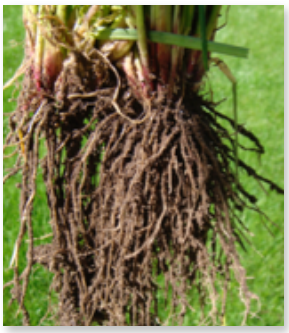
After finely ground agricultural lime is mixed by chisel ploughing down to as much as 40 cm in acid peat, it becomes a mixture which is ready to support good pasture. If lime is coarse, as is Rorisons Aglime which is lime with Serpentine added, it will not all be available to grow pasture for decades. The uneaten dung pats, uneveness and lack of clovers in this pasture near Putaruru, shows a lack of lime. It needs 3 to 4 tonnes of LimePlus/ha.

The many effects of lime

Liming stimulates vigorous growth of all, except the few acid liking plants such as sorrel, chickweed and moss. Ryegrass, clovers and other legumes, also benefit by lime reducing the adverse effects of aluminium and manganese and making nodules grow on legumes.

Apologies for this Calcium chapter being so long, but if you apply enough fine LimePlus to all your soils, animal production and profit should both escalate. The increasing number of long dry summers make the deeper rooting of pastures even more important. This can be achieved with LimePlus, which is not a commercial product, but the name I use for good quality finely ground agricultural lime, with deficient elements based on leaf analyses of ryegrass leaves (or the most common grass on your farm).

In this eBook the word 'lime' always means the best quality finely ground agricultural lime not other forms of lime or calcium. See Sources on page 26 for a list. Ryegrass roots should look like these below. The red bases of the stems show that they are ryegrasses.



Ryegrass roots should look like these on the right. The red bases of the stems show that they are ryegrasses.

This Walton, Waikato soil on the right is a typical hard pan soil causing short ryegrass roots to grow horizontally because the high aluminium levels stop ryegrass roots from going down. The small, few white (low N) clover nodules show molybdenum deficiency caused by low Ca. Read Molybdenum. After two four tonne/ha applications of LimePlus, chisel ploughing and forage cropping, this changed to the photo on the right, showing clover and grass and roots down 35 cm.

Ryegrass roots should look like these on the left. The red bases of the stems show that they are ryegrasses.

This and the top of page 3 are what the pastures were like even in wet weather, because they had not had lime for five decades, because the pH was OK!

Calcium, called 'Fine Lime' by some companies fed to pasture grazing animals is very bad for them. Lime is a fertiliser, NOT a feed. I've helped dozens of farmers solve animal health problems by stopping them feeding fine lime. Some companies selling it, take it out of the lime they then sell to you, as agricultural lime, so check fineness of them all.

Most cows in most areas need magnesium, which the best limes have some of, especially to grow clovers, which contain 50% more Mg (33%) than ryegrass has (22%).

Graymont lime (was McDonald's, Otorohanga) contained 2.4% magnesium in 2016 which is worth $6/tonne which makes it good value, by not having to buy serpentine. Five or six tonnes/ha apply ample Mg, saving close to $200/ha of bought Serpentine.

Lime trials in Ca deficient soils, which is almost all NZ, achieve these 50 benefits.

1. LimePlus is alkali so makes the good elements (phosphorous magnesium, boron, cobalt, etc.) more available, and the bad ones (aluminium, mercury, manganese, cadmium, etc.) less available. Sulphuric acid treated low quality reactive phosphate (superphosphate) fertilisers are acid, so make the bad elements more available. These have been observed by me, many farmers, and in a

government lamb growth trial in King Country NZ ash soils, done between 1975 and 1982. Live weight and wool weight gains were higher in most years, and the lambs were observed to have grazing preferences for the limed pastures. Previous trials had recommended no lime because of 5.9 pH. The same trial examined the mineral content of herbage for limed and non-limed pastures. The limed pastures had lower potassium levels, higher sodium levels and, of course, adequate Ca. Sheep and cattle like clover based pastures, so eat more and produce more from it. Clover is highly digestible and has more Ca, Mg, Cu, Co and B than grasses, all of which animals need, and less K, which animals on many farms get too much of and dislike.

2. Liming improves soil structure by improving soil tilth and crumb formation so holding more moisture.

3. Too much K makes grasses hard and unpalatable, and makes animals sick. They only need 1% in their feed (the Northern hemisphere standard), certainly not the 4% that is in many NZ pastures. The 2.2% I recommend measured in ryegrass leaves and stems is to achieve optimum clover and pasture growth which are essential.
4. Increases the legume content of pastures. Without calcium and its synergisms, of magnesium, OrganiBOR (boron), red clovers suffer and can die out if potassium is above 3.4%. If above 4% clovers die out.
5. Encourages clover rhizomes (surface runners) to spread and take root over bare areas after LimePlus has been applied.
6. Decreases pennyroyal, gorse, rushes, dandelions, buttercup, moss and other weeds that like acid conditions, and decreases other unwanted plants, helped by healthy pasture plants swamping them out. Cows eat buttercup when ryegrass is 0.9% Ca or close to it and other elements are where they should be, so pasture become more palatable.
7. Animals prefer LimePlus fed pastures and the variety of good plants it encourages, such as plantains and chicory. It is when there are too many weeds that animals leave them, because they are unpalatable and animals are so busy trying to find enough grasses and clovers to eat.
8. Increases soil fertility which gives more even grazing of pastures, an important factor with many benefits, such as less perennial ryegrass and other grasses going to seed too soon, less overgrazing of some areas, and less topping (clipping) required.
9. Improves pasture palatability, pasture health and growth - legumes in particular. Grasses become softer. Salt, when needed (away from coast), does the same and potassium above 3.2% does the opposite, i.e., it makes grasses harder and unpalatable. Obviously soils in high sodium areas won't need more. Aim for no more than 2.7% of K in ryegrass leaves and stems, and about half that in supplementary feed.
10. Improves the health and growth of animals. Young animals don't grow well when Ca is lacking.
11. Decreases wilting in leaves and increases pasture growth especially in dry periods.
12. Makes fixed phosphate available to plants. In 1950, it was shown in USA trials that in low Ca soils, with low phosphorus (P) levels, plants responded to P without lime, but not to lime without P. So ensure that P levels are adequate. After Ca, P is the next most important element required for soils, pastures and animals.
13. Increases humus in soils which helps retain more Mg, K, Co, and Se by decreasing leaching, especially if the Na level is near the optimum of 0.2% in ryegrass. If Na is low, applying coarse agricultural salt at about 50 kg per hectare with lime or fertiliser, increases some element levels and retention of expensive ones like potash at NZ$850 per 1,000 kg. Salt (sodium) increases animals' saliva which is the first digestive juice.
14. Gives substantial increases in pasture growth in the following and subsequent years, with pasture becoming greener within a month, and growing more than if N had been applied. This is because Ca stimulates soil microbes, which then make more N available. A few years after applying lime in Tasmania, Australia, increases in pasture growth of up to 50% of dry matter (DM) per ha per year were achieved in dry autumns.
15. Softens pastures, making them more palatable. The softer leaves reduce ryegrass pulling, a major cause of perennial ryegrass thinning, often blamed on soil pests such as grass grub and Black Beetle.

Calves and sheep ate the limed trial plots in paddocks shorter and earthworms swarmed to them from low Ca areas.

16. Reduces ryegrass pulling if caused by high Al levels in soils, which inhibit the root penetration of some plants, especially ryegrass. Velvet grass (Yorkshire Fog) is not affected by high Al. P also lowers the pH so increases Al toxicity. Near Pietermaritzburg, South Africa, annual ryegrass pulling by cattle was so bad that it looked as if the paddock had been chisel ploughed.
17. Makes Al and Mn less soluble (so less available), which is an advantage, because both are toxic and can be in excess.
18. Lowers high Mn levels, which are common in poorly drained soils needing lime. Excess Mn in pastures causes stress in animals, which can make them difficult to handle, and so stress the staff.
19. Ca is essential for legumes and increases their leaf size, growth and nodulation, which in turn increases overall pasture growth. Legumes have nearly double the requirement for Ca of grasses.
20. Increase pasture Mo levels. This is beneficial when below 1 mg/kg. If at least 1.5 mg/kg in pasture, and Cu is 12 mg/kg or more for cattle (less for sheep), it will reduce nitrate's ill effects on animals.
21. Alleviates swollen joints in animals caused by excess P. Read Phosphorus and Boron in Elements.
22. Increases Fe uptake. After applying lime on a Waikato farm, low Fe and anaemia in cows ceased, which could be a reason for warts.
23. Helps rumen bacteria multiply more quickly, giving better digestion and helping when animal diets are changed. Never feed Ca or B to animals; feed it to the soils.
24. They are synergistic so need each other.
25. Makes poor yellow areas in pastures greener.
26. Improves soil structures with light soils holding more moisture, and heavy ones becoming more friable. Some of this may be due to the effects of increased earthworms, soil micro-organisms, bacteria, fungi, protozoa and other soil life, that increase when adequate lime is applied, and are all so important for good soil life. Liming encourages soil life.
27. Increases the efficiency of some fertilisers. Never apply it with reactive phosphaes
28. Helps prevent over-drained, dry, powdery peat from becoming hydrophobic (repels moisture), which is unproductive and causes grasses to die within a few years of regrassing. (Waverley Road, Eureka, Waikato trial) Large amounts of 8,000 kg per hectare, or nearly double that on deep raw peat, are necessary when the dry peat is hydrophobic. LimePlus chisel ploughed in, helps make the dry peat absorb rain. Hydrophobic soils in the Waikato are increasing, mostly through less lime being applied.
29. Reduces the incidence of milk fever if low Ca pastures (lacking clovers) are grazed prior to calving and higher Ca pastures (high clover pastures) are grazed from the day of calving.
30. The incidence of retained membranes decreases.
31. Increases earthworm numbers. Feeding earthworm with lime makes them more active and healthier, with adequate shiny slime so that no soil sticks to them and they can slide through the soil more quickly. Increasing earthworm numbers improves topsoil structure and depth, and breaks down and spreads dung pats to a half metre diameter, giving more even pastures with fewer un-grazed clumps. See Soils > Earthworms.
32. Increases earthworms that eat thatch (dead surface vegetation) after LimePlus is spread on it, increasing organic matter in the soil that then holds moisture and reduces soils drying out and cracking in dry weather. Cracks give crickets protection and breeding areas.
33. Reduces fly numbers because the increased earthworms decompose the animal manure more quickly. Flies travel, especially in the wind, so get your neighbours to also farm correctly.
34. Lowers the facial eczema spore counts to 10% or less, reduces thatch and dead grass and increases green pasture. See Animal Health > Facial eczema. The incidence of facial eczema reduces dramatically after increased earthworm numbers decrease the dead vegetation that supports facial eczema spores. Numbers were one-sixth of un-limed paddocks on a trial on a Rotorangi, Waikato peat farm, and one-tenth on one in Ngatea, Thames Valley. Many farmers who limed regularly for years, so had more earthworms, had less facial eczema than neighbours who didn’t.
35. From 1958 to 1987, when we gave up farming, we always limed adequately and had only one slight eczema on an heifer, which could have been Spring eczema, not facial eczema. In 1987, our

neighbour on Greenhill Road had 30 facial eczema affected cows in the back paddock, while we had none.

36. Increases milk-fat percentages. The fat percentages dropped again when grazing non-limed paddocks.
37. Lambs grow 6% faster. Official trials have not been done on calves, but my trials gave improved growth against little growth when calcium was deficient. See page 25.
38. Pastures become greener and animals prefer them, so pasture growth and grazing are more even.
39. Drought effects are more severe, soils are more compact, clovers have smaller leaves and yellow sulphur deficient patches develop in pastures. I showed this to the Ruakura scientist managing No. 4 dairy that he managed. He didn't know the cause of the yellow, South Island I showed him this photo from the
40. Areas that show drought effects more than others, and are more compact, have clovers with small leaves, are losing clovers or have yellow patches developing in the pasture. These areas usually respond to lime, irrespective of the pH. Yellow leaves can also be caused by a lack of N, S (especially in clovers) and/or Mg which causes thin yellow stripes in ryegrass leaves. Rust, which is a different problem, can also give a yellow to light brown look, but is from low humus, low animal manure, low N, humid conditions and plants susceptible to rust.
41. These areas frequently respond to lime, irrespective of the pH.
42. Helps break down animal manure, the effluent spread from travelling irrigators, and effluent from pond cleanings.
43. Eliminates smells in compost, so flies are not attracted to it.
44. Reduces smells in soils and animal manure. I filled two glass jars with liquid from animal manure and added lime to one. After one month the no lime one smelt dreadful while the limed one didn't. So if storing effluent, add lime. Lime softens soils, making cultivation easier to chisel plough deeper, causing a little more pugging in some cases, but less cracking which hosts crickets and dries soils. See Pugging.
45. Improves soil moisture holding and wetting ability from rain after dry periods, so the first rain after dry periods is absorbed better, giving higher dry weather pasture and crop growth.
46. Increases humus levels in soils as shown below. Soils benefit from humus which is living carbon that increases under good management, and decreases when enough Ca is not applied and too much urea is used. See Minerals > Nitrogen on how not to use N in excess.
47. Releases N in soils, which greens up pastures within a few weeks.
48. Reduces the plant uptake of some toxins such as Pb and Cd. See Minerals > both Lead and Cadmium. This is most important.
49. Increases clovers so can more than double the pasture dry matter yield of LimePlus deficient pastures.
50. Increases clovers so reduces animal methane production by up to 25%. See Pollution, Methane.
51. The worst farmer waste I found happened in 2008. Lime Flour at 200 kg per hectare was flown on by helicopter to 182 ha of hill and flat land near Tauwhare for $27,000 equals $150/ha. Two years later I could not see any benefits, very few clovers, only 10 earthworms per spade spit and soil stuck to them, both symptoms of needing more lime. It cost $148 per hectare for only 200 kg/ha. Ground spreading cost is about $20 per tonne equals $40 for two tonnes which leaves $108 per hectare which would have bought almost two tonnes per hectare, which is ten times more. Fine lime was launched when McDonald's lime was not well ground, in 2015 it was very fine. Rorison's was then coarse. Three tonnes of LimePlus per hectare on half his farm gave a 100% increase in pasture yield within six months and the clovers returned.

Consulting trials

My consulting for farmers, life-stylers, gardeners and others, showed them on their soils what can be achieved, by doing trials, which I have done more of than all New Zealand 'establishment' scientists and staff put together, plus trials in South Africa pre 1954 and around NZ and in many countries. See Japan below.

Most farmers are not applying enough of the best quality LimePlus with its synergisms.

NZ changing to metrics in 1972 could be one reason. Two tons (2,240 pound, lb) per acre is the same as five 1,000 kg tonnes per hectare. Farmers remember the two and shudder at applying five tonnes per

hectare, and fertiliser companies want farmers to buy fertiliser, not lime, so P and K are too high, at a higher cost, and the much more important calcium is half what it should be.

An easy and accurate way of assessing the Ca your animals need and are eating is by doing a ryegrass leaf analysis (or your most dominant grass) then applying a mix of the deficient elements on a trial area of about 10 m2. Enter the laboratory figures into the Plant Minerals Analysis spreadsheet which shows the effects of high and low levels of 15 elements.

Talking about 'Base saturation' is just useless typical science, that scientists still argue over, or bio this and bio that, which sounds great, but are all meaningless. Figures in Plant Minerals Analysis mean something, and the effects if too high or too low. No other organisation shows these.

Only one percent of the 500 pasture analyses I've seen since 1970 had sufficient calcium, so applying LimePlus, which is a mix of the best high Ca, soft, fine agricultural lime with fine LimePlus and the deficient elements revealed in pasture analyses to be needed on their land, is the cheapest form of fertiliser and nitrogen, because it improves things in 51 ways. It also gives long lasting increased clover nitrogen production of up to 500 kg per hectare pa, at no extra cost, which has increased pasture growth by up to 150% (See Dairying > Milk Profit & Quality). LimePlus also makes pastures and weeds more palatable so more weeds are eaten. When correctly limed paddocks are grazed, milk production can increase by up to two litres per cow per a day which with 360 cows (NZ average herd size 2013) is $400 more gross income a day. A similar increase can be achieved from pastures of Bealey NEA2 ryegrass, herbs and clover pastures, as shown on page one.

