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### Introduction

Endophyte means 'Within the plant'. It is a naturally occurring fungus called *accremonium loli*, found in plants to protect them from insects. Some rye grasses and some fescues have them so strongly that they affect the health of animals that eat them, but not much in Brahmans and their crosses. Highest levels occur during summer and autumn.

The endophyte fungus grows and completes its life cycle entirely within the plant, without producing spores or infecting other plants. It is seed-borne, transferring to the next generation through the seed. When the seed germinates, the endophyte grows in the new seedling. The presence or absence of endophyte in plants and seeds is not visible to the naked eye but can be detected by microscope and other laboratory techniques, and I presume, by animals tasting it.

Endophyte can't pass from one seed or plant to another. If seed without endophyte is sown, the resulting plants will never have endophyte, and Agricultural Research (AR) ones will never change. It can't be transferred between seeds or plants by animals or equipment, or put into or removed from plants. Once endophyte-infected or endophyte-free seeds are sown, plants will remain so. Getting the full benefit from animal friendly endophyte requires having no toxic endophyte perennial ryegrass growing in the paddock, which will mean growing a crop between regrassing and not feeding endophyte hay, from which seed can drop and grow. The AR grasses are also more palatable to animals, so they will eat them and leave the high ET ones, which means that the AR ones get overgrazed and ET ones can seed and increase.

Some safe endophyte fescue seed developers have written that very few farmers have given them a fair trial. However, many who have, still end up with mostly perennial rye grasses, so continue to favour them, especially Bealey NEA2 which has a safe palatable powerful endophyte, so animals love it as shown here grazed while the others are left by sheep that broke in to these Canterbury rye grass trials.

Apparently Bealey NEA2 ryegrass originated in Spain or Portugal.

Rye grasses with AR37 endophyte have been promoted as the highest resistance grass, but animals dislike it more than any other. I would never sow AR37. Bealey NEA2 is the best and most palatable of all ryegrasses. I've done and seen many farmer trials, all showing how good it is even after 12 years.

Bealey NEA2 has excellent insect repelling qualities and is highly palatable being grazed to the ground while other rye grasses are almost ignored. See photo.



### Seed storage

Endophyte gradually dies out of stored seed. Under normal seed storage conditions, the endophyte declines to zero in 1 to 3 years, being faster in high seed moisture, humidity and warm temperatures, resulting in plants that may fail to persist in the warmer New Zealand areas.

Tall Fescues with animal-safe endophyte persist in pastures far better than nil endophyte. Endophyte helps protect plants against insects and heat. Old tall fescues are coarse, unpalatable, high endophyte weeds, but modern animal-safe endophyte fescues have a higher ratio of leaf to stem and are much more palatable. They have to be treated more carefully because they are less heat and drought tolerant than the old ones, and cattle love them provided they are not too long before grazing, so will graze them short, which plants won't like if done too many times.

A Waikato dairy farmer with 700 cows had dreadful perennial ryegrass staggers, having to dry off cows after sowing all Yatsyn, using nitrogen extensively and ending up with little clover.

Somatic cell counts (SCC) in milk increase after grazing high endophyte fescues and rye grasses, such as Yatsyn. See below.

### Alpacas and Llamas

These are highly susceptible to endophyte toxicity, possibly because for thousands of years they had never been subjected to it. Another reason is that they often graze perennial ryegrass to the base where the toxin is highest. Most old perennial rye grasses pastures are high in endophyte, so changing pastures from toxic perennial rye grasses to new ones helps. Bealey NEA2 is safe and is an excellent perennial ryegrass.

Apparently excess endophyte can damage part of the brain that co-ordinates movement and the damage can become permanent, and once severe can't be cured, so be careful when buying llamas, alpacas, etc.

Types: There are three major alkaloids in endophytes-

1. Lolitrem B, that affects all grazing animals in varying degrees, produces a chemical that causes ryegrass or fescue staggers.
2. Ergovaline accentuates animal heat stress, scouring, reduced production, feet and other animal health problems in some animals more than in others.
3. Peramine protects plants against insect attack on the leaves (not the roots).

Keep calcium and selenium levels at optimums.

Old (pre-1990) perennial rye grasses surviving in most warmer parts of New Zealand have high endophyte levels that have protected them from insect damage. It also gives plants resistance against heat, so the grass survives longer. Pasture parasites such as Grassgrub (*Costelytra zealandica*) and Argentine stem weevil (*Listronotus bonariensis*) will eat rye grasses without endophyte before those with it. See Pastures > Pests.

