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Introduction

This is a summary of mineral feeding. The most important thing in animal and human health is diagnosing. If you don't know what it is and the cause, you won't know or find the prevention or cure.

At first glance one would think that these heifers were underfed, but they were moved to the best paddocks and not rationed at all. The next possibility is being infected with internal parasites, but one can see that there is no scouring and no swelling under the jaw from worms crawling up the throat. This leaves mineral deficiency symptoms. The hair on top of the neck indicates a deficiency of cobalt. Horses have manes, healthy cattle don't. The rough hair on the body standing on end instead of lying sleekly, indicates a lack of sodium and possibly zinc. The zinc deficiency is reinforced by the long hair on top of the head.

These yearlings on the right were not getting minerals. They walked around a lot and kept going back to the water trough. Note the runny eyes (low zinc), brown coat (low copper), muck on tails (low selenium) and general discontent.

Full information on each mineral is in Elements > Pastures, Soils and Animals. Correct minerals in feed and supplementation are both essential for animal health and high levels of their production. Deficiencies frequently lead to health problems.

Soluble minerals were then fed to all animals on the farm, and the next year, as shown here, all heifers were well grown, but the rough hair and dry noses show that more salt is needed.

In 1984 our son-in-law and daughter, Ian and Sue Dobbs, share farming for us reared 160 Friesian and Hereford cross dairy beef calves each year, on consolidated peat at Puketaha near Hamilton. From our previous peat farm we knew that minerals were low so wanted to develop a commercial soluble mineral mix to be fed through an online dispenser. They divided the calves into two equal mobs of 80 and fed one mob minerals which we adjusted over three years until the animals were in perfect health.

All pastures were limed and fertilised correctly with the necessary elements based on pasture analyses. After the last crop of maize, *Calignosa* earthworms were bred and spread by my wife Auriel.

After six months all were mixed and all fed minerals. The difference in size was amazing. In the above photo, the front one just right of centre was from the mineral group. The smaller one behind it to the left was from the 'no minerals' group for the first six months.

As can be seen, they were fed clover-rich pasture daily.

If you import, manufacture, sell or use agricultural chemicals, fertilisers, veterinary medicines, oral



nutritional compounds or vertebrate toxic agents in New Zealand, you must comply with the Agricultural Compounds and Veterinary Medicines Act 1997 (ACVM Act).

Ignorance of the law of mineral mixes 50 years ago was not a problem. Today you have to know all the possible problems and possible side effects. There are farmers mixing their own and some getting mixes done by companies. Some have been dangerous and have badly affected animals and milk. Fonterra should be policing them.

Some New Zealand rules are in <http://www.nzfsa.govt.nz/acvm/>

If you want to be kept up to date with the mountain of rules as they are formed in your country, Google for “get email updates (name of your country)” and select the categories required.

Diagnosing

The next photo was taken two weeks after these ones arrived on Barry Brunton's Rukuhia farm near Hamilton in mid August 2008. They cost NZ\$425 each. They were about to be moved to their next paddock. Barry's vet recommended drenching them for worms. Knowing how often most New Zealand farmers drenched their mineral deficient animals against internal parasites to try to stop the scouring as seen here, I said, "No, they are likely to have been drenched many times, and I can see that this scouring, the weak tails and the low heads are from selenium deficiency, not worms. Just give them Solminix, now called DeLaval FeedTech soluble minerals, and extra selenium from your vet."



The long hair on top of the necks, showed that they lacked cobalt and the rough shaggy coats showed low sodium, low copper and low zinc.

This was them 84 days later. 17 were sold for \$940 each. They would have fetched \$1,187 two weeks earlier before the schedule dropped. I suggested that he buy earlier in 2009 to be able to ‘finish’ and sell them before the spring



growth pasture surplus ends, at which time farmers start selling before the dry weather slows growth causing the beef price to drop.

The New Zealand exchange rate also affects the price our meat exporters pay for animals. Our dollar has been too high for decades because so many people see New Zealand as a safe investing country (none of our banks have gone broke and NZ is top of the ‘Fraud-free’ country list), so money pouring into our banks strengthens our exchange rate, at the expense of exporters. About 90% of our beef and dairy products are exported.

After selling them he emailed me, "That's better than I've ever done. Your lime, trace elements, fertiliser advice and mineral mix (Feedtech) deserves considerable credit."

This one came right up to me as I photographed. Even weeks after they arrived on the farm, Barry and I couldn't get anywhere near them. I had to use the zoom on the camera. After a month of adding minerals to their water through an online dispenser, and moving them daily, they came up to him and

me and followed us.

This Bill Chynoweth, Pukeroro, Waikato, herd in 1989 was deficient in many elements, because they were being fed only salt, which is necessary with maize silage. I got a pasture tissue (herbage) minerals analysis which showed the typically low levels on most farms in most countries. LimeMag at 3,000 kg per hectare was also applied because Ca was so low.



When chisel ploughing for maize, 8,000 kg per ha of Rorison's agricultural lime (97% calcium carbonate and 0.175% Mg), was applied, based on the pasture analysis below. It yielded 33,000 kg of dry matter per hectare. The area average is 24,000 kg per hectare. The extra is worth about \$3,000 per hectare.



Soil tests, even in 2010, can't achieve this, but many farmers in many countries have never done a pasture analysis, which tells the farmer what the pasture is getting out of the soil and what the animal is eating.

I got Bill to buy an online dispenser and to feed Feedtech soluble minerals in the water. Two years later the herd looked like this one on the right. They were fed only pasture and some maize silage and salt, and produced twice the NZ national average production per cow, and nearly as well as the North American average production per cow in confinement on total mixed rations (TMR).