Suspect anyone who promotes any liquid form of calcium, DAP, seaweed, fish oil (see below), etc., to be applied as a foliar spray at a few litres per hectare every few months. The spreading, if by helicopter, is profiting the helicopter business and breaking the farmer. Also commission sales consultants are not considering the farmers or their soils. It is unfortunate that advisers with vested interests have discouraged the use of lime, which is the most deficient element in NZ farming. After applying LimePlus, you will find that a lot of fixed phosphate that has been applied over the years will be released to your pastures. Also lime and salt in fertilisers reduces potassium leaching which saves money. Salt at about $270/tonne also replaces the need for so much potash at $800/tonne.

Basic solid limes or solid fertilisers are always the most profitable. 99% of the low analyses products that are sold as fertilisers, but are not, are costing farmers a lot for nothing - up to $800 a tonne. Liquid products cost about $3,000 per tonne of dry matter. The rest is water. Many liquid product companies have cost farmers big losses and most have gone out of business.

Those promoting helicopter spreading of 200 kg per hectare of 'fine lime' or similar, should be suspect. A 182 ha of hill and flat, Waikato beef farmer hoping for a silver bullet money making product, paid $27,000 for some applied by air, and got no response. A lot more LimePlus could have been spread by ground on the easy contour half of the farm, for a good response. It had weeds, very few clovers, only 11 earthworms per spade spit all with soil stuck to them, all symptoms of needing LimePlus.

It cost $148 air spread per hectare for only 200 kg of lime per hectare, or $740 a tonne. Ground spreading costs about $20 per tonne equals $40 for two tonnes which leaves $108 per hectare which would have bought almost two tonnes per hectare, which is ten times more calcium. Fine lime was launched when McDonalds lime was not well ground, now it is mostly fine, but all limes can get coarser before replacing the grinders, and from companies selling fine lime, taken out of the already coarse lime, to be sold to someone else.

A client, after reading GrazingInfo and seeing the trials I did on their farm, would still not agree to 3 tonnes per hectare, but agreed to two tons of lime per acre, (which is 4.4 tonnes per hectare) which is available from any lime company that will mix it with LimePlus and the items needed based on ryegrass leaf analysis. Farmers can mix their own on concrete.

Thanks to the bureaucratic establishment's (MAF, Ruakura, AgResearch, DairyNZ.) typical 'soil test' incorrect recommendations, Brendan and Tania Fernyhough's dairy farm (and thousands of others) had not had enough lime or its synergisms applied since bought originally by his ancestors in 1955, so had lost about 25 tonnes of lime per hectare in milk sold. Fertiliser companies have many sales people in the field, who never recommend lime, even when dreadfully deficient.

A pasture analysis showed that calcium and boron were half what they should be and phosphate and potash were toxically high. Applying the needed lime mix saved them thousands of dollars, compared with typical more P and K fertilisers applied annually by most in NZ, on soils that pasture analyses show have excesses, resulting in soil and animal health problems, and less clover growth. Read

Potassium in Minerals in Soils.

On a metre wide LimePlus trial strip, pasture was grazed shorter, showing the animals' preference for the sweetening effect. More would have increased the clovers even more, reduced the weeds more and kept the soil more moist, so the ryegrasses and clovers would have grown even more, especially in dry weather when pasture is worth more.

The 100 attending my field day there on the 4th of March 2011, including one dairy farmer member driven up from Taranaki and one dry stock member flown in from northern NSW, Australia, both coming just for the field day “and to meet us”, acknowledged that they had not seen better pastures.

This one year old paddock is Bealey NEA2 ryegrass, Kopu white clover bred from a short lived white clover and Tahora 2 permanent white clover, with Puna Chicory and some Tonic Plantain. Kopu white clover doesn’t last so should not be sown except in short term (2 year) pastures. Milk production increases by 2 litres per cow after grazing this and similar paddocks.

Lime should never be applied on its own because the extra pasture growth reduces deficient minerals like zinc, magnesium, etc., depending on the soil and mineral levels.

The top 15 cm (6 inches) of soils around much of the world have been mined of humus, carbon, calcium, and trace minerals, even in pastures poisoned with repeated urea, and not fed LimePlus, while often over fertilised with the acid water soluble nitrogen, superphosphate and potassium (NPK), as part of bad farming of crops, which partly caused the Dust Bowl in USA last century. Superphosphates cause acid soils, shallow rooting, and the pollution of surface and underground water. Acid soils also make the bad elements (mercury and manganese in particular), available and the good ones (phosphorous, magnesium, boron) unavailable. LimePlus does the opposite. These horizontal 10 cm deep roots on the right were on the same Walton dairy farm as above in 2009 (and are similar on thousands of farms) where most of the ryegrass roots grow horizontally like these, which is common on many north island farms because of high aluminium and a lack of LimePlus which reduces aluminium and its bad effects.

In 1950 I read ecologist, Louis Bromfield’s Malabar Farm book. He bought and changed four ruined dustbowl farms in Ohio, USA to healthy ones partly by chisel ploughing deeply, and mainly by not cropping, but by rotationally grazing pastures. In South Africa pre 1954 and New Zealand after then, I chisel ploughed and almost doubled crop and pasture yields compaired with mouldboard ploughing, hoeing, etc. By sowing crops within two days of starting cultivation, the crops beat the weeds without any spraying.

In a very dry summer, this paddock of Pasja and Nutrifeed gave five grazings. With better rains, it can give six grazings like this each 60 cm (two feet) high, keeping the cows milking well on ideal balanced feed, and without over-grazing pastures. I know of no other summer forage mix that yields so many grazings. Tania and Brendon Fernyhough were kneeling down. It is 100% safe, which bulbed crops are not if the tops are eaten first.

Weeds don’t thrive in limed, fertile neutral soils (See Pastures > Weeds), while ryegrasses and clovers do, as do cows. If sown within two days of starting cultivation, there are likely to be no weeds. Read Weeds in the Pastures chapter.

Calcium is a unique element for plants and growing animals. You may have heard this bit before, but it highlights its importance. Researchers were studying the effect of different elements and decided to see if roots could grow upwards to get any elements. They used different drums of soil with different elements near the top to see if plant roots would grow upwards. Roots went up for calcium, but not to any others. Calcium is the most important element, the least understood and the most ignored. Only 1% (5) of my 500 clients since 1960, had optimum Ca levels in their soils - measured accurately in pasture leaves.

This dreadfully lime deficient soil on the right (with no oversown chicory or plantain) from Ruakura, is typical of their summer pastures and at DairyNZ and many Waikato farms, while the few best are green and growing.

On page 7 below is a good LimePlus soil photo.

There were fifteen ryegrass plants per m2 pulled out on the right. It was taken on Fernyhough’s Walton farm in 2009. Like most farmers, influenced by MAF, and fertiliser companies and fertiliser consulting (commission) people, their farm had received no lime of any consequence for 50 years, but

about 200 kg per annum of clover-killing and humus-gobbling urea, in recent years and relied on inaccurate soil tests and pH, rather than accurate pasture tissue mineral analysing. Apologies for repeating this, but for obviously good reasons. Their soils and much of the Bay of Plenty have a naturally high pH level, again showing the futility of pH measuring and soil testing.

The newer DairyNZ 'establishment' has done nothing to help their dairy farmer owners by showing them the 51 benefits possible from applying 5 tonnes per hectare (2 tons/acre) of fine LimePlus with deficient elements, which do much more good and usually costs less than P or the very expensive K at $800 a tonne.

The dung on the tails and the rear end of these calves show that selenium was very low, partly because Ca was low, and so organic matter and cobalt. Importantly today, adequate lime causes deep roots which take up more nutrients and moisture, so decrease leaching and pollution into aquifers, which lose farmer's money and increase Waikato Regional Councils costs as their staff travel around trying to reduce pollution, guided by the 'establishments' misinformation, because they don't know the basics of how to reduce leaching, or how to grow more pasture by ryegrass plant analysing, LimePlus, chisel ploughing, using reactive phosphate with elemental sulphur, and with the deficient trace Minerals.

An old timer rightly told me, "Low cost lime ($25/t) makes the high cost existing fixed phosphates ($400/t) more available, and pastures grow faster."

With today's low profits, all are important.

A top person in a New Zealand seed company emailed me, "It is sad that we are not using lime appropriately. It seems that many farmers and scientists have forgotten the basic thing that made New Zealand pastures what they were."

At many field days farmers have agreed with me that most pastures are worse now than they were 50 years ago. Some blame the new pasture varieties, but it is the low Ca and its synergisms.

When newly sown pastures fail within a few years, some farmers blame the new ryegrass varieties developed on high fertiliity land instead of themselves for not chisel ploughing in LimePlus (lime and its synergisms), and not harrowing in three tonnes per hectare more on the surface, which is only 1.2 tons per acre. When lime on its own doesn't grow more pasture, some say it is not needed, but it is usually a lack of pasture tissue calcium figures and poor knowledge about its synergisms of boron and magnesium.

Mike O'Connor of Ruakura was told about the results that I was getting from boron and lime in the Walton area. He disagreed and did a boron trial there in the 1990s - but without adding lime, and reported that the response was insignificant. I got the figures which showed 9% more clovers. Many farmers would love 9% more clovers in one year. My trials with lime **and** boron and lime's other synergisms, gave 50% more clovers. Most so called scientists learn more and more about less and less, so make ridiculous statements like, "We don't want anything else to affect the trial of one product." This shows that they know nothing about synergisms.

The wrong answers of soil tests and using pH have lost NZ farmers collectively millions of dollars. Calcium, not pH (Read pH), is the basis of soil biology, moisture holding, improved soil structure,

fertility and earthworms, and hardpan elimination. Lambs and calves don't grow well if Ca and its synergisms are low, because humus is then low which is what holds cobalt, which is a young animal growth mineral. Cobalt, selenium and boron won't increase and remain, low in soils low in Ca (measured in ryegrass which should be 0.9% Ca), so clovers and their nitrogen making nodules don't thrive.

Earthworms are far better at indicating calcium requirements. If large, shining and moist like these, they are healthy so indicate adequate calcium in particular. These Calignosa earthworms are large and healthy because the farm had two applications of four tonnes of LimePlus per hectare over two years, and their cows got Solminix through a dispenser, some of which goes out in the dung which earthworms then consume.

See more photos about trials under 'Facial Eczema' in Animal Health.

If earthworms are dry and have soil stuck to them as shown on these three sick earthworms, then LimePlus is needed. I say LimePlus because this soil is dead, so dry, and lacking things that only a pasture analysis detected. By comparison, soil analyses are wrong, with some laboratories recommending anywhere between 60 and 150 mg/kg, which is a 250% difference and quite ridiculous, so why bother to soil test? The Pasture Mineral Analysis spreadsheet of optimums, that I wrote in 1980, is still the only one in the world. It gives the exact optimums for which to aim, so use it to 'Aim High' (the motto drilled into us at agricultural university in 1947/8), unless you just want to be another 'average' farmer.

When it comes to the use of lime and its synergisms, it is disgraceful that lime's 51 benefits are deliberately ignored by consultants getting about $12 a tonne commission from fertiliser companies, and the 'establishments' getting about two million dollars a year sponsorships from fertiliser companies to promote fertilisers, rather than lime. This has gone on since the 1960s that I know of, and been so successful that there are now millions of dollars of excess P polluting and fixed in soils, that only lime with it synergisms will make available. LimePlus with the deficient trace elements, have increased Pasture phosphate levels from about 3.5 to 5 mg/kg, without applying any P, shown in the Beef Profiting chapter.

This photo on the right is typical Taranaki LimePlus deficient pasture showing dandelions, small clovers and sick grass.

These deficient clover leaves are from low boron and low zinc. This was after applying three tonnes of plain agricultural lime per hectare. An equal cost per m2 of LimePlus was applied adjacent is shown on the right, in the same soil.

so responded well to LimePlus (No N) shown within the polywire on the right with much better, longer healthier clovers and surviving low fertility cocksfoot. High fertility requiring ryegrasses had died out because LimePlus had not been applied over the years.

I've done and seen many farmer comparative trials of lime on its own against LimePlus (lime, and deficient elements based on pasture analyses), where the lime gave negative results by lowering zinc, boron, etc., as shown above, making pastures worse. This ignorance is one reason for farmers not applying lime. AgResearch, DairyNZ, LIC and some consultants don't know this and fertiliser companies cash in by saying to apply more fertilisers, not lime.

Doug Edmeades, an ex MAF staff wrote that no soils in New Zealand need calcium! Instead he recommends toxic amounts of K which has killed many of his clients' cows.

The above shows that lime should never be applied on its own because it creates an imbalance.

Some farmers complain about the cost of LimePlus, but the lime is only $25/tonne. The main cost is in minerals added - OrganiBOR, Selenium, Cobalt ($50,000 a tonne), Sulphur and Salt and other deficient elements that are essential to grow clovers, grasses and animals. Read Beef Profiting and see how LimePlus helped pastures, cattle and even free-range ducks and cost much less than the fertiliser (P and K) previously applied and not needed. LimePlus made the fixed P become available. The same happened in the farm in 'Milk Profit & Quality' saving the 400 cow farm enough to reduce his mortgage by $1.4 million, and pay me $3,000 in appreciation.

LimePlus is a complete fertiliser and much cheaper than phosphate and potash fertilisers, and when pasture P is optimum, and yields 100% to 150% more pasture DM than urea or other fertilisers - and makes some fixed P available.

Applying the correct amount of LimePlus required, based on grass leaf analyses, has saved farmers thousands of dollars and grown much more healthier and balanced pastures than urea that contains no solids (urea is made from air). Ammo (34-0-0-12) is far better because it has sulphur which is needed for N to work which was proved by ICI Fertiliser Company in UK in 1980 and by me many times.

See Mineral & Supplement Feeding

Some looking for faults without looking further, claim that lime makes the soil softer so it pugs more. The alternative is tight hard pans that most farms suffer without some knowing why. Hard soils don't absorb as much rain, crack and dry out more than correctly limed soils, so crickets breed in the cracks, then eat the pasture. The top of correctly limed soils do become softer, partly because of earthworm activity, however, these soils and pastures improve so much that they recover more quickly and grow a lot more pasture dry matter than lime-hungry, hard, high aluminium soils that ryegrass can't grow through, so hard pans form, that only LimePlus can fix.

More farm evidence

These clients in my Atiamuri consulting group in the Central North Island on improved pumice soils, were delighted with the clover and ryegrass growth after I got them applying enough LimePlus. Their pastures grew better than ever before, thanks to analysing ryegrass tissue for minerals, then applying LimePlus with the deficient minerals and fertilising with reactive phosphate and trace elements based on the analyses.

Many clients have had bloat and milk fever (Read the chapters on them.) decrease after correct liming with , trace elements and reactive phosphate, all with 50 kg of coarse agricultural salt per hectare.

Max van Geest on the left, in preparation for cultivating and re-sowing his worst paddock of poor pasture, at my recommendation, applied 6 tonnes per hectare of LimePlus which is only 2.4 tons per acre.

In about 1985, when phosphate fertiliser was unavailable for a while, and farmers were struggling under the Rogernomics's ACT 25% interest rates, Lex Riddell, a successful dairy farmer at Gordonton in the Waikato, applied 2,500 kg per hectare of lime (1 ton per acre) on the surface of his 58 ha of mineral soil, and grew more pasture than previously, to the extent that neighbours asked him why he had so much pasture. The lime had released other essential elements like so called 'locked up phosphate'. His bloat also reduced to being no problem. A neighbour, who always applied a lot more phosphate and potash per hectare than Lex did, suffered a severe pasture shortage and bloat during the same dry year. A high stocking-rate neighbour, who used the department of agriculture fertilising recommendations based on soil tests, was frequently short of pasture, becasue he applied no lime, so had bad bloat year after year. He died young due to stress. Lex lived until 90.

