

Summer forage crops should be grown to avoid having to buy expensive feeds.

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If farming in the occasional drought areas of Australia or New Zealand, you can expect droughts to repeat because evidence shows that air pollution from China influences them. At different times of the year the soot blows across to Alaska, Washington and Oregon causing heavy rain in large drops. This information is from subscribers there, not people trying to make money out of so called global warming, which has not occurred since 2005, so some now call it 'Climate Change'. The soot can sometime go higher and go east and then south. The large particles from their soot make the large drops of rain that fall out of low pressure systems onto Queensland, Norfolk Island, Northern New Zealand hills and mountains like the Coromandel, causing floods, leaving little moisture for the flat areas and the south. In the Waikato, this doesn't apply to lows from the north-west because there are no mountains between the coast and central Waikato, so when the Weather Office forecasts rain from the NW we get it, but when from the NE we don't, but the hills and mountains there get too much.

Farmers who had insufficient pasture last summer or winter for their grazing animals, should sow forage crops in late spring or early autumn, to avoid a recurrence

Forage crops are one of the best solutions, provided yields are at least 12,000 kg of dry matter (DM) per hectare for brassicas and summer grasses (millets and Nutrifeed), and at least 27,000 kg per hectare for forage maize with pasture as shown, which is vastly better for grazing than maize only. It can be 33,000 kg, worth \$9,000 per hectare. The cost to achieve this is chisel ploughing (See Soils > Cultivation.) with optimum LimeMagPlus (lime, serpentine which has Mg silicate, deficient trace elements, and about one tonne of VJ Gafsa mix fertiliser per hectare.



This photo shows our maize with long deep roots going down 40 cm and yielding 30 tonnes per hectare of silage dry matter. Correct Lime and fertiliser were chisel ploughed in separately, with no side dressed DAP. The middle roots were on a maize growing company's, shallow cultivated without enough lime. It yielded 18 tonnes per hectare of silage dry matter. The right maize was also shallowly cultivated on our old farm sold in 1987 when we were getting 30 tonnes. Its yield was 12 tonnes. Both had DAP side dressed around the roots which encourages shallow rooting, so when summer dry weather comes, growth stops. Even in a perfect summer, chisel ploughing and correct LimeMagPlus and no side dressing, yields 50% more.



The shallow cultivated plants were pulled out with one hand. The fork had to be used to get ours out. All the above were in the 2013/4 dry season.

The spreadsheet 'Pasture, Silage, Hay & Crop Costs' allows users to enter their own figures to decide which is best. New Zealand figures show that to grow a crop of turnips or Pasja Pasja (a fast growing leafy brassica) costs about 30% less per kg of DM than making and feeding silage or hay, after allowing for the bare land value. The higher feed value of brassicas with Nutrifeed in warmer

areas or Shirohie millet in cooler areas, produces more milk or meat than from silage.

The cost of growing and feeding a brassica forage crop, after allowing for bare land valued at NZ \$30,000 per hectare (US\$9,000/acre), increases the crop costs, but a yield of 12,000 kg per hectare from the crops over their 21 week growing period makes them better value than pasture yielding about 6,000 kg over the same time. Brassicas also have a higher feed value than maize or pastures in late summer.

The cost of growing, ensiling and feeding maize (corn) silage is about 44 cents per kg on land valued at NZ\$35,000 per hectare.

Buying maize, ensiling and feeding it, costs about the same as home grown pasture silage and hay, but the maize imports organic matter which increases fertility and frees your land for animal production, however, growing grain on expensive dairy farm land is not economical.

It is normal to crop the worst paddocks on the farm. To obtain the yields above requires the paddocks' fertility to be improved by feeding out hay and/or silage on them, and/or using them as sacrifice paddocks when on/off grazing in winter or summer droughts, so as to avoid pasture damage on good paddocks and wasted energy from animals walking and grazing pastures to the ground for very little extra feed.

If needed, based on pasture analysis and soil and earthworm observation, lime should be applied for summer and winter crops. See Elements > Calcium. It should then be chisel ploughed in. See "Cultivating" for how chisel ploughing improves the fertility and clover health and growth.