In 1981 NZ Grasslands, a major plant breeder isolated and bred perennial ryegrass without the toxin in endophyte that causes ryegrass staggers, but left the insect protection part in. These safe-endophyte fescues and rye grasses gave lamb weight increases of 0.8 kg at weaning, and farmers achieved higher beef and milk production compared with high endophyte rye grasses.

This breakthrough was hailed as a major plant breeding success. Endosafe perennial ryegrass was withdrawn from the market because unfortunately another toxin, ergovaline, was still in, and could cause grass staggers under stressful pasture conditions of drought and heat, especially when selenium levels were low.

Because animals preferred the Endosafe perennial rye grasses, they ate more and produced more. Dozens of dairy farmers told me of milk increasing a litre per cow per day when changing from a high endophyte perennial ryegrass paddock to a safe endophyte one. In some cases SCC decreased.

#### [Storage & ensuring that endophyte is retained in seeds](#)

The viability of the endophyte in seeds decreases over time, and can be completely lost within two years during normal storage. In endophyte grasses, the fresher the seed, the greater the level of endophyte. Fungicides and heat can kill endophyte in seeds, as does storing seed for too long (over a year), especially in a hot building. All pasture (and crop seeds) should be stored in cool places. Where it is necessary to grow endophyte protected grasses, care should be taken to avoid losing the endophytes in seeds. Endophyte can be measured in seeds, so levels can be checked before buying. Some bags show the level. Check the date.

Superstrike coating of seed doesn't kill the endophyte, and fungicide sprays on grasses don't affect the endophyte in them.

Storage at no higher than 4°C (40°F) will preserve endophyte viability for longer.

#### [Fescues](#)

The modern animal-safe or safe-endophyte fescues usually need more N than clovers provide, but if you apply too much, the high nitrates will cause cattle to dislike them - even in silage. Every year cattle die from excess N applied to pastures. To get the best out of animal-safe fescue, N should be applied as required in regular small amounts, even if it is with thriving clovers.

#### [AR is short for AgResearch, a division of Grasslands, Palmerston North, NZ.](#)

AR safe endophyte grasses have been developed by AgResearch Grasslands, so they favour AR, whereas I favour NEA2 as in Bealey NEA2.

Old tall fescues rightly had a bad name because of endophyte toxicity problems causing animals tails to drop off and hoof problems, but endophyte has been bred out of some and only the toxic-to-animals endophyte bred out of others, but they are less heat resistant and of course not insect resistant.

Endophyte-free tall fescues are good alternatives to perennial ryegrass in hot and dry areas with high fertility - provided they are well fed and grazed when 15 cm high, and not allowed to get longer except for occasional harvesting.

There are major differences between fescues, such as speed of establishment, grazing periods, palatability and longevity. Fescues are much slower than perennial rye grasses to establish. There are also lower yielding varieties with finer leaves. I have never and would not grow them, especially with Bealey NEA2 being available.

As seeds age they decrease in germination they lose endophyte and the seedlings can lose the ability to

produce a strong healthy plant. I know of no test for this except germination ones, so with most species avoid old seed. This doesn't apply to *Paspalum dilatatum* seeds which improve for a few years.

Check the seed bags from the grower for - age, germination, weeds, endophyte type and levels.

High N levels increase the production of alkaloids, including neurotoxins and ergovaline, and obviously exacerbate the problem. After long dry periods, soil N levels rise, partly because it has not been used, so never do what DairyNZ recommended which was to apply N after rain fall, following droughts.

Low endophyte palatable perennial ryegrass (there are differences in rye grasses) about 15 cm high, mixed with about 25% white clover, can be so palatable that animals fully fed on it will ignore grain, unless it has salt and minerals mixed with it and the animals are not getting Solmin through their drinking water. No other soluble mineral mix has all the minerals that Solmin has.

ASW can be a problem in some warm areas on some farms, but not on others. A parasitoid has been released in New Zealand to control it. The parasitoid is a small wasp which, like the army worm wasp, will not get rid of all ASW completely, but it is hoped it will reduce it substantially.

If anyone in NZ is wishing to know where the parasitic wasp that preys on Argentine Stem Weevil has been released in NZ, they can contact Mark McNeil at Lincoln University 03-325-6900, and he can inform you how far the wasp has moved.