Humus Increase

In 1979 when I first visited Japan, and again four times later, and communicated many times since by email, I repeated their need for more Ca, based on visual and pasture analyses, not soil tests which they were using and are useless, and I have not used since 1956 (yes 1956), because I saw they were deceptive and loss making, which made them very costly. These pH decreases below after applying lime show how useless pH is for lime requirements. Lime increases the organic matter, carbon and humus as shown here, which then lowers the pH. Many who call themselves scientists in NZ and other countries,

still don't know this. Doug Edmeades wrote that no soils in New Zealand need lime. No wonder he was banned from speaking to the media when with MAF/Ruakura. His Ruakura colleague Ants Roberts wrote that no trace elements are deficient anywhere in New Zealand. Both people are working with fertiliser companies that want to sell more NPK, and no lime. Stocking and selling trace elements is costly because of the low volume and storage cost for low turnover.

Parts of Japan in about 2001 suffered ruminant health and 200 animal deaths from the same as pumice bush sickness in New Zealand pre 1940's in pumice soils low in Ca and organic matter, so therefore low in cobalt (Co). The Japanese ruminant deaths were accentuated by ferns and other toxic weeds that grow on low Ca and low Co soils with no clovers, while limed-livened soils hold Co so grow healthy legume based pastures. The Japanese Ca levels were low because the soil tests didn't show cobalt or that calcium was needed, and their using 25 kg bagged lime at $300 per tonne instead of bulk lime at $25 per 1 tonne, made it too costly.

LimePlus decreases acid loving poisonous ferns which killed hundreds of young cattle in Japan in about 2001 and they didn't know why. Sufficient LimePlus also gets rid of Pennyroyal, buttercup, docks, moss and sorrel. Lime increases humus in soils which then hold cobalt well, and selenium to a degree, so in 2007, after my repeated suggestions since 1979 of needing a lot more lime, they did trials. Yutaka Miyawaki worked with six of my and his clients and the Japanese Department of Agriculture and applied 3 tonnes per hectare on their farms, which was three times more than had previously been applied, but was half what was needed.

These figures show before lime was applied in black, and two years later in red. Their ryegrass tissue had only 0.27% Ca when it should have been 0.9%. They were surprised at the soil humus increase by up to 50% and the drop in pH. I was not. Lime increases soil moisture holding. Moisture reduces pH.

Paddock 地点名	p H	Humus腐食
No.1	5.0	1.3
No.1	4.9	2.3
No.2	5.0	1.8
No.2	4.7	2.4
No.3	5.2	2.3
No.3	5.0	3.1
No.4	5.9	2.8
No.4	5.1	2.0
No.5	5.2	1.8
No.5	4.8	2.0
No.6	4.7	1.9
No.6	4.7	2.3

I and NZ farmers in the late 1950s changed sandy light coloured 5 cm deep pumice soils to 25 cm deep dark (from humus) topsoil in a few decades, and my good Waikato clients who have got clover nodules down to 35 cm in soils in organic matter with optimum pasture Ca levels.

Japan's system of measuring humus in soils is far better than ours measuring organic matter that includes the thatch, which is the dead surface grass on our acid soils which increases Facial Eczema, and is higher in bad farming lacking LimePlus. Measuring both are bad. Measuring plant mineral levels is far better because it tells us what the plants are getting out of the soil, which is accurate, soil is not.

If our MAF and government had known and applied plant measuring, New Zealand could be earning $600 million per annum from the Kyoto agreement, instead of losing that amount pa.

As soils under grazing become more fertile, the humus content increases, unless starved of agricultural lime and its synergisms, or is mined by using urea, which halves earthworm numbers following each application, reduces organic matter, and increases hard pans, so makes soils poorer and harder with shallower roots. See Minerals > Nitrogen. Liming increases earthworms which eat the Facial Eczema causing thatch, and improve soils to a greater depth, which allows them to absorb more animal manure and minerals, reducing leaching. The Calignosa, and large deep-working Terrestris and Longa earthworms, become more healthy and active and increase the soil humus levels, which had decreased on flat dairy land that uses urea, while hill country farmers don't use urea so its organic matter had not dropped. Ruakura, MAF, Minister of Agriculture, etc., should have known this to save us losing $600 million per annum. Most soils and pasture production are getting worse instead of better. Those applying www.grazinginfo.com practises are improving and reducing ovedrafts. Read 'Milk Profit & Quality' in Dairying.

How much to apply

Maurice Thomas who moved to Victoria, Australia, wrote, “As in New Zealand where Vaughan Jones got me to apply 8 tonnes of agricultural lime per hectare with excellent results, here in New South Wales, I now grow clovers that neighbours can't.”

Agricultural lime (calcium carbonate) is the product usually used to increase Ca and pH, because it is available in most areas and is usually costs little, so is excellent value when needed, based on results.

Dolomite away from its mines can be expensive and is hard, so slow to become available and not as effective as fine soft agricultural lime. See Magnesium in Minerals in Soils, Plants and Animals. Too much Mg makes the soil hard in the Thames area, and can cause pastures to have high N levels and be unpalatable, so measure your Mg levels in the ryegrass leaves and stems, which tells you how much the pasture is getting out of the soil. Soil tests can't show it.

The amount of lime required varies considerably between soils. It takes about 17 tonnes of lime per hectare to raise the level to the optimum in raw peat which had never had lime, when chisel ploughed in to 40 cm (16 inches).

The ratios of lime required to increase levels by an equal amount in various soils are about 1 for sand, 2 for sandy loam, 3 for silt, 4 for clay and 5 for peat.

If molybdenum is above 2 mg/kg in pastures when soil is dry, or double that when soil is wet, apply less lime more often, and more Cu, until Cu is 13 mg/kg for cattle and 9 mg/kg for sheep on their own.

Mo at 5 mg/kg in wet soils with copper at 12 mg/kg, is no problem. After the soil dries, Mo levels in pastures will halve.

If you are uncertain about whether your soils need lime, check the earthworms, pasture analysis, soil structure and do some trials by applying 3 tonnes/ha on one paddock, and 4 tonnes/ha on another, and compare them with controls that get no lime. Yields in trials must be done by measuring growth before and after grazing, because the limed paddocks will be grazed shorter each time, so could look to be growing less. On dairy farms, the milk production should be recorded on the limed and un-limed paddocks all year for a comparison. On many farms, milk production has increased by a litre per cow per day after grazing limed paddocks, and by two litres on some.

Alternatively, apply a 25 kg bag of agricultural lime on 80 m2 or 9 by 9 metres (30 by 30 feet), which equals 2,500 kg per ha, and then measure or eye assess the dry matter (DM) or heights before and after each grazing for a few years. Heights can be converted to DM by cutting to ground level, drying and weighing a square metre of pasture at the various heights, and multiplying it by 10,000 (m2 in a hectare) to give DM per hectare.

DM is worth about NZ$0.10 per kg in the fast growing periods, and about double that in the slow growing periods, because of replacement costs. These figures include the value of the land, that is essential for accurate budgeting, because if short of pasture it would cost about these amounts to buy feed. Use the spreadsheet called Costs of Pasture Silage Hay Crops and N.

Field observations and monitoring of Ca levels with herbage testing will ensure enough lime is applied, but not overdone. As with all fertiliser programmes, balance and moderation is the key, and this includes acknowledging the role trace elements play. If a pasture greening is seen within a month of applying lime, it means that it should have been applied sooner.

Lime and cultivation

Before cultivating soils that require lime, apply 5,000 kg or more per hectare, depending on the pasture analysis, soil type and depth of cultivation. Chisel ploughing lime in is much better than any other way, because chisel ploughing mixes it in thoroughly, which is important. I've seen clover roots follow the limed and mouldboard ploughed division vertically down and then follow the horizontal layer, at the bottom of the inverted plough furrow. When I showed a client this, he went straight to town and bought a chisel plough and used it for growing maize, and with LimePlus, grew the highest yielding maize in the area.

The soil surface should always be sweeter, because that is where the dead vegetation and animal manure build up, and they need lime to decompose them, and to make them palatable for earthworms. Effluent paddocks definitely need more lime on the surface on a regular basis, to help decompose the organic matter and control the potassium that increases.

pH

Calcium carbonate in lime raises the pH partly because carbonate consumes hydrogen ions. See Soils

> pH, but remember that pH is a varying inaccurate measurement of little use.

Moisture

In a superphosphate and reactive phosphate with elemental sulphur comparison, on Colin Marshall's farm near Te Awamutu, there was bad ryegrass pulling on the superphosphate paddock and none on the reactive phosphate one, where the soil was also more moist, as it was in a similar trial in an adjacent maize crop.

When avaialble we grew only one Tastiest Tom tomato every year that grows to four metre wide by two metres high. Each yielded about 400 tomatoes. We take and plant two 20 cm long slips from it (see Vegetables) to grow late ones shown below in May 2010. The plant on the left got 6,000 kg of LimePlus per hectare equivalent (6 kg per 10 m2), and showed no wilting or blight, while the one on the left got only 3,000 kg (3 kg per 10 m2) of LimePlus and suffered blight with brown-spots. Both had correct fertiliser and marigolds under them to discourage white flies which spread blight.

Plants lacking calcium can't take up moisture as well as those with sufficient calcium so have curled inwards leaves, which is one reason why correctly limed pastures remain greener and grow more during droughts. This benefit can occur within two months of applying LimePlus which included the deficient elements in October (southern hemisphere), but not when applied after summer dry weather starts. The healthy tomato on the right got optimum LimePlus, which can't be achieved with any other fertiliser. The blighted tomato below got half as much LimePlus.

See Gardening for more on LimePlus helping vegetables be 90-0-0-2 as shown in a warm spot of our garden in June (mid winter). We get fresh tomatoes from December until July every year.

Success at Walton, Waikato

Three generations of the family before Brendan and Tania Fernyhough, of Walton in the Waikato in 2008, had not applied enough lime for five decades because the pH was close to or above 6. I did a pasture analysis. The ryegrass tissue Ca level was very low at 0.5% instead of 0.9% and soils were tight with hard pans and very few, dry earthworms, weeds galore and little clover, and worst of all, ryegrass roots growing horizontally at 8 to 10 cm. LimePlus

Pasture mineral levels of Al, Mn and K were high, and Co, B, Se and Mg were low, so 3,000 kg of LimePlus was applied per hectare in early spring 2008. In late spring the soil and earthworm symptoms, and a Ca pasture analysis of 0.47%, showed that even more lime was needed, so another 3,000 kg of straight lime (97% CaCO3 and 0.175% Mg) was applied, on to the surface of the pasture. After the second 3,000 kg, their pasture cobalt increased from 0.04 to 0.08 mg/kg, despite very little rain (40 mm) having fallen after the second 3,000 kg per hectare.

The pasture calcium level nearly doubled, and manganese dropped from a toxic 90 mg/kg to 50 mg/kg. Magnesium increased from 20 to 25%, boron and iodine levels doubled and the pasture aluminium level dropped to under 100 mg/kg, which is where it should be. The perennial ryegrass root depth improved, while the adjacent paddock that got only one 3,000 kg per hectare still had perennial ryegrass roots growing horizontally at 8 cm, because of aluminium toxicity. They then applied a further 3,000 kg per hectare over the whole farm, giving a total lime application of close to 9,000 kg per ha. Clover seeds spread in November 08, after the first lime and trace element application, germinated and the very few existing clovers grew vigorously.

In summer 2009 the clovers and improved pasture yield had to be seen to be believed. By 2010 weeds had reduced, clover and pastures improved, their animal health improved from 20 milk fever deaths to two cases a year.

The above are thanks mainly to leaf analyses and correct application of agricultural lime, and deficient elements. Animal health also improved thanks to feeding Solmin soluble minerals at 0.006% of live weight daily through an on-line dispenser to all animals.

In 2010 another 3 tonnes per hectare was applied on one paddock with a further improvement, which I wanted on the whole farm. It had been 25 tonnes per hectare behind in calcium over the previous 50

years.

Phil Taylor, a prominent beef farmer south-east of Te Awamutu, Waikato, and others, found that LimePlus and separately reactive phosphate with deficient elements, encouraged deeper rooting of plants, reduced ryegrass pulling, achieved a more balanced mix of minerals in pastures, based on ryegrass analyses, and reduced the incidence of bloat substantially.

Phil wrote on the graze-l discussion group list -

"After being totally confused about fertilisers on my Taupo ash soils, at a chance meeting in 1992 with Vaughan Jones, I explained my problems. He visited our farm, saw the thatch, Yorkshire fog, the few small leafed clovers and animal health problems, all of which I was living with, as do many farmers. He took ryegrass samples and recommended LimePlus. Lime is usually not recommended in this area. The farm soon greened up and started improving. Neighbours noticed it.

"The fertilisers he recommended were no more expensive than previously. After two years of applications based on the best reactive phosphate powder, animal health problems almost ceased, earthworm activity increased so dung patches quickly turned into 60 cm diameter green patches, grazing was much more even, thatch started disappearing, and the previously shallow ryegrass roots penetrated to 23 cm or more. Contrasting green urine and dung patches in the early spring didn't show up because all was greener, and without the use of any artificial N. Clovers made more N, giving the whole farm a green look which made it stand out. During the three years of beef downturn I applied no fertiliser, and yet I still had 17 NZ stock units per ha (1.2 US stock units per a), and everything went away prime - cattle in 18 months (except for a handful) and lambs at around 17 kg dressed weight."

Piako Road Neighbours

It is amazing how long it took some of our neighbours to notice what was happening over the fence, and do something about it. The dandelions, buttercups and lack of clovers on our neighbours' farms indicated that they needed lime badly. In the early days, most of our immediate neighbours on Piako Road, Gordonton, Waikato, applied less lime and didn't chisel plough. Most just disced or rotary hoed to 15 to 20 cm (6 to 8 inches). We applied about 50% more lime annually than our neighbours. Over time, more lime was applied than on other roads and we made 12 chisel ploughs for neighbours on Piako Road.

Client Gary Wilson, a dairy farmer near Matamata, Waikato, who had bad bloat for decades, and was a Ruakura Research bloat monitoring farm, changed from 30% potassic super to my recommendations of reactive phosphate, elemental sulphur, agricultural salt, trace elements and lime as needed, no potassium and fed Solminix minerals in the drinking water. Bloat disappeared completely within a year, production increased, and pastures improved from open sparse ones with gaps from pulling, to dense ones. Ruakura gave up checking their farm because there was no bloat to monitor, but didn't ask Gary or tell anyone how it had stopped, and they call themselves researchers or scientists. While on this subject, most of what research centres in New Zealand promote is what good farmers have been doing for a decade, and some ideas they launch are from farmers, to whom they seldom give credit. Three are, tail painting cows to identify if they have been in season (Barrie Ridler), zinc to control facial eczema (Gladys Reid) and optimum liming based on visual soil and earthworm aspects (Vaughan Jones) and ryegrass plant mineral analyses (Vaughan Jones).

Walton dairy farmer, Tania Fernyhough, who has helped me with proof-reading and improving GrazingInfo, pointed out that, "One reason for them saying that soils are not low in Ca, could be because they are not using pasture analyses and according to the SOIL testing we did before using Vaughan, Ca was usually shown to be adequate by pH and soil levels. They ignored the few sick, dry earthworms, compact soils, poor weedy pastures, and few clovers, all indications of low calcium."

Their farm, and many others, were at least 20 tonnes per hectare behind in lime, because almost none had been applied for about 50 years, before Vaughan Jones showed us its benefits.

The calcium industry selling lime at between $14 and $25 per tonne ex their quarries, can't afford to sponsor scientists costing $50,000 a year to show the benefits of lime. In USA it is US$100,000 to get a scientist to prove anything, many universities told me. When I was trying to get USA universities to research and show their farmers what I was telling my clients there, they all said, “Pay us $100,000 and we’ll prove anything!” Note the ‘anything’.