The Feedtech soluble mineral mix mineral has been so successful since 1989, that veterinarians and others have copied it, but unsuccessfully for a number of reasons, such as economising, and not knowing that the sulphates have only about 25% of the element. One soluble mineral mix supplied by vets doesn't even contain salt, the most important supplementary mineral, because pastures, especially in the tropics, can take up other elements, but never enough sodium, irrespective of how much is applied. See Elements > Sodium.

The worst of all mineral mixes I've see in New Zealand are those with manganese. It is deficient in the UK, but in excess in most of NZ. See Elements > Manganese.

Feeding minerals

A good soluble mineral mix fed in the drinking water is the best so that animals get the eight essential elements of sodium, magnesium, sulphur, zinc, copper, cobalt, selenium and iodine all day and night. Bodies can store some elements, but not others such as Magnesium. Feeding self-help dry copper sulphate is dangerous, and has killed animals. Selenium should not be fed ad-lib because it has made animals (especially horses) so sick that they became useless. Many farmers and universities in the USA have shown that self feeding minerals doesn't work satisfactorily, but some still hope they will work. Decades ago in New Zealand, farmers found that self-help salt in lanes didn't work, because some consumed too much, while some ate none.

75% Ryegrass & 25% clover	25% clover	Yours
Nitrogen N	4.5%	3.8%
Crude Protein	28%	24%
Phosphorus P	0.40%	0.47%
Potassium K	2.7%	3.2%
Sulphur S	0.4%	0.3%
Calcium Ca	0.9%	0.6%
Magnesium Mg	0.26%	0.20%
Sodium Na	0.2%	0.1%
	ppm	ppm
Iron Fe	90	152
	ppm	ppm
Manganese Mn	50	80
	ppm	ppm
Zinc Zn	50	40
	ppm	ppm
Copper Cu	13	8
	ppm	ppm
Boron B	22	8
	ppm	ppm
Molybdenum Mo	1.5	1.14
	ppm	ppm
Cobalt Co	0.13	0.07
	ppm	ppm
Selenium Se	0.3	0.03

In-line tank dispensers made feeding soluble minerals easier. High producing cows need more and drink more, so get more, while calves drink less so get less.

Peta trough dispensers are ideal for adding soluble minerals to one water trough or tank. See www.peta.co.nz and/or email Peter Philips <peta@wave.co.nz>

The survey results below show the benefits of feeding DeLaval Feedtech soluble minerals.

DeLaval Feedtech Soluble Minerals User Survey - November 1990														
21 reports by users with 4,110 cows. Feedtech used in drench or dispenser at 25 grams/cow/day														
	Name	Location	# Months Used	Cow Temperament	Heifer	Animal Appearance	Dung	Cow Cycling	Retained Placenta	Mastitis	Milk	Milk Fat	Milk Protein	Young Stock
1	Bindon Robert	Matamata	2	O	O	B	O	B	O	O	U	U	U	O
2	Black Robert	Matamata	3	B	O	B	O	B	O	D	U	U	U	O
3	Carswell Terry	Te Aroha	2	O	B	B	B	B	B	D	O	O	U	B
4	Chynoweth Bill	Pukeroro	4	O	B	B	B	B	O	O	U	U	U	B
5	Clark Malcom	Patetonga	3	O	O	B	B	O	B	D	O	U	U	O
6	Clausen Craig*	Whitikahu	12	O	O	B	O	B	B	O	U	O	O	B
7	Cropp Kevin	Tatuanui	4	O	O	O	O	B	O	O	U	O	O	O
8	Davis Gary	Tirau	3	O	B	B	O	B	O	D	U	U	U	O
9	Dawson Rod	Waharoa	2	B	B	B	B	B	B	O	U	U	U	B
10	Hawe Keith	Walton	4	B	O	B	O	O	O	O	U	U	U	O
11	Henderson Wally	Matamata	2	B	O	B	O	B	O	O	U	U	U	O
12	Marson Gary	Waiuku	2	O	O	O	O	B	O	O	O	O	O	O
13	Orr Richard	Kereone	3	B	B	B	O	O	O	D	U	U	U	O
14	Saforson Sterling	Rotorua	2	B	O	O	O	O	B	D	O	U	U	O
15	Simpson Kerry	Matamata	2	B	O	B	O	B	B	O	U	U	U	O
16	Singh Jesse	Tauhei	2	B	B	B	B	B	B	D	U	U	U	O
17	Stent Mike	Putaruru	2	O	O	B	B	B	O	O	U	U	U	O
18	Webb David	Waharoa	2	B	B	B	B	B	O	D	U	U	U	O
19	Whittaker K*	Matamata	14	B	B	B	B	B	B	D	U	U	U	B
20	Wilson Lloyd	Matamata	3	B	B	B	B	S	B	D	O	O	O	B
21	Wright John	Waharoa	6	B	O	B	O	B	B	D	O	O	O	O
B = Better, U = Up, D = Down, W = Worse, 0 = No change sometimes because already feeding minerals.														
* Original trial farms Solminix contains seven elements at optimum levels,														
Trials with young stock showed those on Solminix, now called DeLaval FeedTech soluble minerals, ate less, grew faster and needed no, or very little worm drenching.														
See http://www.grazinginfo.com > Minerals														

Feedtech Solminix mineral mix for cattle on correctly fertilised pasture

Solar fine sea salt	81.45%
Mag Sulphate	15%
Copper Sulphate	2%
Zinc Sulphate	1.5%
Cobalt Sulphate	0.03%
PVP Iodine	0.015%
Sodium selenate	0.0008%
Total	100.00%

Minerals in pastures

In most areas of the world, even after correct fertilising of pastures and crops, based on pasture analyses, pastures can't provide all the minerals that animals need, so it is highly profitable to supplement them. The cost is nothing, because animals then eat less pasture and grow faster.