Where ASW is prevalent, endophyte perennial rye grasses and/or other species should be sown. High endophyte perennial rye grasses increase naturally in pastures if the plants without endophyte are killed off by ASW. There are low endophyte (LE) perennial rye grasses and LE fescues, but they are less insect, heat and drought tolerant, unless they are the new ones which have the animal safe endophyte.

#### [Animal symptoms & effects:](#)

The symptoms are generally called fescue toxicity or perennial ryegrass staggers and can show up in a number of ways including "fescue foot" which is a lameness, "summer slump," which is poor performance during the hotter summer months, loss of tail switch or ears, and abortions in mares. The alkaloids are found throughout the plant, but most are in the seeds, which is the way the endophyte spreads, and in the stems.

As with most things, some animals are affected while others aren't. This is possibly because some animals are more allergic to the toxin, or because they consume the high endophyte parts which are the base stems and seed heads, while cows not affected select the leaves. As with bloat, facial eczema and nitrate toxicity, ET is cumulative, so affects the animals only after a quantity of the toxin has been consumed.

Some farmers don't realise that ET is affecting their stock because they don't know the symptoms. Some blame summer heat for the slow movement of their animals and the drop in production when it can be ET, as well as perhaps facial eczema spores which occur at the same time.

A survey in Northland, NZ, showed that Holstein-Friesians suffered ET more than Jerseys. High endophyte perennial rye grasses are not as bad as high endophyte fescues.

#### [Symptoms](#)

From early summer, animals consuming endophyte fescues have shown one or more of the following -

The first symptoms can be that affected animals look empty, their hair stands on end, and they stand to one side of the mob, possibly because affected animals are recognised by others as being sick so are placed at the bottom of the pecking order.

Some stock, especially younger ones, show no symptoms except to get thin, or drop in milk production.

A few noticeable symptoms are;

- Nervousness.

- Some become irritable and difficult to handle.

- Tremor.

- Muscles can twitch and swell.

- Stand awkwardly.

- Heads can shake.

- Arched backs.

- Some animals limp as if they have an injured leg.

- They walk more slowly.

- Stagger and fall over in milking parlours, into ditches or against fences especially when being moved.

- High body temperatures.

- High respiration rates.

- Rapid breathing.
  - Some froth at the mouth and pant.
  - More time spent in shade and standing in water where possible and even trying to climb into water troughs to get cool.
  - Less time spent grazing.
  - Loss of appetite and lower feed consumption.
  - Lose condition and suffer lower weight gains and milk production.
  - Rough hair and coats.
  - Lower conception rates.
  - Liver damage.
  - Abortions.
  - Pregnant mares have lower conception rates, increased number of stillborns and retained placentas. —
- Severe digestive problems.
- Scouring; Sheep can have more dags.
  - Skin discolouration.
  - Slow in shedding their winter coats.
  - Swollen extremities.
  - Hoof issues; Red line at the coronary band above the hoof, gangrene, loss of hoof known as fescue foot. It causes the blood to thicken and settle in a lower limb (usually a hind foot) in the summer causing it to swell and become very sore. If severe it can cause ears and tails to freeze off in winter.
  - Reduced immune system.

### [Trials](#)

Comparative milk production trials in spring 1995 on new animal-safe endophyte tall fescue in Taranaki, where temperatures are between about -5 and +28°C, showed that it produced the same amount of milk as endophyte perennial ryegrass, and two litres more per cow per day than cocksfoot (orchard grass).

The modern animal-safe endophyte-free fescues usually need more N than clovers provide, but if you apply too much, cattle will dislike it. To get the best out of fescue, even with clovers, N should be applied in regular small amounts.

Argentine stem weevil necessitated the growing of high endophyte rye grasses that caused animal health problems and lower animal production with a high incidence of dags and fly-strike. The dags caused farmers to drench their sheep against internal parasites more often, when worms were not the cause, resulting in drench resistance.

Some NZ farmers and researchers have found that high endophyte perennial rye grasses adversely affect clover establishment and production, but it is not known how. It is worse in the hot summers of Canterbury in the South Island during their hot north westerly winds, because of clover stress in hot dry conditions.

Over-mature hay cut low to include lots of the base, and having seed heads from high endophyte grasses, can cause problems when fed. Stored seed loses ET over time (a year or more), especially if stored in a hot building, so the hay may do the same. If fed in winter in small amounts when animals are not grazing ET pasture, there will be less cumulative effect.