Some big fertiliser companies pay researchers so much that they discourage farmers from using lime. Before the Labour Party’s Rogernomics ACT policies in the 1980s, continued by the National Government, the NZ government paid for research like lime trials, but today ignorant self centred scientists think that lime is too “ordinary” to research, and few promote old research unless it suits their sponsor to pay them more. VA Tiedjens in USA wrote a whole book on agricultural lime, some on peat. He got the same results as I did. See the ‘Further Reading’ chapter on how to buy his book. Those who have, thank me. Some scientists distort the 1954 liming peat trial to suit their aims, sometimes to promote fertilisers for big companies who reward them with research funds and/or commissions. I saw the trial in 1955 and spoke with Dr Frank van der Elst, the scientist.

The two previous farm owners had gone broke, mostly through ignoring lime or using soil pH levels which are wrong. Read Soils > pH. It had clay soils and very shallow peat in maize for grain so earned no profit because the price maize grain buyers paid us was based on 50% subsidised maize from USA, so we applied and chisel ploughed in between 6 and 8 tonnes of lime per hectare and sowed pastures with fertiliser containing the synergistic elements required.

We applied most of the lime before chisel ploughing twice, and then 3 tonnes per hectare on the surface of all soil types and harrowed it in. This must be done after cultivation because the crop and new pasture seedlings need optimum Ca levels in the top few centimetres, which deep cultivation reduces.

Two New Zealand, ex Ruakura so-called soil scientists, have written that Ca is not low in NZ soils. This shows their lack of practical experience, because 90% of North Island soils are deficient, and are becoming more so, accentuated by using urea and other water-soluble fertilisers, such as superphosphate, DAP and MAP, all of which are acid forming and grow grass which uses Ca. Dairying removes up to 900 kg of agricultural lime per hectare per annum. Beef removes about 750 kg and sheep about 600 kg per annum. These figures are if no lime is applied, but depend on which phosphate is applied. Superphosphate has 20% Ca, Gafsa 35%, DAP and MAP have none.

An accurate way of measuring whether Ca is required is to inspect the soil and earthworms, and by getting a ryegrass leaf analysis. If ryegrass is 0.9% Ca, none is needed. The soil will be soft, easier to dig, friable, with no hard pan and pasture roots will be going down 30 cm or more, and the earthworms will be plentiful, active, slimy and with no soil stuck to them. See Soils > Earthworms. See the Pasture Analysis spreadsheet for figures, and look at those on the left side of the spreadsheet in the columns C to Y to see the levels for most grasses and plants.

When pasture leaf Ca levels are low, there are many examples of farmers getting excellent responses from applying LimePlus, even on soils with a pH of 6.3. A PastureGauge measured comparative trial can reveal benefits within a few months (sometimes one month) of rain washing it in.

The misinformation that lime takes a year to give a response comes from being applied to dead soils starving for lime and/or using hard coarse lime instead of finely ground soft lime - with its synergisms. In the past I’ve pointed out the faults of coarse lime. To my knowledge in New Zealand all limes are now fine at between $17 and $26 per 1,000 kg.

The accepted soil optimum pH is 6.3, but pH figures are not accurate or consistent. Soil and earthworm symptoms are.

In alkaline soils, where an accurate pH measurement is high (> 7), but Ca is needed, use Gypsum

(CaSO4, 23% Ca and 18% S). Stunting and death of growing points indicate an extreme Ca deficiency, but can also indicate low Mg and/or low P. Gypsum is water soluble and faster acting. On saline and alkaline soils Gypsum can improve soil condition by making heavy clays more friable, granular and more absorbent, so less prone to erosion. However, on steep slopes, Gypsum can increase slips. These can be reduced with deep rooting pasture that LimePlus gives. Countries with heavy rainfall on sloping land should use diversions, contour furrows, banks or terraces. See Soils.

LimePlus photographic evidence

Soil samples in 1983 from this consolidated peat soil farm in Hamilton that had been badly farmed for 100 years, until 1980 when LimePlus was applied at 5,000 kg per hectare on the left, and 10,000 kg on the right before resowing a year before a soil test when they had similar pH levels on the right and on the left. The soil samples were taken on the same day in late February in dry conditions. Soil pH levels can take three years to increase, and P levels a year.

As shown, the left was weedy and dry with Yorkshire Fog and weeds, with little clovers, while the right was moist with 75% perennial ryegrass and 25% white clover and calcium levels were 0.7% and 0.9% respectively. It had previously been one paddock before being split for this trial.

The moisture difference could be seen and felt. I've seen similar differences in other soil types, with lower application rates. Every summer subscribers phone me and ask if the increased growth and greeness can be just from LimePlus.

I asked Roger Hill, the owner of Hill Laboratories that did the tests, how it was possible that the pH was virtually the same when double the lime had been applied before cultivating then resowing it a year before. He replied that this was common because of the different soil moisture levels. Note that the LimePlus was the reason for the higher moisture level which is worth a lot.

In 1959 when developing 20 hectares of raw Manuka and rush covered 10 metre deep adjoining peat we had bought, I found that 14,000 kg per hectare of lime chisel ploughed in deeply (30 to 40 cm) followed by 3,000 kg harrowed in on top, totalling 17,000 kg per hectare, gave the best results of grazing 2.5 cows per hectare within three years of developing it. See the chapters in Soils called Peat. For cropping or resowing any lime-hungry peat, apply 8,000. On pumice loams and clays about 6,000 kg per hectare has changed paddocks from very dry poor ones to top producing ones - assuming lime was needed, which it is in 99% of cases. Only one percent (5) of the 500 farms of all types that I've consulted for since 1960, had adequate calcium levels. In 1965 USA researcher, Dr VA Tiedjens found the same figures as I did. See Further Reading.

Most farmers around the world are missing out on the 50 advantages of liming, because of bad

advice from the Mafia or establishments. When it comes to the use of lime and its synergisms, it is disgraceful that lime's 51 benefits are ignored by the establishments of MAF, AgResearch, DairyNZ, LIC, major research establishments, agricultural universities, most fertiliser companies, some banks, and the consultants being paid $12 a tonne by fertiliser companies for selling their products.

Australia doesn't allow consultants to farmers or to finance investors, to call themselves consultants, if they receive a commission. This regulation is needed here. There is not a similar army of lime sales people calling on farmers, because it sells for only between $14 and $26 per 1,000 kg at the quarries.

After liming, clovers produce free nitrogen and higher metabolising energy (ME) pasture. Urea lowers the pasture feed value, energy and palatability, while lime increases them.

Limed pasture roots go deeper, a most important fact, because it then makes pastures less susceptible to dry conditions, and increases pasture yield. I, and farmers who have done trials, have known this for 50 years, and I'm sure some have for a lot longer. The trouble is that most farmers, some scientists and the 'establishment' still don't know it, or won't acknowledge it, or they won't promote it for fear of upsetting their sponsors - the massive fertiliser companies.

Do equal cost trials based on returns. They are easy to do, and using the results on your farm can be highly profitable. Use the spreadsheet called Pasture, Silage, Hay, Crop & Nitrogen Costs. Open and name the spreadsheet, then enter your costs and it will show you and keep the records.

Despite the evidence of lime being needed for most soils growing clover based pastures, there have been many cases when I have recommended lime and it has not been applied. Then at the next visit many clients would ask, "Do I really need lime?" If I had recommended N36 some would be on the phone ordering it as I drove out the gate!

It's an ill wind that blows no one any good. The 2007/8 increase in the price of most fertilisers made my consulting easier, and more satisfying when clients, after my repeated requests, applied lime which had not gone up in price. A few months later many phoned and asked if just lime and the needed trace elements could make pastures grow so well, and clovers return, despite the dry weather.

Don't mix calcium and phosphorus

Calcium mixed with P fertiliser slows the release of P, including reactive phosphates, which is already a little slow in becoming available, depending on its availability (reactive level), the essential elemental sulphur with it, the acidity of the soil and how well it is mixed in. Chisel ploughing it in deeply mixes it more thoroughly for perfect soil contact and faster release, for faster pasture and crop growth.

Some companies and consultants mix lime with superphosphate to slow down P availability, but I see it as a ridiculous and pointless expense. Why pay to have it mixed with sulphuric acid to make it the faster superphosphate, and then slow it down? Use the best reactive phosphate you can get which is cheaper per kg of P, and with elemental S is a far superior fertiliser in 99% of cases because it doesn't wash or leach. See Minerals > Phosphorus. Superphosphate uses the cheapest phosphate they can buy which is high in heavy metals which the sulphuric acid makes available to 'poison' the pasture and plants and animals and people that eat them of what comes from them through animals. Read Milk Profit & Quality in Dairying in the Milk chapter.

When to apply lime

LimePlus can be applied at any time of year over just-grazed pasture and plants, without ill effects, but must not be grazed or harvested for hay, until well washed in, so it is best applied when rain is certain. However, lime on its own should not be applied on pastures to be grazed by cows within three or four months of calving (depending on rainfall), because doing so can increase milk fever. LimePlus with OrganiBOR (slow release boron) and deficient elements to reduce or even eliminate milk fever. Read Animal Health > Milk Fever. Obviously lime should not be applied to frozen ground. Never apply any lime or alkali product on pasture to be harvested for silage because the acid preserving pasture will not be acid enough to make proper acid silage.

Pugging

Some complain that liming softens soils and makes them more prone to pugging. They are partly right, but the pugged soils recover faster, and the alternative is a dead, hard, dry, drought-affected soil covered in facial eczema causing thatch, cracks with crickets and weeds galore. Dead soils are low

producing and get worse.

Light occasional pugging is not bad because it tramples thatch into the soil, but is not the recommended way of correcting the problem, unless there is a thick mat through inadequate liming and a lack of earthworms. In this case, liming and trampling it in can improve the soil and pasture. Oversowing with the seeds of the latest grasses, clovers and herbs, can be done before heavy grazing, and can achieve excellent results, but chicory doesn't germinate well unless buried somehow.

The typical grazing pattern in much of New Zealand is that overstocked farms run short of pasture for a period in late winter or early spring, especially if spring is late, and in late summer. However, 'cleaning up' of pastures and light trampling of dead vegetation twice a year are good practice,s in that they help control thatch and maintain pastures and soils in good condition. Overdoing it is damaging to pastures, soils and the animals doing it, and increases weed infestation.

To check your paddocks, use a spade to see what is happening. There should be very little dead material on the surface, no moss, or only a little at the end of winter.

Don't overdo it

Farmers seeing improvements from calcium, could be tempted to apply more. Avoid doing this unless the pasture Ca is well below 0.8%, because problems can occur such as zinc deficiency. Regular liming is beneficial for its Ca supply to animals through pasture, and to earthworms, so a smaller amount every year or two, on soils that need liming, is better than more every three or four years.

Aim to apply lime to dry pasture that has been grazed short, and avoid grazing it until at least 50 mm (2") of rain has fallen to wash it all off, or milk can drop and animals can scour from suffering a damaged gut from eating, especially coarse lime.

Avoid applying lime to pastures to be cut for silage in the same season, because even small amounts will raise the pH of the silage and lower its quality, because acidity is required to preserve it. Also, lime can release nitrogen that can cause high nitrate silage.

Don't apply lime at the same time as a nitrogen-containing fertiliser, because they will combine and release ammonia gas, wasting valuable nitrogen. It is also a waste, because in acid soils lime balances the soil's ions by increasing cations, so briefly makes nitrogen available, which is a reason for pastures greening up soon after applying lime. Also, the long term increase in clover nodulation, so pasture growth, after applying lime, could be because clover nodules need molybdenum to produce nitrogen.

After calving, bone serves as a readily available pool of calcium and P for cows during early lactation, when dietary intake and animal absorption are not sufficient to meet the requirements for the level of milk produced. Calcium deficiency can reduce milk production.

Diets containing 25% legumes do not suffer from a lack of calcium, while diets based on grasses (without legumes), cereals or corn silage can require supplemental calcium. Supplement with about 10 grams of good quality lime-flour per kg of grass, cereal or maize, depending on the Ca levels of other feeds. Avoid feeding too much Ca because it lowers Mg, which should be supplied all year with the other six essential elements through the drinking water in most countries.

Calcium oxalate

The calcium level in lucerne is 1.6% of the dry matter weight, but it has only 31 to 41% availability because much of the calcium is calcium oxalate, which is low in availability. This is not bad because plants containing more than 2% soluble oxalate in dry matter have the potential to cause oxalate poisoning in ruminants. Poisoning is more likely in higher concentrations of more than 10%.

The effect on stock depends on 'pre-conditioning,' i.e., whether stock have had previous exposure to plants containing oxalate, and whether the stock are hungry or not when given access to the lucerne or other high oxalate plants. Hungry animals gorge, so can get too much of even good things.

Big-head in horses

If most of the calcium in plants is in the form of insoluble calcium oxalate, then horses grazing such plants will be at risk of developing calcium deficiency. This does not occur with ruminants as the rumen bacteria breakdown the calcium oxalate, releasing the calcium for absorption.

As a result, pasture that may be excellent for ruminants can be dangerous for horses. Plants that have a calcium to total oxalate ratio less than 0.5 and more than 0.5% DM total oxalate content is considered hazardous.

Clinical signs include weight loss, lameness, fracturing of long bones and swelling of the bones of the face and jaw; hence the term ‘big head’. Perennial pastures and shrubs reported to cause big head in horses include; buffalo grass, setaria, panic grass, kikuyu, signal grass, small leaf bluebush and saltbush.

As with ruminants, make feed changes gradually over ten days. High endophyte grasses can make horses very sick or even kill them.

Grains have less calcium, but higher availability. To be absorbed, calcium requires boron, and vitamin D from sunshine or supplementation in humans.

Taking too much calcium can cause kidney stones, and taking calcium without taking vitamin D may increase the risks of heart disease. Very large amounts of vitamin D may increase the risk for fractures.

Calves absorb about 98% of Ca from milk, but mature cattle absorb only about 22% from feeds.

Applying too much lime, above optimum levels, will create high pH & Mo levels and lower B, Co, P, Fe, Zn, Cu, Mg, Mn & Al. Ca induced low Mg can inhibit clover growth.

If Mo gets too high, apply Cu and/or more elemental sulphur, but only after taking grass samples to get the exact figures. Don't over-lime the surface, and if Mo is above 4 mg/kg never apply more than 1,000 kg per hectare at a time. However, Mo levels of 5 mg/kg are OK if pasture Cu is 13 mg/kg and sulphur level is 0.4%, and provided Cu and sulphur are supplied in products like the best complete soluble mineral mix.

Read ‘Molybdenum’ to notice that it drops in dry conditions and rises in wet. In the Waikato wet winter of 2010 many pasture levels rose to 5 mg/kg, and then in the dry November that followed, dropped to 2.5 or less.

Beware

High levels of calcium **in the bought feed** of pre-calving ruminant's, increases, the incidence of milk fever (MF), because consuming an excess makes the cows’ absorption less efficient and very high Ca levels suppress Mg. Before calving a low calcium intake of 80 grams per day for a 500 kg dairy cow reduces the incidence of MF. This can be achieved by feeding a 500 kg cow 10 kg of pasture dry matter a day, that has 0.9% or a bit less Ca. Legumes have >1.3% Ca, so, before calving, don't graze high clover pastures and don’t feed silage or hay with a high percentage of legumes, and avoid grazing pastures that have had lime only, applied up to four months before calving. Keep the legumes and limed only paddocks to graze from the day after calving.

Milk fever is caused by low levels of magnesium, boron and calcium, in that order. Read Animal Health > Milk fever. Briefly: milk fever is reduced by feeding magnesium before calving, fertilising with and OrganiBor (slow release boron) in deficient areas especially the high rainfall South Island west coast of New Zealand and most of USA.

In the 1970s, Ian McDonald of Patetonga (Waikato) did all these correctly and calved 500 cows with only one getting milk fever - the same cow each year.

This photo was taken in 2008 on Ian and his son Paul McDonald’s two metre deep peat farm.