A sign of optimum correct minerals and good health is when cattle hold their heads up above their back like the heifer on the right, that had Feedtech Solminix in the water and had been grazing correctly fertilised peat pastures without spray. The heifer on the left, from the same herd, had been grazing on a so-called better mineral soil of



Hamilton clay loam, but without correct fertilising and without Solminix.

I've seen and read about many calves grazing pastures and suffering cold and health problems, while those fed concentrates with well (perfectly in most cases) balanced minerals in total mixed rations (TMR), are thriving.

Unfortunately, some farmers (especially organic minded ones) change to 100% grazing and think pastures provide everything, when it often has less, especially if there are no legumes in the pasture and fertilising is not based on pasture tissue analyses.

The low calcium levels of 0.3% to 0.6% (when it should be 0.8%) are caused by agricultural lime and its synergisms not being applied, aggravated by antagonistic items. When calcium is low, selenium, cobalt and some other minerals won't rise until the calcium level is corrected.

Ad-lib free choice minerals are a disaster

In New Zealand it is not allowed to supplement with any mineral mix without Animal Health Board, now called Agricultural Compounds & Veterinary Medicines Group approval, because animal products are for human consumption.

Making the 16 essential minerals freely available to animals is of little use.

Free-access mineral systems are not a satisfactory way of providing essential elements. It is a fallacy that animals will actively seek all the minerals or trace elements in which they are deficient. The main reason why animals eat some free-access minerals is that they like the taste of some!

Some lick mixes are purposely made to be palatable by adding molasses. Animals can then consume too much, which is wasteful, costly and sometimes dangerous. Both fast growing, tropical and nitrogen forced pastures are lower in some elements than slower growing temperate pastures.

Some farmers have put the needed minerals in separate boxes and hoped that animals would help themselves, but it doesn't work. Cornell University, USA proved this in the 1990s and wrote that lick blocks don't work because high producing cows would have to lick all day to get enough, and the worst thing is that some take none.

A US beef farmer asked on graze-1, an international farming discussion group, if self feeding minerals separately had been tried. Another replied, "Yes, unfortunately, around here that is a recipe for dead animals, poor performance and weak lambs."

Another wrote - "I would like to report my experience with "free choice minerals"! I went back to the farm and took over the management of ours as a new BSc graduate in 1956, with an animal science speciality in small dairy operation of 30 cows. During my undergraduate years I focused more on our family's pure bred beef operation and the nutritional requirements of beef cows. As a result I wasn't really up on the needs of dairy cows. I didn't, however, realise that at the time.

"I knew that the cows required a calcium/phosphorus supplement so I purchased one with the proper proportions and made it available free choice to my dairy cows in the exercise yard. This was about the same time that we started using artificial insemination in our dairy herd (1956). One day our AI technician (my brother-in-law) reported that we had the poorest conception rate in the whole AI unit. It was about 45%. He suggested that I contact our veterinarian. Our vet did some examinations and reported that, from his experience, the cows appeared to be phosphorus deficient. He also noticed the cows in the exercise yard eating dirt and chewing on sticks of wood!

"He suggested that free choice minerals were the culprit. We started incorporating the mineral mix in the grain mix at rates that would meet the dairy cows' requirements and within a month our conception rate was up to almost 70%. Free choice minerals was indeed the cause of our bad conception rate.

An Australian university student I was helping emailed, "I've now learned that my university education had not taught me everything I needed to know!" This was after I told him about pasture analysing, and his tutor knew nothing about it!

The problem with most universities is that the tutors were taught by tutors, etc., and never farmed.

These cows were on a Ruakura farm in March 1988. Their low heads show they are deficient in selenium and



unwell, simply because Ruakura didn't, and worst of all still don't (2010) believe in analysing pasture minerals, or in liming correctly. Their ex top soil scientist wrote that none of New Zealand needs lime, so Ruakura got none for decades until I persuaded the manager of one of their farms to lime one paddock. A year later he did them all, but without serpentine and boron and trace elements, so achieved less than half the benefit.

Our second farm had not been limed sufficiently by the two previous two owners who applied none and went broke, so we had to catch up by chisel ploughing in about 8,000 kg per hectare after maize, before resowing it to pasture. On the same day ours was green with 20 cm tall pasture.

The neighbours told us we were mad, but after our pastures stayed green and grew no weeds, they applied lime.

Calcium (Ca) and phosphorus (P) make up about 70% of the minerals in the body, with about 99% of the calcium and 80% of the phosphorus in the bones and teeth, where they are a reservoir of both. Feeding these two has all sorts of problems, and doesn't feed the soils, earthworms, soil microbes, pastures and animals as well as through the pastures.

Animals need sulphur. Pasture containing 0.4% S, and feeding the sulphate forms of minerals can provide it. The oxide forms are not soluble in water, and because about 10% of people are allergic to oxides, they are best not used unless essential, such as when dusting pastures with magnesium, because magnesium oxide doesn't wash off pasture as fast as magnesium Sulphate. Magnesium oxide is bitter, so some animals avoid it and therefore don't get their supply of magnesium. See Elements > Magnesium on how to overcome this and for full information. The pasture tissue mineral level should be at least 0.24%. See Free Items > Pasture Mineral Analysis for the optimum levels in the 17 important minerals. It is free, because it is so important to farmers to use it. It is the only one in the world like it.

Quantity & type of minerals to feed

DeLaval Feedtech minerals should be fed at 0.006% per kg of animal live weight per day, which is more than their suggested 20 grams per cow per day. Bill Chynoweth fed his big bodied cows with 50 grams and produced twice the national average of milk solids per cow.

The typical 4.5% nitrogen in many clover-based pastures equals 28% crude protein, which is too high for optimum animal health, and is one reason why animal health and production usually improve when top quality silage and/or hay with a quarter the N levels, are fed by some farmers when pastures are too high in N, sometimes from urea. Some farmers who have never seen a pasture analysis have fed urea to supply more nitrogen. Doing so to animals on high protein pastures and has been fatal.