Even when no symptoms are shown, pasture consumption and production can be reduced, because most animals dislike endophyte grasses, so eat less. Sheep have grazed Endosafe perennial ryegrass to the ground and ignored endophyte perennial ryegrass in the same paddock.

Recovery after providing endophyte-free feed can take from two (from mildly infected perennial rye grasses with clover) to twenty days after having been on heavily infected pure fescue pastures for a while.

SCC in milk can increase when cows are on high endophyte perennial rye grasses. The SCC figures on one farm in the Waikato, NZ, in the summer of 1996 were -

- Day 1     Low (new) endophyte perennial ryegrass 160,000.
- Day 2     High (old) endophyte perennial ryegrass 440,000.
- Day 3     Low (new) endophyte perennial ryegrass 200,000.

The above was repeated with similar results. Endophyte's toxic effects have been well proven at Massey University in NZ, Australia, South Africa and other countries, although one Ruakura so-called scientist claimed in 1994/5 that there was little effect. His faulty methods explained why. The trial was not



well set up in that the cows were moved on and off high endophyte pastures. A few kilometres away a herd on all high endophyte perennial ryegrass pastures, fertilised heavily with N (about 250 kg/ha pa, so had little clover) had to be milked only once a day from early summer and were dry by autumn, because of ET. Scientists surveying ET effects on dairy farms would give a cheaper and better result.

One ET trial at Massey University had to be stopped because the cows were suffering so much on high endophyte perennial ryegrass.

A grazing study with endophyte-free tall fescues at Auburn University, USA, showed an 82% increase in average daily gain and 42% increase in gain per acre compared with endophyte-infected fescue. Interestingly, gains occurred throughout the grazing season, not just in the summer. Other grazing studies with steers in Kentucky, Alabama, Georgia, Missouri, Texas, Tennessee, North Carolina, and Maryland achieved average daily gains 50 to 100% greater on low-endophyte, as compared to high-endophyte tall fescue pastures.

In Georgia, Stuedeman and co-workers found that steers on low-endophyte fescue grazed 43 to 65% of the time between noon and 4.00 pm, while steers on high-endophyte fescue grazed only 5 to 21% of the time during the same period. Steers moved from high to low-endophyte fescue did not resume normal grazing habits for 26 days, indicating a 'bad experience' memory. HW Essig at Mississippi State University found that the body temperatures of cattle did not return to normal until 56 days after removal from infected fescue. Other studies in Alabama and Kentucky have shown increased gains, increased intake, and lower body temperatures of steers consuming endophyte-free hay containing seed, when compared to animals consuming endophyte-infected hay containing seed.

Research conducted by University of Kentucky scientists Drs R Hemken, J Boling, and colleagues revealed a 39% reduction in forage intake and a 37% decrease in milk production during summer, in lactating dairy cows consuming endophyte-infected fescue. In addition, these cows lost weight, while animals consuming non-infected fescue gained weight.

Dr. Nelson Gay and associates in Kentucky found that beef cows had a 34% lower pregnancy rate when grazing high endophyte, as compared to endophyte-free, fescue pastures.

The University of Kentucky found that low endophyte fescue produced more meat than high endophyte fescue, even in winter.

Trials in warm parts of USA, comparing beef grazed on high endophyte fescues against zero endophyte fescues, showed up to 50% weight gain advantages from the endophyte free pastures.

It was estimated by Evans in 1985 that ET in fescues cost the US farmers US\$360 million pa in the 80s.

In Australia milk production in autumn was 2.2 litres (5 lbs) per cow lower on high endophyte than on LE pasture.

The above is repetition, but shows that ET should be taken seriously wherever there are ET grasses.

Cutting the grass for hay does not destroy the endophyte. The fungus cannot be detected visually, but it can be measured by some laboratories. See Pastures > Sampling & Reading Pasture Analyses.

#### [Conditions that increase endophyte intake](#)

Set stocking on stemmy or stressed high endophyte grasses and allowing them to seed.

Some calves, when moved to a fresh paddock, will eat the seed heads first and then suffer more than older stock.

Forcing animals to eat the infected base of endophyte grasses on over-stocked farms, and the high nitrogen (N) areas around urine patches.

Artificial N increases the production of alkaloids, increases toxin concentrations, and lowers the percentage of clover. A lot of farmer observations, which cannot be dismissed, indicate that some perennial rye grasses are worse in this respect than others.