8 tonnes of LimePlus per hectare was chisel ploughed in the whole paddock and 3 t/ha spread on top on the left only, six years before this photo was taken. I’ve seen benefits on mineral flat and hill soils, but not as pronounced.

The 'establishment' still say that lime applied on the surface of peat, gives no response, because fertiliser companies have given Ruakura and DairyNZ $2 million a year, and consultants 12% for promoting lime, rather than fertiliser.

The ryegrasses in those days were not as good or as vigorous as Trojan NEA2 and Bealey NEA2. Clovers are also better now, except for Kopu ll which dies out within two or three years. Farmers now complaining about new ryegrasses not lasting are indicating that they are not liming and fertilising correctly to replace the 800 to 900 kg of calcium removed in milk annually from high producing dairy farms.

I have taken dozens of photos like this from the many Ca deficient farms and have received some by email showing poor soil structure, sick anaemic earthworms with soil stuck to them and shallow ryegrass roots growing horizontally because of low Ca causing high aluminium.

When I saw this paddock a few months after sowing I could see by the weak clovers and bare patches that it had not had the essential 3,000 kg per hectare of lime harrowed in on top. I convinced him to apply a strip which is easily seen here on the left of the photo taken six years after applying it. For all that time the limed strip had yielded much more per hectare than the rest of the paddock which grew more weeds. The extra lime area produced 3,000 kg per hectare per annum more pasture dry matter every year ($750 worth) paid back the $240 lime cost spread per hectare many times every year for more than six years. This was spread on top of peat, that many so-called scientists say is of no benefit. They, and Lincoln University in their 2011 manual, repeat this wrong statement without any practical knowledge, experience, or trials. I've also seen nearly as much benefit on mineral soils. The first photo at the beginning of this chapter was on Walton light volcanic soil. See Soils > Cultivation for more info about it.

There is no other fertiliser (LimePlus is a fertiliser) that can achieve the return of lime and its synergisms on NZ soils. All sorts of 'Silver bullet' sales people make claims for their products, but don't do comparative trials compared with a same-cost LimePlus, or the best reactive phosphate and elemental sulphur fertiliser application, depending on what pasture analyses show is needed most.

Ca deficient soils, which is most of New Zealand, can be seen visually, to have fewer clovers, more weeds and a low number of earthworms looking unhealthy. Pasture ryegrass with lower than 0.8% Ca, or other grass analyses figures in the Pasture Mineral Analysis spreadsheet, can confirm deficiencies.

Many farmers, consultants and sales people don't see differences. The farm owner above had not noticed the nearly double difference in this photo above for six years, and would have driven along the lane past it a thousand times. Before farm bikes, farmers walked or ran, and saw more, dug out weeds, and kept fitter, so more Waikato farmers were All Black rugby players.

There is no other fertiliser (LimePlus is a fertiliser) that can achieve its return. When calcium is low, there is less clover so more nitrogen is applied.

All sorts of 'Silver bullet' sales people make claims for their products, but don't do comparative trials compared with a equal-cost LimePlus, or the best reactive phosphate and elemental sulphur fertiliser application, based on what pasture analyses show is needed most.

Many farmers, consultants and sales people don't see differences. The farmer above had not noticed the nearly double difference in this photo above for six years, and would have driven along the lane past it a thousand times. Before farm bikes, farmers walked or ran and saw more, dug out weeds, and kept fitter, so more Waikato farmers were All Black rugby champions.

Fully feeding cows from the day of calving, preferably on clover-based pastures, decreases the incidence of MF. Mg is important to prevent MF and grass tetany. If pasture Mg levels are low, or if MF and/or grass tetany have been a problem, supplementing with Mg (Australian Causemag is best) for a month before calving, and for a few months after, may be necessary. Some drinking water can have high levels of Ca and while the optimum amount of Ca in drinking water can be beneficial, an excess can make the body decrease the absorption rate of Ca, which is necessary after giving birth, when the female suddenly needs a lot more for the colostrum and 20 or more litres of milk. Goats drinking high Ca water have died within a day of kidding through not being able to absorb enough Ca, because the excess made their digestive system inefficient. Feeding Ca before calving can be dangerous and has caused MF and killed cows.

The solution is to filter out the Ca from the water.

Always graze grass pastures prior to calving, and the day after calving graze pastures with high clover levels which will have extra Ca and Mg in the clover. See Pasture Analyses.

Ca is vital for proper soil, pasture and animal growth and health, especially bone and tooth formation. Ca is also needed for nerve and muscle function and in the blood clotting process. Many enzymes require calcium for their activity.

Approximately 99 percent of calcium in the animal is in the bones and teeth.

Animal deficiencies

Low calcium and cobalt caused no growth on these heifers. They were sent by two of my clients in the Waikato to graze on this Te Puke, Bay of Plenty, NZ, farm, and gained almost no weight in three months. The clients asked me to check them. As can be seen they were being offered more pasture and hay than they could eat, but the extremely low Ca made the grass hard and unpalatable, so very little was eaten, and the low Ca and cobalt, and no clover, limited animal growth. Low cobalt causes a lack of

vitamin B12 and appetite, so accentuated the lack of growth. A pasture analysis confirmed what I saw. Two warts on two heifers confirmed low Ca. Long hair on their necks proved low Co.

The farmer offered to apply lime immediately, but it would have taken months to help the calves. It was midwinter and only three months until mating, so I recommended that they be moved to a good farm and pasture immediately. This was done and their growth started straightaway. The farmer told us that MAF had told him that his farm would never need lime because his light volcanic soil has a natural pH of 5.8. Many others have been told the same by the establishment. Even a pH of 6.3 doesn't always mean that Ca is not needed. This MAF, Ruakura, AgResearch, DairyNZ and LIC mistake has cost New Zealand farmers millions of dollars in lost income and low pasture and low animal production.

The warts show that this calf was suffering severe calcium deficiency so was not growing. A virus that lives in the soil causes them on cattle when calcium is deficient.

Horses, nursing animals, and growing animals all need more Ca than dry mature animals.

After applying between four animals eight tonnes of LimePlus per hectare on deficient farms, the warts disappear. This is not likely to be believed by some vets who will say that warts are caused by a virus. If your animals have warts, apply LimePlus. Other minerals could also be low. Check your pasture analyses. and graze them on adequately limed pastures. If B and/or Mg are low, Ca uptake will be reduced.

Ca deficiency symptoms include ketosis, milk fever*, grass tetany, low conception rate, dullness, lethargy, trembling hindquarters, weak legs, stillborn calves, retained placentas, broken bones**, and, in young animals, very slow growth***. Osteoporosis can occur from low Ca, B, and/or Zn. Arched backs can also be a symptom of lacking selenium. Read Selenium.

* Boron and magnesium prevent MF more so, but lime is the best carrier and is a synergism of them both.

** Copper reduces broken bones because it softens them. Read Minerals > Copper.

*** Cobalt slows the growth of young animals, but Ca increases organic matter which holds cobalt so increases its level in plants.

In grazing areas where Ca is needed, but applying is impossible and clovers are not present, some feed extremely finely ground lime flour, but when Ca is supplemented, P should also be added at half the amount, to avoid creating an imbalance, so feeding bone meal is better. Dicalcium phosphate, used by some, supplies both, but is expensive for what you get. Never apply it where lime can be spread.

'Hip-down' in cows is seldom caused by injury, but can be a sign of mainly low boron, low Ca and/or low P. This is more common in South Africa where Ca and P are both low in the natural unfertilised grasses (veld), so animals go down with Three Day Sickness which is prevented by feeding bone meal (Ca and P).

Animal excesses

If Mo increases to above 2 mg/kg (ppm) in pastures, and Cu is below 10 mg/kg the pastures won't suffer, but animals might, so fertilise with copper sulphate at about 5 kg per hectare (4.3 lb per acre) and supplement animals with copper sulphate in Solminix through the drinking water in a mineral dispenser. Excess Cu, and especially dry copper sulphate, can be dangerous to animals. See Minerals > Copper.

Excess consumption of Ca in grazed pastures and forage crops is not a problem except for the months prior to parturition, when Solminix has extra magnesium to prevent milk fever. Excess Ca is excreted in the dung; however, if high levels are fed (excess clover and/or lucerne in the months prior to calving, as mentioned, can result in increased milk fever, because too much lowers the cow's efficiency in absorbing Ca, then after calving when needs increase, which Solminix supplies, cows don't suffer.

Excess calcium lowers magnesium. Feeding (or humans consuming) too much supplementary Ca without sufficient B and Mg can cause osteoporosis, which is another example of excess symptoms being about as bad as deficiency ones.

Read the Human Health chapter on Calcium for more on this.

I thought that farmers and consultants knew this, but in 2008 two farmers phoned me because they were getting 10% of cows with milk fever when they should not get even 1%. They were feeding lime flour or Calcium Sulphate before calving, and not enough magnesium to counter getting milk fever. Two weeks on my advice of no lime flour, their health improved with no more deaths. One was using a nutritionists' typically common wrong advice! Read Animal Health > Milk Fever.

Animals and people should NEVER consume calcium, but most should apply it to pastures and gardens - for crops.

Symptoms of Ca deficiencies in pastures, crops & animals

These white spots on animals are a sign of low calcium. They dissappeared within a few months of applying agricultural lime. Some vets claim that it is impossible for agricultural lime to cure spots. I've done it dozens of times.

When determining lime requirements, field observations are most important, yet many will believe a pH and a soil test before believing their own eyes. Knowing the symptoms is important, and worth more than a pH test which are known to be erratic. Clovers' optimum Ca level is 1.3%, while ryegrass optimum is 0.9%. See the free spreadsheet Pasture Minerals Analysis for levels in other plants.

Acidity, low boron, excessive potassium, sodium, sulphur and fluoride, lower the soil and/or pasture Ca levels. Symptoms are -

- Vegetation and thatch (un-decomposed organic matter) on top of the soil, causing sod-bound choked pastures. Clover stolons don't root into thatch layers and pasture seeds don't germinate in it. Bare patches then develop in pastures. In summer the bare areas become very hot (30 degrees C or 86 F) and dry, and can then crack. Heavy rain runs down these cracks to depths below the root zone, taking water and soluble fertilisers (N, Superphosphate. DAP, etc.) with it.
- Dry, hard, tight soils with large hard lumps, poor friability and cracks.
- Not many earthworms and they were dry and had soil sticking to them, as shown on this, the only one we found in a paddock in the AgResearch Lye farm where they don't believe in lime. I consulted for Elsa and Ray Lye and increased their earthworm numbers from very few to 20 earthworms per spit. Lye Farm under AgResearch in early 2000 had only 1 per spade spit. When Ca is at optimum levels, earthworms glisten and are sleek and slimy with no soil sticking to them. Earthworms are animals, and this is cruelty to them! This is how they should look.
- The previous two owners had gone broke, mainly because they didn't think lime was needed - based on their pH and soil testing instead of pasture tissue analyses.
- Good soils have at least 20 earthworms per spade spit of 20 x 20 x 20 cm (8 x 8 x 8 inches) when the soil is damp to a depth of 20 cm. Very good soils on very good farms have 40, which is about 10 million per ha, however, most farms have only about five per spade spit. In dry soils none will be found, except those curled up a lot deeper.
- Cow pats two weeks old and not consumed because of a lack of earthworms. This doesn't apply in very arid areas and conditions when earthworms are low in numbers. The small beetles should be encouraged there.
- Clovers growing slowly, having small leaves and disappearing, while on adjacent limed areas clovers flourish.
- Reduced legume nodulation.
- Grass leaves are lower in Ca than their stems and can be distorted, with growing tips hooked and dying.
- Legumes, brassicas, tomatoes and corn are intolerant of low calcium. Leaf tips can be stunted and total yields low.
- Decreased nitrogen production by clovers, which shows up in patches of poor and yellow grasses. The urine patches that contain N are much greener and more pronounced when Ca is lacking.

- An increase in ryegrass rust, which occurs when nitrogen levels decrease, and is seldom seen in ryegrass growing in fertile clover patches or in urine patches.
- Low Mo and/or high manganese, as well as low Ca in herbage analyses can indicate a strong need for lime.
- Acid tolerant, low fertility plant species thrive. These include rushes, Browntop, Poa annua, Paspalum, mallow, Storksbill, chickweed, buttercup, moss, and flat weeds such as Dandelions and old wild Plantain. Commercially developed plantains are now being sown by some farmers in their pastures, which is a good idea to provide variety and minerals from their deep roots. However, if plantains do well and legumes don't, suspect a need for lime. The correct amount of Ca won't adversely affect the modern plantains developed for modern pasture mixes.
- Chickweed thrives in situations where there is high fertility and a lot of organic matter on the surface of the soil, irrespective of the pH. Like some other plants, it generates its own conditions by increasing the levels of organic matter on the surface, which then makes the surface acid and deters earthworms and the germination of good pasture seeds. The best way of reducing chickweed is to apply lime at 3,000 kg per hectare (2,700 lb per a) with any deficient elements (fertility is usually high), and to graze it short, to trample the dead vegetation into the ground to encourage earthworms, which then reduce the levels of dead vegetation on the surface. This encourages the germination of grasses and clovers to compete with the chickweed.
- Cultivation releases potassium (K) from the soil and decreases Ca levels, so if Ca is not applied when cultivating for a crop or pasture, there can be an increase in animal metabolic problems from the new pasture, which will have higher K and lower Ca levels than previously.

This photo of a Ruakura pasture lacking calcium lacks earthworms, so the animal manure has not been eaten, so is a spreader of internal parasites.

Effects of liming

If pasture Ca levels are low, don't fear that applying it will raise Mo too much and/or lower Zn, cobalt and/or B levels too much, because Ca is the first essential. If necessary, also fertilise with copper sulphate at about 5 kg per hectare (4 lb per a) to reduce Mo, zinc sulphate at 6 kg per hectare (5 lb per a), boron at about 12 kg per hectare (11 lb per a) and cobalt at about 0.5 kg per hectare (0.4 lb per a). For optimum levels see the spreadsheet Pasture Mineral Analysis, and see Pastures > Analysing.

Clay soils high in Mg and low in Ca cement together and are subject to compaction, crusting, pugging (because water doesn't drain out of them), clodding and drying out, because moisture movement up and down is very slow. Pastures suffer in these anaerobic conditions and are more subject to diseases. While lime can help these soils, gypsum (calcium sulphate) may be necessary because it is water soluble, so moves down into the soil more quickly, and for those who worry about it, it doesn’t increase the pH.

The substantial responses most get from lime on most soil types show how much this vital element has been neglected. In New Zealand 1,000 kg per hectare costs only about $60 per hectare spread, in areas up to 100 km from quarries. Increased production can return much more than the cost in the first year, and reduce weed infestation which is a bonus in subsequent years. If a response is seen after applying lime, it should have been applied sooner. Rarely should more than 3,000 kg per hectare (2,700 per acre) be applied on the surface, unless cultivating it in, or Mo pasture levels could rise too high. Mo levels of 5 mg/kg are OK if pasture Cu and sulphur levels are adequate, and if Cu is supplemented by feeding a soluble mineral mix in the water, when high producing cows or large animals drink more, so get more, than small animals that drink less. This can’t occur with licks.

Lime getting wet loses nothing because it doesn't leach, but it could be harder to spread evenly. If it is only slightly damp (as long as you are not paying by weight), it will spread without losing any by dust. You can moisten lime before spreading it to reduce the very slight loss by dust.

Optimum rates of a good, fine, soft, reactive phosphate powder, with about 30% CaCO3 applied annually can reduce the amount of lime required annually, while water-soluble phosphates (Super, DAP, MAP) and nitrogens increase the amount of lime required.

In most of the South Auckland, New Zealand, area, agricultural lime used to be applied at 2,500 kg per hectare of 97% CaCO3 lime every three years, but this has decreased, and in some cases is seldom done, mostly because some people work on the wrong assumption that if the pH is above 5.6 lime is not required. Read Soils pH.