Phosphorus is a mineral that can't be dissolved and fed in water and is better applied to the soil to increase pasture and crop yields and levels to the optimum of 0.39%, not above. See Elements > Minerals > Phosphorus. Applying agricultural lime and its synergisms as LimeMagPlus, releases P fixed in soils, which is cheaper than than buying P.

Potassium can be dissolved, but is also far better used as a fertiliser. Farmers who use soil tests usually apply too much, which can reduce clover and adversely affect animal health, and costs \$850 a tonne.

Iron is seldom needed and can be consumed to excess when grazing animals eat mud and/or dust on what they are grazing.

Zinc sulphate is added to some soluble minerals, and to fertilisers at 6 to 10 kg per hectare. Copper sulphate is in most soluble minerals, and if low in pasture analyses, should be added to fertilisers. Boron is needed by animals and legumes, so is best added to fertilisers. Molybdenum is needed by legumes to form nitrogen filled pink nodules. It can be low in calcium deficient soils. Cobalt sulphate is added to some soluble minerals. Selenium is covered above. Iodine is low in all New Zealand and some other countries, so should be added to most soluble mineral mixes. Aluminium is toxic, so not necessary and should be avoided, by not using aluminium troughs or containers. Avoid toxic containers and troughs. Copper chrome and arsenic (CCA) treated Radiata pine feed troughs have adversely affected animals. Remember to see the full information on each mineral in Elements and in the spreadsheet called Interactions in Blood, Soils & Pastures.

Chelated elements

These are promoted by some as superior with lots of flowery words, but no comparative trials. A

client fed Solminix soluble minerals from 1989 with excellent results. In 2005, he was 'sold' on chelated minerals by a salesman, since then his cows have become smaller and show mineral deficiencies, as seen in the photo to the right. This cow below is an example. Despite being a crossbred, it has a smaller body and shows severe cobalt deficiency (hair growing on top of its neck) and thinner bones.

Chelating of minerals refers to a theoretical bonding to improve absorption, which is quite often done by using mercury. Mercury is also used to bind the silver in amalgam fillings in teeth. Chelated minerals cost 10 to 15 times more per milligram of elemental mineral compared to normal, natural sulphate sources. All comparative trials should be done on an equal cost basis, otherwise they are useless. I've been suggesting this to NZ research people for 50 years, but still very few do it, making some of the millions of dollars spent



annually a waste. Some of it is farmer money. An example is the AgResearch \$5,000,000 spent on research trying to reduce methane production by ruminants. It was a complete waste because the suggested solutions were to grow Sulla, a low producing legume that doesn't survive, etc. Clover pastures make less methane than ryegrass pastures, but that has not been promoted, the opposite has, by those recommending the use of urea, but not recommending LimeMagPlus (a lime, Serpentine magnesium and element mix).

From Florida University (no date). "In ruminants, chelated minerals have been of less concern due to the rumen microbes and their involvement in digestion. Under certain conditions ruminants have responded to mineral chelates, but it is not clear from the studies reported whether this response is due to the form of the mineral or simply to increased mineral consumption. Information presently available does not consistently show advantages for chelated minerals in the diet."

Some of us find it more economical to add more of a non-chelated mineral, rather than use the much more expensive chelated minerals, for no known benefit. A client who fed Feedtech minerals for decades changed to chelated minerals, and his animals started to show deficiency symptoms, which they hadn't for the previous 20 years. Another changed from chelated minerals to DeLaval Feedtech minerals, which with other improvements, reduced milk fever from about 10% to almost none, with a dramatic improvement in overall animal health.

A student from Wisconsin wrote, "Scientific studies do not tend to support the idea of chelated forms of minerals to be better for growth or health. Could anyone point to such studies done by reputable universities. Companies that have an agenda and are selling a product don't count as unbiased." There were no replies.

Animals need sulphur so feeding the sulphur forms of minerals provide it. The oxide forms are not soluble in water and because about 10% of people are allergic to oxides, they are best not used unless necessary, such as when dusting pastures with magnesium, because magnesium oxide takes more rain to wash off the plant, than magnesium sulphate. Magnesium oxide is bitter, so some animals avoided it and don't get their supply of magnesium unless made palatable by mixing salt based minerals with it.

It is known that copper, zinc and some others, are poorly absorbed by animals. Absorption figures are as low as 3% for some elements, however, part of the remainder benefits soils, so is not all lost. Low absorption is not just from supplements, but also from pastures and other feeds. Chelating was developed to try to overcome poor absorption, but I have not seen trial evidence that it does so, when compared with ordinary minerals on an equal cost basis, and there are times when the sulphate in minerals helps animal health. North American trials have shown this with milk fever.

When Googling for chelated minerals there are many supplying companies that rave over them, and some users do the same, but I've not seen comparative trials by any.

This Waikato cow, after changing from a sulphate based soluble mineral mix (Feedtech), to chelates, which were more expensive, had deteriorated in health and shows deficiencies of cobalt (long hair on neck) and zinc (long coarse hair especially on the crown).

Chelated minerals are usually bound to amino acids and organic molecules and claimed to reduce antagonism and increase absorption. How much more beneficial they are than standard minerals depends on many things, such as other elements used at the same time, the quality of the drinking water

and the extra cost.

Curtis W. Richardson, Extension Dairy Specialist, Co-operative Extension Service, Division of Agriculture, Oklahoma State University wrote in Minerals and Vitamins For Dairy Cattle -

“Chelated minerals are those mineral elements that have undergone a chemical reaction intended to affect its absorption and utilisation by the animal. For chelated minerals to be economical in rations they must either improve animal performance or cost less than other mineral sources. Improvement of performance could result from: greater bio-availability of the mineral, a secondary effect due to a change in the microflora, or secondary effect due to a change in metabolism of another nutrient. A limited number of published research reports are available on the use of chelated minerals in ruminant rations. Statements such as ‘bio-availability of minerals is improved’ mean nothing.”