Pure old fescue or old perennial ryegrass pastures.

Anything that slows growth in summer.

Anything that stresses high endophyte grasses, such as drought, heat, spraying with fungicides or some weedicides.

Set stocking on stemmy or stressed high endophyte grasses in summer.

Endophyte increases more in perennial rye grasses with a high N content, so applying artificial N prior to summer can increase levels. Applying N to pastures at any time decreases the clover content of pastures, except on new grasses prior to the clover establishing and producing its own N. Some high endophyte perennial rye grasses somehow discourage white clover from growing around them in hot areas. This decreases the percentage of clover, so further increases the incidence of ET.

The application of N will result in increased production of alkaloids, including neurotoxins and ergovaline, and obviously exacerbate the problem. I cannot comment on cultivars, but like you I have a lot of farmer observations, which cannot be dismissed. (Reg Keogh, June 1998.)

#### Conditions that decrease endophyte intake

Grow more grasses, other than high endophyte grasses, including clovers and summer forage crops, Tonic Plantain and Puna chicory, which grow well during the ET period, or change grasses to LE rye grasses and fescues such as AU Triumph and NZ bred ones.

Have green leafy pastures with ample clover and other species, rather than perennial ryegrass stems and seed heads.

Rotate faster rather than slower, and don't set stock, so that there are fewer seed heads, less grazing short, and animals get a mixture rather than just endophyte grass during the last period in the paddock. Avoid hard grazing, because higher levels of the toxin are at the base of the perennial ryegrass plant. Allowing animals to selectively graze the leaves reduces the bad effects.

Puna chicory is a wonderful addition to temperate pastures that can be oversown (over-seeded) into pastures in spring. Tonic Plantain can do the same.

One kg per ha of Massey Basyn velvet grass seed in lower fertility areas.

Sow the latest more productive clovers.

If ASW and heat stress are problems in your area, it may be necessary to use only high endophyte perennial rye grasses and other species such as AU Triumph, cocksfoots and Maru Phalaris with lots of clover. Otherwise use endophyte free perennial rye grasses, but don't overgraze them in hot dry summers, because doing so can kill them.

Don't use nitrogen to the extent that it lowers the percentage of clover to below 20% of the total pasture.

Eradicate old toxic fescues and sow new ones. Most fescue seed germinates within a year of seeding, so prevent self seeding in pastures and then grow a summer forage crop before regrassing. Control new fescue seedlings by grubbing, rotowiping and spot spraying carefully, so as not to kill surrounding grasses which would leave bare areas for fescue seeds to germinate. Avoid pugging or pasture damage which leaves openings for germination. Grub or spray fence lines and ditch banks.

Keep soils moist and pastures green and growing by liming, using the best rock phosphate fertiliser, and encouraging earthworms and a thick dense sward to reduce plant stress.

Correct minerals are unlikely to eliminate ET, but healthy animals cope with it much better, and that is what good farming is about.

Make hay and silage early and no later than heading stage, when concentration of the toxin is about half that of mid-summer grasses.

Move affected animals slowly and avoid stress, mustering and yarding.

Fertilise correctly and encourage legumes to dilute the high endophyte grasses and as the supplier of N, so apply lime, P, K, S and trace elements as required. The use of Sechura RPR by Winchmore Irrigation Farm for six years created pastures with more clover (and fewer weeds).

Supplement pasture with forage crops and/or non-infected supplements.

Oversow coated clover seed at 1 kg/ha with safe non-burning fertiliser or lime.

Using lime as recommended from a pasture analysis encourages clover growth. Clover herbage figure is 1.3% calcium, so it needs plenty of lime. Perennial ryegrass has only 0.6%.

#### Reducing endophyte effects

Grow and graze forage crops such as Pasja and Nutrifed in warm areas and Pasja and Shirohie millet in cooler areas.

Feed a high quality supplement such as silage, endophyte-free or last season's hay and/or maize.

Leave higher post-grazing residuals of the high endophyte stems.

Avoid consumption of seeds by controlled grazing or if necessary, topping. Top or clip seed heads.

#### Treating Affected Animals

There is no way of completely preventing endophyte toxicity when grazing high endophyte grasses such as the old fescues, but there are ways of reducing the ill effects. A problem is that it is a snowballing problem and the degree of infection varies so much. The feeding of selenium acts as a neutraliser of the fescue toxicity. The feeding of supplements helps.