Where farmers have also changed to applying reactive phosphate powder (RP), salt and trace elements, as well as regular lime applications, their soils have changed in two years from compact, shallow rooted, dead soils, to live, moist, friable, highly productive, earthworm-full, weed free assets, and their animals' health has improved, sometimes almost eliminating bloat and MF.

A Waharoa, Waikato client on flat light loam soils applied 500 kg of lime per hectare annually for 14 years, and then 600 kg for 11 years and created healthy live soils and clean productive pastures, achieving the excellent production of 1,260 kg (in 1990) of milk solids per hectare per annum with calves on, so up to 200 kg of CaCO3 was leaving the farm annually, plus what moved down in the soil to lower levels. His earthworm numbers were about 40 per spade spit (20 cm x 20 cm x 20 cm) during rainy periods. We found clover nodules as deep as 35 cm (14 inches). He also applied 1,000 kg per hectare of the best reactive phosphate per annum with the other elements needed, so there would be no Al toxicity problems and the deep rooting pasture would use more of the elements before they leached below root depth, turning them into pasture and profit and reducing pollution from leaching. He also fed Solmin soluble minerals and had a somatic cell count of about 60. On the right was his pasture then.

In 2000, he was influenced by his vet back to substandard farming without feeding Solmin minerals, and things collapsed to cause 13 of 120 cows to get ketosis, a tenth the number of earthworms, hard soils, weeds and less clover, shown below. In 2010, his vet converted him to Abron and a humate and not enough lime, which in one year increased weeds to pastures like this below right, with decreased clover and earthworms. Humates are soils from above coal mines so the weeds must have been in it. The owner admitted that his cows had become stressed for the first time ever. Even the visitors with me noticed his stressed cows. The cost of Humate, which is not a fertiliser by the standards, is up to double the cost of proper organic far better fertilisers. The same vet converted another to Abron, but after two years the farmer stopped using it.

It is not the hard pans in soils that deflects ryegrass roots and rain, it is high aluminium levels that cause the hard pans, because of a lack of lime, magnesium, boron, etc. Gafsa reactive phosphate with its 35% calcium carbonate also reduces the bad effects of aluminium which superphosphate increases with heavy metals by making them more available. Hard pans and dreadful ryegrass pul1ing occurs in superphosphate soils, mostly blamed on Black Beetle, which in this and most cases I check with a spade, and find very few.

To overcome the perceived belief that surface applied lime is of no use, especially on peat, unless worked in, the drilling in of lime was tried on peats in the Waikato. Clover roots grew down the slots and they nodulated heavily there, but nowhere else, so it was of no advantage. The belief goes back to NZ MAF peat research I saw in 1955 on 10 metre deep Waikato Rukuhia raw peat, that had not been correctly cultivated with chisel ploughing, or sufficiently limed or fertilised when sown out of Manuka, so was still raw with no earthworms, so in my language the soil was “dead”. As well as these omissions, some lime in those days was not finely ground. Since then I’ve seen hundreds of successes of spreading at least 3,000 kg per hectare of correctly ground LimePlus on the surface of poor peat pastures. Without LimePlus applied on the surface, every year or two, peat pastures deteriorate and have to be chisel ploughed and resown more often as DairyNZ is having to do on Lye Farm. For more information read the Peat Chapters in Soils.

The above MAF Department of Agriculture deceptive trials, still promoted by the establishment and Doug Edmeads, have cost our farmers millions of dollars in lost income collectively.

A Matamata member’s wife asked me, “When will we get the profits you spoke of?”

I replied, “When your husband (right) does what I suggest, which is apply LimePlus.”

I then did a 3,000 kg per hectare (3 kg per 10 m2) trial with LimePlus shown here on the right. Clovers came on their own, another example of lime’s many benefits.

Hundreds of trials I’ve done or organised in New Zealand and overseas, proved that lime responses are far better when

with boron and magnesium or all thoroughly mixed in by chisel ploughing, or when applied on pastures with close to 40 earthworms per spade spit, because they take it down. When growing forage crops, deep chisel plough lime in and bring up some stronger subsoils to reduce pugging, and to give your plants and animals the minerals we don't know about, but which make clover grow much faster and reduce bloat. Bringing up subsoil in some soils, gives more benefits than buying and spreading quarry dust, and if done while cultivating, is cheaper to do. See Soils > Cultivation.

In 1992, a 3,000, 4,000 and 5,000 kg per hectare surface liming trial of a few square metres was done on our client, Grant Wilson's Matamata farm, an area claimed by MAF, LIC and others to not require much, if any, lime. The 5 tonnes per hectare gave the best response by far. Sufficient lime had not been applied there for a decade, while calcium was leaving the farm at about 0.7 tonnes/ha every year in milk.

The very few earthworms there multiplied and moved to these lime trials, and the 5,000 kg per hectare had the most by far, and the soil became wonderful. Although 5,000 kg per ha on the surface is not recommended in one application, this comparative test showed that on a deficient soil the pasture was not affected adversely and except to lower cobalt, zinc and magnesium very slightly, and increase Mo slightly. More importantly, the lime increased phosphorus and humus levels, two very valuable elements. It also reduces the leaching of the expensive potassium from the soil.

The soil was a good clay loam that had been grazed by cows for a hundred years, but in recent years under MAF and LIC guidance had not been limed enough, so, where it was limed, pasture DM production increased by 40%, giving a very profitable return. Unfortunately, very few farmers do comparative lime and fertiliser trials on their farms, but those who do, see substantial benefits. Do pasture leaf analyses in spring and autumn, and then apply the correct amounts of the elements shown in Lime and Fertiliser Nutrient Planner spreadsheets.

Too much lime

Lime should never be applied on its own because doing so lowers in varying degrees K, Co, P, Fe, Cu, Mg, Mn & Al. Lowering K, Mn and Al can be beneficial. See Pasture > Analysing Tissue Vs Soils for optimum Ca levels in most species.

Remember the old saying, "Too much lime and no manure makes the father rich and the son poor." This old saying would have come about because while calcium has 53 advantages, if applied without other deficient elements, can cause deficiencies and the deterioration of soils, something I have never seen or recorded on 500 farms and in a dozen countries, but I've seen Ca deficiencies on 495 of them. Most NZ farmers have doubled pasture and animal production over three decades, but only 1% have increased lime application sufficiently.

Fertiliser companies make their money out of P at $400 a tonne and K at $800, and most don't sell lime ($25 a tonne), so they promote P and K. The result is that 90% of NZ farms have too much K and about 50% too much P. Lime reduces the leaching of K and makes P available. Read Beef.

In New Zealand, high **surface** liming rates of 5 tonnes per hectare (only two tons of the mix per acre) at one time should only be applied when the soil has a history of insufficient lime for decades, and Ca pasture analyses levels are half what they should be, and visual evidence of soils and pastures all show extreme deficiencies. Lower regular amounts of lime are better than occasional heavy dressings, and can be more profitable, because pasture deterioration doesn't occur, as happens if waiting for five years between lime applications. In high Mo soils, small annual amounts don't increase the Mo levels as much as less frequent large amounts.

In some countries like England right across to Wales, where soils lie over chalk as seen in the White Cliffs of Dover, liming is not so often needed. Chisel ploughing where chalk can be brought up, can make liming not necessary.

Leaching

This can be a problem with water soluble fertilisers and in sandy soils, but less in clay soils and less with adequate levels of calcium which softens and deepens top soils, to make them more absorbent.

One of the most important and cost saving things I learned was from an Indian publication. It was that water soluble sulphate as in Superphosphate (11% S) leaches and takes other elements with it, and that calcium and salt reduce it leaching the potassium (K), selenium (Se) etc., saving costs and reducing pollution. I told Ruakura about it and they would not believe me. However, Massey University (a more

open minded body) did trials and found it was correct. Ruakura then rebuked it saying that it was only one trial (ignoring the Indian one*), so Massey did another one and found it did. Long before, in 1964, Hogg and Cooper proved it, but AgResearch and LIC consultants still, 50 years later, ignore it, costing farmers millions in buying potash unnecessarily and still using Superphosphate (0-9-0-11) causing leaching, pollution, heavy increase and bloat, after applying more K than necessary. Peat and many soils (not all) need potash, but applying optimum amounts of lime where the pasture tissue Ca levels are low, and 50 kg/ha of coarse agricultural salt (where low) annually, reduces the amount of K required. A Massey scientist proved and promoted this.

*Ruakura suffered dreadfully from the NIH syndrome - 'Not invented here' so it must be wrong. Examples are not believing that zinc controlled facial eczema and worse still not believing that LimePlus eliminates facial eczema and worm drenching, in all cases, provided all other good farming practises are used.

Conditions that reduce soil and pasture Ca levels

Acidity, low boron, excess nitrogen application, especially urea, which has done this in much of Holland before 1980 when I was invited to their agricultural university to explain to their scientists why they were growing less pasture each year, despite increasing annual urea applications. New Zealand and ruined soils, making them harder and caused shallow rooting of ryegrass and caused it to pull out very easily. Potassium and the following three slightly - sodium, sulphur and fluoride.

Weed control

The peat farm correctly broken in from rushes, gorse, blackberry and ragwort, and then well managed with adequate lime, fertiliser and controlled grazing, without pugging or overgrazing, gave a dense sward that did not need weed control (except under fences). See Pastures > Weeds.

Weed spraying thins out pastures and lowers earthworm numbers, causing tight hard soils. Grubbing weeds doesn't, and is quite often cheaper, even when paying people to do it. Our children did a good job.

Chickweed thrives in situations where there is a high level of vegetation and organic matter on the surface of the soil, irrespective of the pH. Like some other plants, chickweed generates its own conditions by its shallow rooting increasing the level of organic matter on the surface, which then makes the surface acid, and deters earthworms and the germination of clovers, which are plentiful in most New Zealand soils, but lie dormant until LimePlus or its equivalent is applied.

Over-grazing in mid-summer heat, and dry conditions, and/or in winter wet conditions, are other causes of weed infestation. As well as perfect drainage, adequate fertilising and liming, avoiding overstocking, and using on-off grazing, are the best weed control methods, so that pastures thicken up instead of thinning out. Pugging and sacrifice paddocks are being looked at by the pollution controllers, so don't overdo them. We installed half metre deep spinner drains 30 metre apart so pugging, helped by being peat, was no problem.

Applying 2,000 kg per hectare (= 0.8 tons per acre) every second year gives far better results than applying 4,000 kg per hectare every four years - on all soil types, especially peat, in contrast to what the establishment (not the scientist who wrote it in 1954) say about surface applications not working on peat, which is one of some New Zealand scientists biggest lie. Do your trial and you'll see, but be fair and apply a complete LimePlus mix based on a pasture analysis of the paddock concerned.

On all soil types, regular liming gives better and deeper topsoils, thicker, more palatable pastures, fewer weeds, more and larger clovers, improved stock health, greater earthworm numbers and activity, in fact improves 'biology' as many call it, but don't know how to achieve it. Earthworms eat weed seeds. One of the best dairy farmers I've consulted for had applied 500 lb per acre (550 kg per ha) every year for 14 years before I started with him in 1990, and ever since, and more when cropping. He had almost no weeds, and clover nodules down 35 cm (14 inches), which is the deepest I had seen. He had high production per cow and per ha. He and two others are the only ones of 330 clients, over 50 years, who had applied enough lime. That is only 1% of farmers. In 2010 he applied Abron and no lime and in one year his pastures deteriorated dreadfully, and animal health suffered. He admitted that his cows were more stressed. The weed seeds could have come in the Abron. See page 22. Abrons and Humates are just soils mostly with insignificant amounts of minerals added to make its analysis look good.

Lanes

Soft coarse lime makes an excellent thin surface for lanes. Footrot bacteria, like most bugs, don't like the alkalinity, so cows on lime based surfaces develop harder hooves, with a reduction in hoof infections, which can be a problem in large herds walking long distances on large grazing farms with acid dead soils.

Sources

There are also slaked limes, unslaked limes, burnt limes, quick limes, caustic limes, anhydrous limes, lime flours, fine limes and lime chips or pellets, none of which should be applied to soils. They cost more, and for soils, have no advantage over conventional finely ground high calcium agricultural lime. Some have no calcium carbonate so will not raise the soil pH.

Applying fine lime by air at the low rates often recommended by helicopter operators for their benefit can only be a short term 'flash in the pan'. In the cases I've checked going back 25 years, they've achieved nothing, but one at 200 kg per hectare cost as much as 2.5 tonnes per hectare of the best agricultural lime by ground spreader. Do your sums. If necessary get your spouse, grown children or friend to help you.

LimePlus which has 97% CaCO3 is softer and finer than most and only $26/tonne at the quarry. Magnesium is needed on most farms so LimeMag (73% CaCO3 & 7% Magnesium Mg) is a good buy where available. LimePlus corrects the levels of all elements on your farm.

The lime companies that sell fine lime often take it out of their lime so you should not buy either from them. Fine lime is not necessary and is expensive. The left over is coarser than straight lime, so is not good value compared with good finely ground soft lime which has nothing removed, so has the benefits of both.

Summary

The last possible objection against lime raised by a few, is that some trace elements like zinc can decrease. One reason is that lime grows a lot more legumes, more grasses and more crops, all of which then consume trace elements, but applying, for example, only 8 kg of zinc sulphate per hectare is usually enough to correct its level and costs only NZ$20 per hectare. Some lime companies mix requested minerals with their lime. Beware of those who want to mix in their fancy low content products like Calmag, Rok, Abron, Humates, Agrisea, etc. Always ask the vendors of all alternative products (most are not fertilisers) for names of farmers who have used their product with success for three or more years. After some soils are fully improved they may help, but on NZ typical low Ca soils, they won't as shown in these photos of Matamata pasture that had 500 lb/acres (600 kg/ha) for 17 years, and then Abron at $800/ha. As shown weed seeds were in it. Avoid the above 'alterntaives' not based on ryegrass analyses.

Good lime companies will mix in seeds for over-sowing grasses and herbs like Tonic Plaintain and summer growing chicory shown below on cattle farms, and the shorter, denser Lancelot Plantain for sheep. The herb roots go much deeper and get minerals for the animals, which is perhaps why animals like them, and produce up to two litres more milk per cow per day. LimePlus adds deficient elements and prevents deficiencies.

Use the Phosphate Nutrient Planner and/or Lime Nutrient Planner spreadsheets. They use pasture mineral analyses, so leave New Zealand's antique Overseer for dead, because it lacks pasture analyses information, so ignores essential elements required in soils and animal feed, which is what grazed pasture can provide almost perfectly if measured and applied. Even perfectly fed pasture can't take up enough minerals, so mineral supplements are still needed to be fed.

Dolomite, calcium and others trials

On **an equal cost basis,** several Dolomite trials were the worst by far. 99% of soils need more

calcium than Mg, P or other major elements. This is based on leaf analyses I've done on 500 farms. Only 5 (1%) had enough calcium. One was in Wales over their chalk subsoils that are from the Channel White Cliffs to Wales.

Almost all of the 500 had too much potassium, and most had too much phosphorus, but I repeat, 99% were low in Ca.

The high price of Dolomite, especially in the North Island of New Zealand, makes it too expensive. Dolomite mineral levels vary depending on the source. New Zealand South Island Golden Bay Dolomite contains 11% magnesium and 24% calcium. This is less than half as much Mg is in Graymont, Otorohanga, with its 2.4% Mg.

Gypsum is calcium sulphate (23% CaSO4 and 20% S), which can be used as a calcium source where Ca is low and the pH is high. Spreading it on dirty water in dams clears the water. See Gypsum (Calcium sulphate CaSO4-2H2O) (23% Ca, 18% S).

Don't use Dolomite if it is more expensive per kg of Ca and Mg, which it is the North Island of New Zealand. LimePlus with Magnesium, out-produced an equal dollar value of Dolomite by a long way. Read Minerals > Magnesium. If unsure, do your own comparative trials on an equal cost basis. I've done several, and Dolomite was always the worst by far.

Further reading

Read Vegetables in the Garden chapter to see that tomatoes, maize and legumes need lime, so apply it before growing them, not before potatoes and carrots, which don't like too much.