I’ve asked chelated mineral manufacturers for figures based on costs and returns to show that chelating is rewarding, but not received a single one.

Proteinates systems are now also being promoted as the latest and greatest and some now say that ‘colloidal’ is the best form, but until one sees cost/benefit comparisons feeding, the lower cost sulphate forms in drinking water should be continued. Sulphur in normal minerals which are not in chelated ones help reduce high molybdenum effects, milk fever and nitrate toxicity.

If anyone has evidence of the financial benefits of chelated minerals please send them to me or tell me where I can access them. Thanks.

I have explained that free-choice doesn’t work because, for example, Magnesium oxide that is often needed by most cows on pasture in most areas before calving, and for a few months after, will not be eaten because it is so bitter. With salt, which animals need and like, they will eat it, or better still it can be mixed with a good mineral mix and spread on pasture before animals graze it. However, it is best dispensed through the drinking water with other minerals when each animal then gets the right amount because big and high producing cows need more and drink more water, while small and dry ones, need less and drink less and milking ones need more and drink more.

A good soluble mineral mix fed in the drinking water is the best so that animals get the eight essential elements of sodium, magnesium, sulphur, zinc, copper, cobalt iodine. Feeding self-help copper sulphate dry is dangerous, and has killed animals. Selenium should not be fed ad-lib because it can also kill animals. Many farmers and universities in USA have shown that self-feeding minerals doesn’t work satisfactorily. Decades ago in New Zealand, farmers found that self-help salt in lanes didn’t work, because some consumed too much, while others ate none.

In line dispensers made feeding soluble minerals easier. High producing cows need more and drink more, while calves drink less so get less.

Metering dispensers need adjusting to increase the minerals in rain and cold weather and decreasing in hot weather. If a leak develops on the farm, a week’s supply of the minerals in the supply drum can be lost, whereas online tank dispensers lose only the amount added for that day.

Some minerals help keep water troughs cleaner and freer of algae.

Some colouring should come with it. Adjust the taps so that before milkings there is still a very small amount of colouring in the water. It can be measured by opening the drain tap. If there is no colouring, it means that the trough will have no Feedtech in it for the first drinkers at the next grazing of that paddock. This is just a small thing, but is part of the essential meticulous farming necessary to succeed without stresses, such as milk fever. A herd of cows can go into a paddock and graze before drinking, then two hours later the first ones can drink the water that doesn’t yet have minerals, and may not have had at the previous drink five hours before.

Preferences

Animals prefer water that has the eight important minerals, as in DeLaval Feedtech minerals. Where farmers add it to drinking water for calves, they will run up and drink immediately. The preference for minerals in water is advantageous in wet weather when animals could drink from puddles which means they don’t get the essential minerals, or even worse still, they can become infected with liver fluke.

Spraying minerals on to pastures is promoted by some suppliers. It is extra work and a machinery cost, and in rainy weather when minerals can be most needed, rain can wash them off before they are eaten.

Iodine is also essential in some areas - in minute quantities - so it should not be fed ad-lib.

Zinc sulphate has to be fed at 25 to 30 grams per cow in much of New Zealand and parts of South Africa, France, Canada and North America (and possibly other countries) in summer and autumn to prevent facial eczema. Animals won't consume that amount on its own.

If an animal craves a dry lick that contains copper sulphate, it can kill itself by eating too much, which is not very much. See Elements > Copper. The same amount in drinking water will cause no harm because it is consumed over a day. Always be extremely careful with supplementing minerals because almost all in excess can kill, or stress animals, as with manganese. It is safest to use a commercial mix from a reputable company. In New Zealand DON'T buy a lick that contains manganese because it is in excess in most soils here. See Elements > Manganese.

Some proprietary products often contain minerals that are being over-supplied already from pasture such as manganese, while some do not contain enough of those that are deficient such as selenium.

As with all things, there are good companies supplying good products and good advice, and the opposites. Some magnesium oxides and other useless ones are coarse, hard, of low quality and not absorbed in the digestive system of animals. Supplementing with a good magnesium oxide such as Causmag from Australia, gives the best results in Australasia. Some bad minerals have cadmium. See Elements > Cadmium. Always insist on an analysis of minerals and fertilisers. Once cadmium gets into your soil it remains for a long time.

Ratios

Some people emphasise ratios between minerals, however, ratios can be useless. If both levels are low, but the ratio is perfect, they will be of little use, and if both are high, they could be dangerous. It is better to aim for optimum levels of each element in each pasture type and in animal blood and livers. See Free Items > Pasture Analysis for optimum levels of pastures and most grazed plants.

Soluble mineral mixes (SMM)

While some element levels can be high pastures, animals need more of most than pastures can provide, so correct minerals should, if possible, be supplied in the drinking water to animals on pasture all year because most pastures are low in some elements, especially salt, even when it is in the soil.

Sheep don't drink much, so need dry licks, but be careful with them to avoid excess copper and smothering. See Sheep.

I belong to several internet discussion groups that have discussed mineral feeding and all end up in favour of in the water.

Blocks are worst. Cornell wrote that a high producing cow would have no time to eat if it had to obtain its minerals from blocks and would wear its tongue away.

Self help were second worst because some ate too much and others none. Loose licks were third to worst and had to be kept dry and free from birds messing in them.

Many farmers have said that after they changed from drenching minerals twice a day during milkings, to providing the same amount of the same soluble mineral mix in the drinking water through an on-line dispenser, animal health improved. The success of TMR in US and TMF in UK are reflections of feeding everything as a mixed feed, rather than separately. Minerals in the drinking water mix with the pasture all day and achieve this.