Feeding 1 ml per cow per day of the NZ sea weed based product called Nutrimol (Seagraz in US) in the drinking water has been reported to reduce ET, and some farmers have reduced ET effects within four

days of supplementing with 3 ml per day of Selovet 5 (5 ppm Se solution made for oral consumption) per cow per day, and in calves at 20% that rate.

Three ml per day of liquid Selovet 5 from a vet in drench or drinking water for three months over spring on pasture grown on peat (very low Se) caused no ill effects. Blood levels rose to the minimum of 800 nmol per l. Some vets have recommended 6 ml per cow per day, which in my opinion is excessive.

In Mississippi, supplementing with Se reduced ryegrass staggers caused by high endophyte, and I achieved this with many clients' calves in New Zealand by adding Selovet 5 to their drinking water, which already had DeLaval FeedTech minerals with the maximum allowed selenium.

Mississippi State University pinpointed selenium deficiency as the major cause of the endophyte problem.

"I'd like to introduce you to an often neglected little trace mineral that can work like a miracle for you called selenium.

"Now this is especially true if you live in an area where the soil is low in selenium and you feed or graze fescue which is grown on more than 35 million acres in USA.

"Tall fescue can cause low conception rates, high abortion rates, tough placentas that can suffocate the calf."

If you try anything new, such as the above, do so carefully on a small scale and remember that you are producing food and it is illegal in New Zealand to feed anything not approved as a food or medicine. To give an example, imported Palm Kernel Extract for dairy cows has to be approved.

#### Seriously affected stock should be -

Managed separately from the main herd and milking frequency reduced to once a day to reduce walking and handling. Fed a high quality supplement (silage, last season's hay, turnips, maize), to reduce their intake of endophyte grass. Fed pasture of Bealey NEA2 or other safe species - tall fescue (not wild), annual rye grasses, cocksfoot, lucerne, clover or chicory are excellent. Moved slowly and left undisturbed as much as possible. Not grazed in paddocks with hazards that could injure animals such as ponds, ditches and bluffs. For badly affected calves consider a 100% supplement diet. Depending on calf weight, 4 kg dry matter per head will be required, such as brassica crops still with leaves.

#### Which ryegrass

Bealey NEA2 ryegrass came out in about 2010 and has been a real hit for all year growth, palatability, safe endophyte, etc. In a mix of grasses it will be grazed shorter than others.

If the number of ryegrass cultivars on the market doesn't make it confusing enough, the endophyte choices and descriptions do. The reason for this is that the seed industry doesn't have a standard when it comes to the labelling and description of the endophyte of ryegrass seed. However, it is very important that when you are ordering seed you specify the endophyte type. Sometimes seed is sold without the endophyte status declared, so if you ask a retailer to add a ryegrass or fescue to your mix without stipulating which endophyte you require you could be buying either nil-endophyte seed, or seed with the standard "wild type" endophyte. So if you farm in summer dry regions you could be sowing a pasture that has poor persistence, or one that causes ryegrass staggers and reduces animal production.

The seed that is best for insect pest areas should be labelled 'Safe endophyte' or one of the AR novel endophytes, because these have no toxins that affect animal production or health. Still confused? If so, ask a knowledgeable seed retailer or AgResearch Grasslanz, PB, Palmerston North, NZ. Ph 06-356-8019. [www.grassland.org.nz/](http://www.grassland.org.nz/) However, you should remember that seed companies and Grasslanz will promote their varieties, even if they are not the best available at the time. There are so many rye grasses on the market now that it is difficult to decide which is best for your farm. See Pastures > Grasses. There are not many that are the best in all locations from Northland to Otago.

Grasses with animal-safe endophyte persist far better than nil endophyte.

High endophyte toxic grasses should be grazed from 2,800 kg DM/ha to 1,600, or from 20 cm average to about 10 cm (8 to 4 inches) average to avoid stems and should not be allowed to seed. This means that some could be 20 cm long. It must be kept leafy all spring and into early summer, or some will run to stem and seed, become less palatable, yield less, produce less milk or meat, and have endophyte in the stems and seed so can be toxic.

#### Palatability

All elements, especially agricultural lime, boron, selenium, and coarse agricultural salt, should be at optimum levels in pasture herbage for maximum growth and palatability. See information about them in 'Minerals in Soils, Plants and Animals'.