All pasture farmers and soil and pasture researchers should read the book, More Food From Soil Science (The natural chemistry of lime in agriculture) 1965 by USA researcher Dr VA Tiedjens. It was available from Growers Chemical Corp, Milan, Ohio, 44846, USA. Phone (419) 499-2508. ISBN 0-682-43057-9. Some have bought it from Amazon web used book sales. It is about the importance of applying lime first, before applications of other elements. The book is not just chemical theory. It gives many success examples. It is brilliant. A very kind follower of mine, Ken Scharabok, of Waverley, Tennessee, gave it to me after one of my Stockman Grass Farmer "Controlled Grazing" presentations at Jackson, MS in 1992. He asked if I had read it because I was recommending the same things. I didn't even know it existed. I'm grateful to Ken because VA Tiedjens confirmed what I've practised since 1957, when I noticed that wherever a heap of bulk lime had been stored in a paddock (peat soil), or where I spilt some, the pasture grew much better than where it got even 12,000 kg per ha. Pasture was also softer there, animals preferred it and grazed it shorter, and earthworms increased more than in normally limed areas. What more information is needed? A pasture analysis to add deficient elements to make LimePlus.

Amazingly, I found that 17,000 kg (17 tonnes) in total per ha on two metre deep raw peat from Manuka in 1958 gave the best results for pasture grazing 2.5 cows per hectare, within three years of converting the land from raw peat covered in Manuka scrub and rushes, to high producing pasture equal to good Waikato pastures. Dr Tiedjens recommended 40 tons (USA 2,000 pound tons) per acre, which is about the same.

Dr Tiedjens and I both noticed that many critics of lime were selling other products, but not lime, or they were sponsored by fertiliser companies.

The result is some farmers saying that 6,000 kg per hectare could ruin their severely Ca deficient soil that often needs even more, because they have already made it toxic with too much urea, superphosphate and or potassium, and made animals sick without recognising the cause. What unproved tripe, some from scientists. Lime helps release P and suppress excess K, or makes low K more available.

Some fertiliser companies bribe researchers with large research sums to rubbish lime at $15 to $25 per 1,000 kg so they can poison farms with too much P at $450 and K at $800 per tonne. LimePlus makes fixed or locked up P available and with 40 kg of coarse sea salt, reduce K leaching. Calcium and salt make pastures more palatable so animals eat more and produce more, with less bloat.

Some New Zealand fertiliser companies are costing our farmers millions of dollars collectively, in wasted money on too much of wrong fertilisers or products, then loss of clovers, ryegrass pulling,

costly resowing, animal health problems, dying soils, weed infestation, lost earthworms, etc. Applying LimePlus has fixed these bad farming faults that many farmers don't even notice!

90% of farmers, who should know about their profession, show extreme ignorance. Some of them get sucked in to buying unproven products, sometimes registered as 'organic', but of little fertilising value, and applied before correcting the soil's calcium level.

No wonder increasing number of New Zealand consultants and townies are losing patience with some 'broke' farmers, too many of whom get sucked into buying feed, rather than growing forage crops, and paying helicopters to apply very small amounts of DAP three times a year, or 200 kg per hectare of fine lime or lime flour (200 kg per hectare off insurance lime equals nothing) by air at a spreading cost greater than the product cost. Some farmers buy made up products of low fertilising value, or liquid seaweed and fish oil at about $3,000 per 1,000 kg of dry matter, instead or the much cheaper agricultural salt for $220 per 1,000 kg. Un-processed coarse agricultural salt contains all the elements from the sea, which is more than the fish or seaweed can absorb, so is better value.

NEVER buy a fertiliser or lime without knowing or seeing its analysis and origin, because some cheap ones can have toxins, as occurs even in human vitamin and mineral supplements. See Human Health Minerals. A third of the supplements I was taking had mercury, cadmium, manganese, lead and other toxins causing pimples, boils and adversely affecting my joints and memory.

Enter the analyses of 'silver bullet' fertilisers such as Abron, Roks and Humates into the spreadsheet called Fertiliser Value Analyser which will show their low value.

Fertiliser Nutrient Planner shows the value of solid fertilisers and trace elements in percentages which will be better value than the high margin, so promoted extensively, products containing elements measured in parts per million (ppm).

I've asked suppliers of all the 'alternative' products I know of for names of farmers who have continued with any of these supposedly 'magic bullet' products for more than four years, but got none. As they give it up, others who believe there is a magic product that they haven't yet found, get sucked in to buying them. Unbelievable! No wonder some farmers go broke while others flourish. Figures are there for all to use with the help of GrazingInfo spreadsheets.

Testimonials

These are because most farmers, 99% of fertiliser companies, consultants and sales people, don't want to believe that LimePlus can do what it does at half the cost of most fertilisers and typical useless silver bullets. LimePlus is a fertiliser. Read the Testimonials. In Australia, by law, consultants are not allowed to receive commissions or rewards. It should be the same in NZ, to get honest rcommendations.

Deficiencies

Correctly taken pasture tissue tests don't cheat you, and in 1990 client David Webb, in the Eastern Waikato, found that despite his pH being about 6.2 over most of his mineral soils, taken to a depth of 15 cm (6 inches), his clovers were not growing as well as they should, dead organic matter (facial eczema spore feed) was increasing on the soil surface, earthworms were not as plentiful, as big or as active as they had been about seven years before when he was applying lime regularly. He had been told to stop liming by a fertiliser sales person because of the soil pH being 6.2, no doubt to sell fertiliser. All information from anyone who sells things, must be taken with extreme care. Most sales people are after your money.

Read pH for more information relating to calcium and farmer profits.

If being paid for carbon in soils ever comes, liming could end up costing little because it would increase carbon, but I'm sure that carbon measuring of farm soils won't happen, because of the vastness of the job. Even without carbon payments, applying LimePlus when needed, gives vastly improved soils and improved pasture with healthier animals and profitable returns.

Please encourage

A bank would not lend for more lime to do the other half of a farm. I know of three banks that have declined lending for lime on three diffent farms, which shows their extreme ignorance. Ask for it for fertiliser, which LimePlus is. If they decline threaten to change banks. Farmers have to become firmer.

All agricultural consultants, scientists and bank managers should read all this chapter. Why bank managers? Because three Waikato bank managers refused to lend to farmers who wanted to lime to

correct their extremely low calcium levels, causing soil and animal health problems, and suffering from no earthworms, ryegrasses pulling, bad drought effects, etc.

More seriously, calcium deficiency, accentuated by Diammonium Phosphate (DAP), caused cow deaths on Kevin Phillips's farm near New Plymouth (Waikato Times item). DAP has no calcium, so boosts the fatal N and P caused pasture growth that lacks calcium. Superphosphate contains some Ca, so it is not as bad as DAP (Diammonium phosphate).

Since 1960, 99% of the 540 grazinginfo members who have contacted me for help had not applied sufficient agricultural lime with its synergisms of other necessary elements, all of which can help grow a lot more clovers and pasture long term, than any nitrogen. LimePlus (lime with synergisms) improve deficient soils and reduce weeds, ryegrass pulling and facial eczema. On many farms lime has been replaced by urea, which reduces clovers, organic matter and earthworm numbers, and destroys soils until artificial nitrogen no longer works (See Nitrogen, Holland), by which time the organic matter level in the soil is too low to keep ryegrass and other high fertility species growing, so they die or pull out, and farmers blame the seed developers. Some went back to buying the 40 year old Nui ryegrass seed which is a disaster, growing only a third as much as Bealey NEA2 in my trials, when it is primarily and simply a lack of lime costing from $14 to $26 a tonne at the quarries. LimePlus with deficient trace elements costs more and freight is a major part of its cost. Lime on its own won't achieve the above, but MAF, Ruakura Animal Research Centre, AgResearch, fertiliser companies, most consultants (especially if bribed by fertiliser companies), scientists, and worst of all, the farmer owned DairyNZ and LIC, don't know this. Their ignorance or deliberate denial is disgraceful.

Doug Edmeades, Ants Roberts, Arnold Bryant and the Ruakura No 2 dairy farm manager for years all said that it didn't need lime. After Cor Feyter saw our Greenhill Road farm green when Ruakura was brown like this, the manager agreed and applied some, but not with all its synergisms.

These cows at Ruakura on 30 January 1988 were low in selenium (heads well below back level) and pastures were low in it, Ca and boron, so it was dry and brown while our Greenhill Road farm 2 km north, was green and growing, on the same day.

When I told some Ruakura staff and scientists that our farm was green and growing and that theirs needed lime badly, Cor Feyter, Mike O'Conner and another Ruakura scientists visited our farm and said, "You've had rain." "Yes", I said, "Look at the boundaries. Rain fell only on our farm." They then asked, "What are you doing?"

My answers were -

1. Correct drainage. DairyNZ's peat pastures on their Lye and Scott farms near Newstead have almost no drains. No wonder they complain about peat being hard to manage.
2. Applying the previously neglected lime at 6,000 kg on the Horotiu Sandy Loam and 8,000 kg per hectare on the peat, as LimePlus with elemental sulphur and trace elements, all based on pasture analyses, not old fashioned inaccurate soil tests that ruin soils, pastures and cause farmers financial losses. These amounts helped make fixed phosphate become available.
3. Chisel ploughed deeply to bring up subsoil and move the lime down.
4. Bred and spread earthworms. Read Soils > Earthworms.

Ruakura, after my recommending lime to them for years, applied some (no one was sure about how much, but I could see that it was not enough). The difference between a good and bad farmer is one week, not a year, or, in Ruakura's case, 30 years, of not enough lime. They used to drill ryegrass into ¾ of their ruined pastures every autumn, while we and other good farmers did not have to drill, and had far better pastures.

The Ruakura staff didn't contact the farming lunch time news program and tell them how to grow a lot more pasture than Ruakura grew. They did nothing, except crawl back into their ivory tower and look for a silver bullet they could write a "paper" on, for an increase in pay.

Cynical? What else can I and thousands of farmers be?

The Greenhill Road maize growing bankrupt farm we bought in 1984 was the worst farm on the road. We

improved it to become the best farm on the road, in 1987 when we sold it. The neighbour's in 2010 (23 years later) saw that ours still grew more and was still free of weeds as shown above, without any boom weed spraying, and with less lime applied than we did. The capital dressings of between 6 and 8 tonnes per hectare were still working.

Note the half metre deep spinner drain in the foreground of the above photo, that we put in to the foot of the hill to drain the seepage that comes from most hills and causes wet acid conditions and weeds like rushes, pennyroyal and buttercups, at their base. Correct drainage is the first essential.

The neighbour in the background, with thick buttercup, took 23 years to identify that our farm next to his grew a lot more clover and pasture than his, without weeds, especially in summer, so in 2010, he and his manager phoned on the same day and asked why. It was the capital dressing of between 6 and 8 tonnes of lime per hectare (2.4 t/acre & 3.2 t per acre), chisel ploughed 40 cm (16 inches) in to the lime-hungry consolidated peat, some up to two metre deep growing maize, and then 3 tonnes per hectare (1.2 t/acre) more, harrowed in on top before sowing pasture.

This neighbour then applied capital lime and their pastures improved dramatically in months, and buttercups became palatable so were eaten. Our Greenhill Road farm has deteriorated because their consultant, a MAF follower, doesn't believe in lime. When bought from us, the new owner, Mrs Plank of Burton Trust, wrote saying how impressed she was with our pastures, which were much better than on their three adjacent farms.

Both our two arms are still comparatively weed-free, while neighbours, and many in the Waikato, are covered in weeds. See the photos of ours and neighbours' farm on page 13.

After correct drainage, calcium is the most important mineral, which, with its synergistic elements can grow more clovers and then grasses, than any other fertiliser, and give higher yields than urea can

Below is what happens in paddock corners of Ca deficient soils where lime and fertilisers don't reach from spreaders. Gorse seedlings and weeds prefer sour hungry soils, pastures prefer correctly limed and fertilised soils.

Some gorse germinated in the healthy dense pastures, but was eaten by the grazing yearlings. Not one had to be sprayed or dug out. In the poor areas and under fences the gorse was not eaten when on its own, so was grubbed out.

At a Tatuanui, Waikato, lime field day in 2009, the hundred farmers agreed that many pastures in the Waikato were better 50 years ago than they are now. A lack of lime and its synergisms is the main reason. Perennial ryegrass pulling was very bad on that farm. Farmers asked what caused it, but the two scientist and others running the day didn't know that it was simply a deficiency of a capital application of lime, to lower the high aluminium levels. See Minerals > Aluminium. However some scientists claimed that there were no trials to prove what I said. That is their fault for not doing them. I have done hundreds, so the sooner they do some trials themselves the better, but under current government requirements for government employed scientists to find their own funding, who would pay them to do it? Meanwhile I and hundreds of farmers know it, and the lack of lime is losing most New Zealand farmers thousands of dollars every year, while many LimePlus users increase profits by $100,000.

In all Ca deficient soils (which in many countries is most soils), after chisel ploughing lime in deeply enough to bring up subsoil, it is essential to apply about 3,000 kg per hectare (2,700 lb per a) on top and harrow or roller-cultivate it in lightly.

If a handful of farmers say that LimePlus, or the best reactive phosphate, has improved their pH 6.3 soils and pastures, then I agree, and I ignore the so called scientists who don't want to see, so they stick with a pH 5.8 as their guide, often to protect their sponsored research or employment.

Most so called fertiliser consultants are actually commission agents getting about $12 per tonne commission from some fertiliser companies. On an average farm, this adds up to about $500, plus their fee, per visit, so by doing two farms they can earn $1,400 a day. The result is that they seldom recommend lime which varies from $16 to $26 per tonne at the lime quarries, which doesn't allow anything for bribery.

Results

No pasture pH meter or dry matter measuring device was needed to confirm the benefit of 8,000 kg of LimePlus per hectare on Bryce Wilson's farm near Te Kawa, Waikato, in front of ex-Ruakura staff member Koos Baars, compared with 4,000 kg per hectare behind him. Both were chisel ploughed in 30 cm (1 foot) three times. Even after seeing this, Koos was still not convinced enough to recommend LimePlus at more than 1,000 kg per hectare, which he was MAF trained to, or to do trials on obviously severely lime deficient soils, which is 90% of the Waikato. This is a problem I have to work around all the time because there are so many 'establishment' MAF, AgResearch, DairyNZ, LIC, fertiliser companies, and private consultants who have not been observant, read, or done comparative trials, which I've done or organised in many countries, totalling thousands. I have the records as evidence.

The client of Baars for ten years, Allan McDonald of Lichfield, sent me 10 cm deep turf. I added LimePlus containing the deficient elements to half (you can see which half). Each side started with three ryegrass plants. In the summer drought, the limed half grew well as shown in the photo, and remained a little moist, while the no-lime half became absolutely dry. It was all then cut. The limed side still had three ryegrass plants, which became quite large, while the other had only two, each a fraction the size. After the soil became dry in summer, the limed half continued to thrive while two lime starved ryegrass plants on the right died, leaving only one, I've seen this difference on whole farms many times. See Beef and Dairying chapters.

The insufficient use of lime comes partly from a 1972 NZ Department of Agriculture book, which is full of other old wrong information that was not even right when it was written. It has caused insufficient lime to be applied to most NZ soils for decades. It stated that light ash soils from Bay of Plenty to Taupo, and all pumice soils, don't need lime, and that liming causes imbalances (which is does without synergisms. It also said that pH is the only measure necessary for deciding lime requirements. These statements are naive, completely wrong, costly and disgraceful, from so called scientists, and have caused dreadful ryegrass failures and pulling in pastures. In the 1990s the 'establishment' always wrongly blamed Argentine Stem Weevil and in 2010 sometimes blamed Black Beetle for ryegrass pasture failures. The lime deficiency decreased pasture growth, increased weeds, all of which have lost NZ farmers millions of dollars in total. It was accentuated by applying the wrong fertilisers containing water soluble phosphorus and potassium, which were often in surplus up to toxic levels, while calcium, the most important element, was ignored, so was deficient, causing a mass of small disasters. See the list below.