Some people who should know better have written that adding minerals to the drinking water reduces water consumption. If the minerals are balanced with salt as the main element, which it should be because it is the most needed, animals will drink more water. If you don't believe this, buy one bag of a good SMM of the eight essential elements and add some manually to your calves' drinking water at 0.006% of their live weight and mix it in. Within a few weeks the calves will wait for you to add it and then drink. I've seen a farmer try to fool the calves by walking up and going through all the motions, without adding the SMM. The calves ran up and started to drink then stopped and waited.

Good eight mineral soluble mineral mixes reduce the growth of algae in water troughs and tanks and make the water taste nicer for animals.

Soluble minerals & fly nuisance

Rukuhia, Waikato, hobby farmer Des Holmes had a 4 ha (10 acre) peat block and another mineral

soil one. He soon found out that animals on the peat needed something so was recommended to contact me. We worked out correct fertilisers and he started feeding Feedtech mineral mix in the drinking water. Calves leapt ahead and all animals thrived. When summer came he noticed that the calves on the mineral soil bunched up and fought the flies, while the calves on the peat spread out and grazed as usual. He phoned me and asked why. I asked him if he was feeding the calves on the mineral soil soluble minerals. He wasn't. Within a few weeks of supplying minerals through a dispenser in the water the bunching and biting flies stopped and didn't recur.

Soluble minerals in the water don't always solve all fly problems, but usually help. See Flies.

These yearlings were fed Feedtech minerals from the first week which almost eliminated worm drenching on Des Holmes's farm which had such bad calf rearing problems after 20 years of rearing calves, that his vet advised him to sell the property because it was "worm infested". Look at the excellent pasture on raw poor Rukuhia peat, correctly limed and fertilised.

Des was amazed at how tame they became even to strangers like this visiting client of mine. Many have reported this improvement of tameness in animals on Feedtech minerals.

Bryce Wilson of Te Kawa Rd, Te Awamutu, Waikato, also found his calves lay down more because flies stopped worrying them. Two of his calves changed from being very deficient to healthy in three months of my getting him to feed a nine element soluble mineral mix in the water. I said that the two worst should be eliminated. Three months later he proudly asked me to point out the two in his mob of 30. It was difficult.

Read Beef Profiting for more information on minerals helping make profits, and see how fertilising pastures correctly helped ducks, so could do to free range poultry.

Licks - but be careful

If there is no other way, feeding mixed minerals (not blocks) may be necessary to provide trace minerals, some of which can be unpalatable, or made so palatable with molasses that they are gorged, so salt is used as a carrier to overcome both problems. Salt can reduce excess consumption, except if animals have been deficient in salt when they can gorge on it when first supplied, so be careful and ration it initially until all have their craving satisfied which can take a few weeks.

Animals can also gorge on other minerals (palatable ones) if they are deficient and are suddenly given them. Deficient sheep have smothered each other to death when trying to get to minerals, so be careful. Poultry have poisoned themselves on salt.

Placing the minerals close to the water trough encourages consumption.

Elements in animals

On-farm comparative trials by commercial companies and farmers have given excellent and profitable results from supplying some minerals and some vitamins to half a herd, and using the other half as a control. Some trials have been on farms where pasture analyses showed no pasture deficiencies in the main elements, but even items such as sodium are required by some animals (high producing cows) in amounts greater than pasture can provide. Iodine is a trace element that most soils and pastures generally don't provide the grazing animal in sufficient quantities.

A 1986 milking cow trial showed a 388% return on the cost of the supplement. Improved conception rates gave a further benefit.

This survey of 21 farmers who used an SMM tells more. Read this thoroughly.

User names are held for references.

The name Solminix was later changed to DeLaval Feedtech soluble minerals.



Immune system

To maximise immune functions some minerals are needed on a regular basis. The immune system is a complex and intricate system. Some minerals act as keys which unlock the ability of the immune system to ward off invaders. Correct mineral supplementation will not eliminate diseases, but will allow animals' immune system to work to its ultimate ability to minimise health and even some parasite problems.

See Animal Health > Ill Health Symptoms & Causes.

Feeding minerals

As explained above, the best and most accurate way of supplying minerals is through a non-moving part, 100% plastic tank system.

If using town water, a non-return valve must be fitted into the main water pipe before the dispenser to prevent minerals going back into the town system during a water pressure drop.

Where there is no water reticulation system (piped water to all or most troughs), but there are water drinking troughs, Peta dispensers can be used. See <http://www.peta.co.nz>

These float in the troughs and very cleverly dispense the minerals slowly. If not available, placing the animals' daily requirements in an old milk sock or in a nylon stocking and then in the trough can do the job. Learn to place it for optimum dispensing within the time required which can be 8 hours under 12 hour grazing or 20 hours under 24 grazing. The position could be under the inlet, or away from the inlet.

Where water is only available from natural sources such as streams or dams, it is better to feed a good loose mineral than nothing. These mixes should have enough salt to make them palatable, but not so much that animals don't consume enough.

Rumen acidity

Ruminants fed good correct mature (for grazing) pastures don't have acidity problems. They've been grazing pastures for a zillion years. As little as two kilograms of concentrates or grain, or too much acid silage can change this and should be corrected by adding bicarbonate of soda, or similar in the concentrates, or a good yeast product fed with acid silage, thought is if fed to excess without enough pasture. Correcting acidity can increase milk production by a litre per cow per day that more than pays the cost.

Drenching, dispensing & dusting minerals

Many New Zealand dairy farms have a cow drenching system for supplying minerals and bloat control products, however with the continuing trend to labour saving, on-line dispenser use is increasing. After they change, milk production goes up because minerals consumed all day do more good than just once or twice a day. Some dust Causmag onto pasture for a month before and several months after calving to control metabolic problems. See <http://www.causmag.com.au/>

When adding it to the water is not possible, I suggest -

- Dissolving soluble minerals and pouring the thick solution over ALL the supplementary hay or silage EVENLY so all get it.
- Mixing Feedtech minerals with the Causmag to reduce waste because it is acid and some cows won't eat it. Feeding Causmag reduces milk fever to about 1% or less and increases milk production by up to 15%. Some cows will still get milk fever because they are either prone to it or because they hate Mg oxide so much that they avoid in on the pasture. Try licking magnesium oxide. It is bitter. Also some of the Mg oxide is not eaten so is wasted. When mixed with a good SMM, all is eaten and is even licked off the ground.

Some people are allergic to oxides. Dairy farmers spreading it on pasture can become unwell (diarrhoea) and off colour and can blame it on winter stress when it is simply oxide allergy. Zinc oxide can do the same in summer when used for facial eczema prevention.

An on-line dispenser is the easiest way to supply minerals, is more effective than drenching and is reasonably reliable for bloat control.

If you plan to mix your own elements get approval from animal authorities or organic ones if farming organically. For drenching systems or on-line dispensers, dilute each one separately before

mixing them to prevent reactions. You may then ask how a premixed mineral product avoids this problem. It is because they have a buffer added to overcome clashes of elements. However they should also be dissolved in plenty of water before mixing with other products. If you don't dissolve each separately they can cause chemical reactions which can make the mix go thick, cause some elements to settle out, or make some elements ineffective. Good SMM's have stabilising additives. One farmer mixing his own minerals had Cu settle in the bottom of his on-line dispenser and build up there, rather than staying in the mix and going to the troughs. Some waters accentuate these reactions, while others are no problem.

When dissolving a bloat oil, pour it into the water, not water into the bloat oil, and dilute the bloat oil first in ample water, then add the other products, after also diluting them.

Drenches that close the animals reticular groove and bypassing the rumen can be a problem, especially if a bloat preventer is being used because bloat occurs in the rumen. See Animal Health > Bloat.

Much of the digestion occurs in the rumen, so it is important that minerals enter it and are not allowed to bypass the rumen. This can occur when drenching if the cow is handled roughly or stressed, the drench gun is pushed too far down the throat, if the drench contains some minerals (salt, Cu and others), or is too concentrated, has too much of some, is bitter, and/or if the water is very cold. However, Ruakura trials showed that with some cows even plain water can bypass the rumen.

Products such as molasses and Molvinate (a thinner and easier to use molasses based mineral and vitamin product) make the drench more palatable and relished by animals, so instead of drenching being a fight, cows open their mouths for it.

Molasses provides energy which can be a digestive aid when feeding short fast growing, high-moisture, sappy, spring pasture and/or low quality hay or other poor feeds.

All figures and suggestions are given in good faith and relate to successes in some instances, but supplementing of all elements must be done with knowledge and care, to avoid creating imbalances and toxicities.

Soil Eating

When grazing, cattle can consume up to a kilogram (sheep 400 grams) of soil a day of useless topsoil which can be harmful to digestion. High rates occur in dusty and muddy conditions and can adversely affect the balance of minerals in the body, however, where animals are lacking some minerals, especially sodium, they will deliberately eat subsoil from banks. I saw foot prints from birds, wild pigs, deer and beef cattle showing that they had been eating subsoil below pasture root depth from a bank on a farm in Ohio. Animals seldom eat topsoil for minerals which is just as well because some topsoil contains listeria. Some wild animals travel miles to eat minerals, especially salt, from some soils.

Animals eating soil in New Zealand can supply them a little cobalt (Co) which is low in much of New Zealand and especially in sandy and pumice soils, but it is better to supply Co in a soluble mineral mix.

Decades of crop and pasture farming to a depth of about 15 cm (6") depletes trace elements which we don't replace. Animals and people are then fed on what grows in the top depleted 15 cm, so no wonder both suffer unexplainable deficiencies.

When the deficient minerals are mixed with solar dried complete sea salt, which has most things, and fed to animals, soil eating usually stops. Sea salt can give the benefits of seaweed. Vacuum-dried table salt which has had Ca, Mg and other flavours removed for human consumption is not as beneficial, but in New Zealand does have iodine added which gives it higher levels of I than sea salt, so iodised table salt is better for humans. In New Zealand soluble mineral mixes for animals should include iodine.

Which mineral mix

In New Zealand there are several to choose from, but in some countries there is none. When checking them, remember that in most areas salt is essential, so if not the main item, then the product is not as good as those containing adequate salt. Magnesium is the next most required in most of New Zealand. After analysing your pasture tissue, you will have a better idea of which minerals are required.

Vague, undefined and non-specific supplements can be a waste of money with few benefits.

Feeding some such as manganese in New Zealand, has caused animals, and farmers by association, to be severely stressed. Palm Kernel (PKE) is extremely high in manganese and copper, so should not be fed at more than 2 kg per cow per day.

Read the labels. In New Zealand they should contain enough of the eight essential elements of Na, Mg, S, Cu, Co, Zn, Se and iodine. Some areas may need manganese. When boron is low, it is better applied with fertiliser because soils, legumes and maize need it.

When checking mineral mixes, remember that in most areas salt is the most deficient in pastures, especially tropical ones, so is needed. Also, insufficient sodium, a digestive aid, reduces Mg absorption. If it is not the main item in a mix, then the mix may not be as good as those containing mostly salt. Magnesium is the next most required in most countries and in most of New Zealand. After analysing your pasture tissue and fertilising with what is practical, you will be able to see what additional minerals are required. Use Pasture Analysis and Fertiliser Order spreadsheets. The first explains 17 element levels and the second helps you calculate how much of each to apply, based on a pasture analysis.

How much to feed

DeLaval Feedtech minerals should be fed at the NZ Animal Remedies Board approved 0.006% per kg of animal live weight per day, which is more than the DeLaval suggested 20 grams per cow. Other products have their own instructions. Some don't contain salt which is the most important element, especially in the warmer areas where grasses don't take up much sodium, which is needed for animals to keep themselves cool and warm.