This photo shows perennial ryegrass roots growing horizontally at 15 cm in consolidated peat on the Newstead DairyNZ Lye Farm in 2008, because it was not limed enough, and not chisel ploughed. This dug out clump was held above the pasture which had no clover, another sign of lime and sometimes magnesium deficiency, or excess potassium (See Minerals > Potassium) or excess application of urea (See Minerals > Nitrogen), occurring in AgResearch farming disasters.

Fortunately, good farmers do their own trials and see how wrong the so-called scientists are, but I still come across farmers on pH 6 soils who have not applied any lime, or not enough, for 50 years. This means that they are up to 18,000 kg per hectare (15,000 lb per acre) of lime behind, so several capital applications of 3,000 to 4,000 kg per hectare are needed, but check the pasture analyses, soil and earthworms (See Soils > Earthworms) with a spade and do pasture analyses. Applying more than about 5,000 kg on top in one application, unless chisel ploughing it in, is a waste of money. If necessary, based on a pasture mineral analysis, a lack of clover nodules and few earthworms, second 3,000 kg should be applied after a few months of rain.

There are many examples of farmers getting excellent pasture growth (better than from urea) after

applying LimePlus, when the pasture Ca, Mg and/or molybdenum tissue (leaf) levels were low, and pasture aluminium was above 100 mg/kg. It should be well below 100. See Free Spreadsheets for the free Pasture Analysis Planner spreadsheet for optimum levels of all minerals.

When sharemilkers are expected by owners with these conditions to get top milk production without lime, both the sharemilker and farm owner become frustrated. I have resolved many cases by doing liming trials on their farms to show them that the 'establishment' is wrong - again. Had more lime been applied when cultivating, and been chisel ploughed in to 30 to 40 cm (12 to 16 inches) or deeper, and earthworms brought in, the raw looking rough peat would be a rich humus soil, not raw peat, and not need resowing, which many done by AgResearch methods needed again within three years.

Every litre or kg of milk takes 1.2 grams of Ca with it, and culled cows remove some.

The following from a very experienced, practical large pasture analysing laboratory 65 year old manager sums up the major reason why many New Zealand pastures are not as productive as they should be, and is one reason why clovers are not producing as much N, why clover root weevils and clover fleas damage clovers so much, and why animal production is not as high as it could be. The manager wrote, "My impression of NZ AgResearch is that they have neglected lime (to put it very mildly). Refer to page 27 of their 'Fertiliser Use on New Zealand Sheep and Beef Farms' 1999 edition, which is a review of the 1993 edition, when describing a soil with pH at about 5.7 from 1988 to 1992, it pointed out, "Soil pH has generally remained in the target range with no lime application." This statement shows ignorance. Read pH.

In the Dairy version of the same series, the corresponding comment is, "Soil pH on this farm is close to the lower end of the target range, indicating that lime is not required at this stage."

I agree with the 65 year old laboratory manager and many others who have learned, while others are apparently still influenced by fertiliser companies millions of dollars annual sponsorships for promoting their products, and certainly not by practical or scientific facts.

One only has to visit DairyNZ and NZ AgResearch Waikato research farms on Vaile Road east of Hamilton, to see pastures crying out for lime, and animals showing severe trace element deficiencies. For evidence see the photos in Soils > Earthworms and in Minerals > Cobalt.

Some farmers ask how the 'establishment' can all be so wrong. Is it because fertiliser companies have given them millions of dollars annually for ages to promote fertiliser, so they tell negative stories about lime, or is it because they have not done any lime trials since 1954 (which was inaccurate, but is still quoted by the ignorant and dishonest) or have done useless ones with lime only, rather than LimePlus and its synergisms. You can't test detergents without water.

Do your own trials, starting now. These can be done on a paddock by paddock basis or in 10 m2, which is 3 by 3 metres (3.15 if pedantic) squares. Choose an average area close to where you pass frequently. See Trials for full instructions.

Dig into your pasture and see if the perennial ryegrass roots are growing horizontallly at anywhere between 7 and 30 cm, caused by aluminium which can be made less available by applying the optimum amount of lime, which is a lot more than a few hundred kilograms per hectare per annum.

Many from all walks of farming know nothing about aluminium toxicity, so blame a hard pan that occurs when lime is lacking so roots don't go through it and earthworms are few in number, covered in soil (see Soils > Earthworms AgResearch earthworm photo), sluggish so don't mix the soil. Correct LimePlus corrects toxic aluminium levels and increases earthworms by up to ten times. See the photos below.

Further evidence of the ignorance about lime is on page F-37 in the 2003 Lincoln University Farm Technical Manual, "Calcium deficiency is not a common soil fertility problem in New Zealand."

The Lincoln comments on liming peat (page F-38) also show a complete lack of experience and no knowledge. They wrote, "Clearly, lime can only be incorporated when pastures are being resown."

Read the GrazingInfo 40 pages in Soils > Peat to see who knows about it.

When cultivating is certainly the best time, but to save having costly re-sowing so often, peats, pumice and mineral soils need regular liming at about 3,000 kg per hectare on the surface, every three years or, better still, smaller amounts more often. Base the quantity on the earthworms, pasture leaf mineral analysis. See http://www.grazinginfo.com > Spreadsheets > Plant Mineral Analysis.

Not liming at least every three years is expensive, because pastures then deteriorate and need cultivating and resowing with ryegrasses that many find don't last as long as the older ones. At this stage Bealey NEA2 is the best lasting tetraploid ryegrass by far in NZ. It may need thickening after

three years, but so do others for less pasture production, and far less milk production. Some report milk increasing by two litres per cow per day when they graze Bealey NEA2 ryegrass. Trojan NEA2, is the best perennial ryegrass diploid now in NZ, and is from the same family imported from Spain and improved. NEA2 is the best and most palatable endophyte at this stage, and AR35 the worst, followed by other ARs. Ryegrasses using AR endophyte, especially when LimePlus is lacking, suffer pulling which 'arm chair' advisers who don't own a spade, wrongly blame on insects.

The wrong liming recommendations from New Zealand's pathetic 'bad science' are costing farmers dearly in failing ryegrass pastures which pull out and die.

On a healthy live peat soil, well ground soft limes with synergisms do move down, and it is essential that it be applied AT LEAST every three years at 3,000 kg or more, per hectare (1,500 lb per acre). If it doesn't work down, it is because lime has not been applied for so long that there are no earthworms, and surface moss and thatch have built up, and the lack of calcium has made the soil 'dead'. Applying lime increases earthworm numbers, and they certainly do take lime down. See Soils > Peat.

I and others have found not enough black beetles or other insects to cause ryegrass pulling, caused by a lack of LimePlus.

Cropping farmers, who see improved yields within months of applying lime, then apply much more than animal farmers do. In countries where sugar cane is grown on volcanic soils, correct liming has even increased sugar cane yields.

Many farmers build a bin for lime and fertilisers. This is over capitalising and costly in time, because carting it from the bin to the back of the farm in a spreader is much more costly than having the 30 tonne truck and trailer tip it close to where it will be spread.

Choose a level smooth area of pasture, and after spreading it, you will see clover grow like you've never seen before, which will show you how far you are from applying too much. To avoid it getting too wet, cover it with used silage low cost plastic and a few tyres to hold it down.

At the backs of large farms spreading time can be halved. The small amount left on the soil is worth only a few dollars. Your townie friends may like to come and scrape it up for their garden, but for you to see the extra clovers and then grass growth there will be worth a lot to you.

Farmers give many excuses for not buying and spreading lime, for examples - no fertiliser bin, being too far from a depot, and no rain forecast - then, when rain does come, there is a demand and delay in getting lime, and soils becomes too wet because they are not correctly drained, so they miss out again. Lime can be stored on the ground and covered with old silage covers and a few tyres.

Look for solutions to fix things not excuses for not doing them.

The cost of fertiliser storage bins would be better put into more lime, because bins are seldom big enough for 30 tonnes (10 t truck and 20 t trailer), which is the size necessary to get the cheapest freight. Bins are usually at the front of the farm, which increases the cost of transpiring to the back paddocks.

Lime and fertilisers can be tipped on pasture near the middle of the farm, or a truck and trailer load can be split between the front and the back the farm. Some then complain that there will be too much waste; however, if spread on a smooth level area of pasture, the waste is very little. The small cost of the waste is more than saved in tractor transporting time. The left over will show you what ample liming can do to the quantity and size of clover leaves and plants.

The extra clover, and then grass growth, shows the benefits of adequate lime, and disproves the propaganda from some fertiliser sales people, who suggest that too much lime will cause all manner of problems - which it does to their fertiliser sales, especially after lime releases phosphorus and reduces potassium leaching.

Another excuse for not buying lime ahead of spreading is that it might get wet. However, many farmers have old silage plastic silage covers, or can obtain used plastic at minimal cost if a bin is not available. Old tyres or lime can be used to cover the plastic edges to stop it blowing off.

LimePlus, if magnesium and other minerals are needed, which it is almost always - based on the accurate ryegrass analyses, not on inaccurate and inadequate soil analyses, at a much lower total price per hectare than P at $400/t and K at $800/t, based fertilisers, after which lime mixes always grow more pasture than P and K. 99% of pasture tests I've done show Ca is very low, P is adequate and K is too high, so is killing clovers. Read the Potash chapter. LimePlus makes surplus P and K available, so saves money and pollution.

Facial eczema controlled

If Ca is low, buttercup and thach increases, as does dead, tight compact soil, with low moisture retention, low dry summer pasture growth, few earthworms, small clover leaves, flat weeds, retained membranes, milk fever, thatch and facial eczema. Also, Ca deficiency causes low Mo, Mg & boron, high Al & Mn.

Below got twice as much LimePlus and as can be seen, earthworms increased (5 casts can be seen compared with none above) and all the thatch (dead grass) that breeds facial eczema spores was eaten by earthworms. Read Facial eczema.

Solminix

The five large healthy earthworms shown below were under the above limed soil. The reason for their extra plumpness was because the cows were fed Solminix, some of which is excreted in the dung, that earthworms then eat.

Agricultural lime

The most important element in all soils for pastures and grazing animals is Ca, which is also necessary for earthworm, soils and the health of good soil microbes.

It is the carbonate in agricultural lime that increases the pH, not the calcium which is needed by the earthworms, plants and animals (especially young ones) that graze the plants.

If unsure, do your own equal cost (essential) comparative trials on your farm.

The softer and finer that lime is, the faster it becomes available. Chisel ploughing it and reactive phosphate into soils to be cropped, speeds up their release for the fast growing crops

All references to lime in this book refers to top quality finely ground agricultural lime, not lime flour, dehydrated, slaked, coarse or any other lime. These forms of lime are not as suitable for soil application. Lime flour is unnecessary today when all good lime companies produce finely ground lime. Feeding some quick acting Ca products are harmful to stock, and in soils they don't give the long-term benefits of good correctly ground agricultural lime.

Get the analysis of the lime you buy. Place some in a glass and stir it. The clay will go into suspension and make the water muddy, Ca will not, it will settle quickly. Magnesium makes the water grey, so if magnesium is needed, then grey is OK.

Reactive phosphates contain up to 33% calcium carbonate (CaCO3), so are slightly liming in action, and certainly not acidifying like superphosphate is. The elemental S used with reactive phosphate is slow acting, doesn’t leach and is less acidifying than Superphosphate.

Low Ca accentuates high K and low sodium (Na) levels. Cows died in the NZ Bola floods and in other prolonged cold weather, from low Na, and where lime had not been applied for decades, because advisers and scientists said it was not necessary, and most probably coarse agricultural salt had not been applied in recent months.

Pasture energy levels are lower when Ca is low, and when ryegrasses are short, partly because ryegrass stems have more Ca than their leaves. The same applies to boron (B). Both need to be present for the other to be taken up, so a trial evaluating B as done by MAF at Walton, will be useless if the Ca tissue level in ryegrass is not close to 0.9% Ca.

Quality of lime is important

Coarse, 2 mm diameter, hard lime chips can take decades to become available, even in acid soils. Good quality agricultural lime should be nearly as fine as cement (calcium oxide). When off-loaded or heaped, finely ground dry lime should spread out to a fairly flat 30 degrees slope. Coarse lime will sit in a steeper 45 degree heap. Damp lime will sit steeply even if finely ground. Get an analysis from the supplier before buying products, because you don't want to apply elements already in excess, such as

Mg, too much of which can make soils hard and tight. See Minerals > Magnesium.

Cost savings can be achieved by shopping around for lime, cartage (back loading if possible) and for spreading prices. Savings can also be made by buying the lime in bulk 10 tonne truck and 30 tonne trailer loads, having it tipped in a bin on your farm or on the soil in a paddock, and then having a contractor spread it, rather than have the contractor/spreader transport and spread it in 5 tonne loads. When getting quotes, ask for a price on your total year's requirement to get the best price, with deliveries as required.

Small amounts (200 kg per hectare) of 'lime flour' achieve nothing in the soil. Pelleted lime is more expensive and while spreading is easier (less dust and a wider spread), it has no other benefits, but a major disadvantage in that earthworms don't like it and can't consume it, so earthworm numbers decrease. Most importantly, some (not all unfortunately) lime companies are now mixing and trace elements with lime to make LimePlus. In the past phosphorus has been the carrier of other elements needed, but P levels are now too high (above 4% P) in many soils. Lime increases the availability of P, from the "fixed P".

Most soils are low in sodium, so almost all lime and fertiliser mixes I do, have 50 kg per hectare or more of common coarse agricultural salt, added to them. Salt is moist and draws and absorbs moisture which reduces lime and fertiliser dust - which can blow away in wind, losing some of the fines. If necessary, sprinkle water over lime to reduce dust, but beware of too much moisture that can prevent it from leaving some spreaders.

If dust is a problem in residential areas, dampen it with a fine spray of water, though still able to be spread. Don't overdo it, because very wet lime may not come out of the spreader. Doing this is better and cheaper than paying for pelletised lime which doesn't work because earthworms can't use it. Even 100 kg per hectare of salt in lime and fertiliser mixes won't do any harm to the soils, and the animals will like the pasture so eat more. Farmers give many excuses for not buying and spreading lime, for examples - no fertiliser bin, being too far from a depot, and no rain forecast - then, when rain does come, there is a demand and delay in getting lime, so they miss out again. Lime can be stored on the ground and if necessary covered with old silage covers and a few tyres.

Look for solutions to fix things not excuses for not doing them.

The cost of fertiliser storage bins would be better put into more lime, because bins are seldom big enough for 30 tonnes (10 t truck and 20 t trailer), which is the size necessary to get the cheapest freight. Bins are usually at the front of the farm, which increases the cost of spreading on the back paddocks.

Lime and fertilisers can be tipped on pasture near the middle of the farm, or a truck and trailer load can be split between the front and the back the farm. Some then complain that there will be too much waste; however, if spread on a smooth level area of pasture, the waste is very little. The small cost of the waste is more than saved in tractor transporting time. The left over amounts will show you what ample liming does to the quantity and size of clover leaves and plants.

The extra clover, followed by extra grass growth, will show the benefits of LimePlus, and disproves the propaganda from fertiliser sales people, who say that lime will cause all manner of problems - which it does to their fertiliser sales, especially after lime releases phosphorus and reduces potassium toxicity and its leaching of an item costing you $800/t.

An excuse for not buying lime well ahead of spreading is that it might get wet. However, many farmers have old silage plastic silage covers, or can obtain used plastic at minimal cost if a covered bin is not available. Old tyres or lime can be used to cover the plastic edges to stop it blowing off.

Last, and best, is the fact that, if beef and milk payouts drop, and/or fertiliser prices increase, the smart consultants and farmers apply LimePlus. If magnesium is needed, some, like McDonalds Aglime, now called Graymont Aglime contains ample magnesium, the value of which brings the lime cost down to $19/t.

Another thing is to be careful of is buying lime from companies that also sell 'fine lime' to companies and farmers, so the left over lime that you buy from them may be coarser.