Feeding minerals

Under-feeding and parasite infestation can cause mineral deficiencies, and conversely when minerals are balanced, animals can tolerate most parasites much better. If infestation is not too high, animals need not be treated and can build up resistance to the parasite concerned. See Drench Resistance below. If you doubt this, then how is it that old animals can thrive while young ones in the same mob suffer severely from parasites.

The correct balance of all minerals in a soil is more important than having sufficient of any one element. When soils become a little drier than usual, plants which suffer from toxic levels of some elements and start to wilt, although soil moisture may still appear to be adequate. Adequate calcium (agricultural lime) reduces wilting. See the photos under Gardens > Vegetables > Tomatoes and Broad Beans. Wilting symptoms in pastures are not as easy to see, but after farmers apply lime to deficient pastures, they notice improved growth in dry weather.

As plants mature, the percentage of trace elements of the whole plant tends to decline. Mature grasses vary in their element content between leaves and stem.

Different levels of Se cause different problems on different farms, and amongst different breeds of cattle. Not all the conditions will occur on one property, and not all animals will be affected.

Promotion of minerals can be hard to follow. Supposed benefits of boluses, organic and chelated forms are sometimes promoted, but costs are seldom included. The results of all comparisons should be cost based. Some have promoted, "Blood levels from brand xx are twice as high as from brand yy." However xx could be four times the price of yy. Feeding more yy may have given equal results and cost less.

When comparing, allow for convenience because if a system is long lasting or easy, it will be more likely to be used.

If the only way to feed minerals is loose, don't buy mineral feeders that can rust, rot or poison stock if made of treated timber. Use any of the following.

On farms where animals are moved frequently, use tyres cut in half by professional tyre cutters and attach a chain, rope or baling twine doubled or tripled to pull it with a vehicle to the next paddock. Add enough minerals to last until the next move. For large mobs use large tyres. Drainage holes may be necessary. During heavy rain minerals need not be fed for a day or two.

On small farms with fewer paddocks, use discarded wide flotation tyres that will stand up on their own and can be tied to a post. Position them with a side to the prevailing rain and the minerals should not get too wet. In very wet areas a hole may have to be drilled or cut in the bottom, to allow surplus water

to escape. Plastic 44 gallon (55 US gallon) drums. Cut a lot of one side out so stock can put their head in and reach each end. Fly-control ear tags for face flies can be attached to the top or sides of the opening where drips over the tags won't fall into the minerals. Tie the feeders to trees or fence posts or special posts. In both cases choose raised areas to avoid mud and move them occasionally to avoid dust. Over-sow the bare areas three days before moving them so the seed gets trampled in.

Trace boluses

The system of placing a bolus in the rumen has merit, but not if the bolus has elements your animals already have plenty of. Some are designed in other countries and then used in New Zealand, so in one case manganese was included which is low in UK, but adequate, or often too high, in some of New Zealand's acid soils and in some other countries.

A peat farmer believes that his calves were adversely affected (grew less) by getting trace boluses when they were about 200 kg live weight, compared with his father's which didn't get boluses and were grazing in the same mob. Trace boluses are made for adult stock.

I've seen calves with zinc boluses showing slight zinc deficiencies. See Elements > Cobalt > Ruakura.

Elements in seaweeds and seaweed products

The levels of most elements in kelp and other seaweeds and their products, are so low that they will not prevent deficiency symptoms in areas very low in any particular element. Some claim that feeding a little kelp will supply some minerals, but an example analysis was Cu between 1 and 10 ppm (about 13 ppm is necessary in the total feed), zinc was between 10 and 50 ppm (at least 30 ppm zinc is necessary in the total ration). Se is between 3 and 4 ppm (about 0.3 ppm is necessary in the total ration so if the pasture being grazing has almost none, which is the case in the many deficient areas, 1.5 kg DM of kelp would have to be fed per grown beast if 15 kg DM pasture is fed per day.

The following from a farmer in Maine, USA, is one of many examples that show that there is not enough Se in kelp. "I've fed kelp meal (didn't say which one or how much and they do vary in quality) and salt for 2.5 years now. Last March, shortly before lambing, we lost a ewe to an unknown cause. The vet during autopsy diagnosed a Se deficiency."

The above refers to elements we know of. I'm sure that we don't know all the elements that there are in seaweed and fish products. When gardeners use fish or seaweed products some notice an improvement in plant health, and organic farmers achieve improved animal health, but their cost on a farm scale is not always profitable.

Sea salt has the same elements in higher proportions, so always insist on sea salt in your soluble minerals. Salt from deserts are not leached by rain, so have higher levels.

Herds and breeds can vary in their requirements of vitamin supplements. Most vets know about vitamins, so discuss it with them, but animals fully fed on balanced pastures, seldom have problems.

Summary

Farming is so simple. Why do so many make it so complicated by following out-of-date mistakes, such as soil testing that I did once in 1956 and saw was plain wrong and inadequate, so never did it again. I used a spade and my eyes with comparative trials until pasture analyses became available. Even pasture analyses are not as accurate in the major elements as comparative trials.

Believing the fickle soil pH system causes more problems.

Pasture analyses are so far ahead, as are the farmers who use them.

The died-in-the-wool, never improve, blind, soil scientists, consultants and farmers, led by the fertiliser companies, are costing New Zealand farmers and the country millions of dollars in lost money, and worse still in today's world, pollution.

Soil tests have serious faults which many know about, but no one does anything to correct. The soil K optimum figure is too high, so too much is applied, causing a loss of clovers in pastures, and animal health problems. Superphosphate leaches it, but when changing to reactive phosphate and elemental sulphur leaching stops, so the high K remains a pasture and animal health problem.