Northern and Southern Hemisphere forage crops should have the same procedure of increasing fertility by using the paddocks as sacrifice ones before growing a forage crop. The higher crop yields will make the effort well worthwhile.

Grazing the crops will leave animal manure so increase the fertility for subsequent pastures. See the spreadsheet Pasture, Silage, Hay & Crop Costs

Buy pasture and forage crop seeds early so you don't miss out on the best seeds and crops. Plan to receive seeds at least three weeks before needed so you can do a germination test by spreading about 20 seeds taken from the middle of the mix, on a paper towel on a plate or tray, and then spread a paper towel on top of the seed and moisten it thoroughly because it dries out quickly on the first day, then spray more water on as required. Place it where you'll see it daily to keep it moist. Germination should be better than 90%. Only 20% of one ryegrass ryegrass germinated in 2011.

A two hectare summer forage crop sown last spring failed, because no Pasja was in the seed mix. Another failed because rolling was inadequate. See Cultivation for a photo of how firm the seedbed should be. I frequently see higher germination in the tractor wheel marks, simply because of more compaction of the soil around the seed, reduced evaporation and more moisture sucked up. Dry late springs have become common, so again, read Cultivation so you are prepared.

To be able to graze pastures 100% of the time all year, without making silage or hay and without growing forage crops, would be great and more profitable, but is seldom possible, however, the best forage crops correctly timed can help. Spring calving on irrigated pastures in a temperate climate comes closest to it. Fertilising with complete fertilisers, timed to encourage extra growth before and during shortages helps. Fertilising before flush periods is a waste, because the surplus has to be conserved which doubles the cost. See the spreadsheet Pasture, Silage, Hay, Crop & Nitrogen Costs.

Calving dates should aim to maximise pasture growth utilisation. Growing forage crops is a solution, but they can be **unprofitable** if they yield less than the optimum amounts of 12 tonnes per hectare for grazed forage crops and 30 tonnes per hectare for silage maize.

The establishments (who don't farm, but often give incorrect theoretical advice) in New Zealand criticised forage cropping saying that favourable weather can provide enough pasture and the extra crop grown may not be used, or has to be conserved, which can't be done with turnips. However, it can be done with Pasja and summer grasses, or with the surplus pastures while grazing the crop. Anyway, too much is a lot better than too little as has happened in early 2000 summers, especially on overstocked farms, partly because the LIC policy of "More urea and more cows", to sell more semen and more herd testing.

The 2008 to 2010 North Island of NZ dry summers, stunted young stock, caused hungry cows and low animal production adversely affected many farms. Parts of all Waikato summers are drier than pastures like. Some farmers then buy Palm Kernel Extract (PKE) which keeps cows milking without profit. A bank manager said in the summer of 2011 that highly stocked farms buying feed were just treading water, in other words getting nowhere.

Modern forage crops like Puna chicory can be sown with new pastures as was done herewith Bealey NEA2. They can be very profitable yielding well in summer dry periods.



The Australian Shirohie millet is better than New Zealand Japanese millet. With Pasja (being held) in the next photo, was not doing as well because of dry weather. Millets like ample moisture. The crop was grazed 16 days before the photo was taken which was two days before the second grazing. It gave five grazing. In dry summers, bought feed can cost 40 cents a kg fed, while a forage crop cost is about 21 cents, plus the land value of \$30,000 per hectare, of about 9 cents, which equals 30 cents grazed, and has a much higher feed value than maize or summer pasture. See Free Items > Pasture Analysis Planner and Pasture Silage Hay Crop Nitrogen Costs in Spreadsheets.



Obviously, the poorest paddocks should be cropped - after the reasons for it being poor are fixed. The new pastures grown after fixing the faults, can be the best. The solutions are mostly lime, serpentine, trace elements and deep chisel ploughing bringing up subsoil, which grows far better and cheaper crops and pasture than bought quarry rock dust (some commercial ones sell for \$400 per tonne) none of which I've seen grow clover like the much cheaper LimeMagPlus and trace elements.

If farming in cold winter or dry summer areas, forage crops can provide low-cost grazing feed much more profitably than silage, hay or bought feed.

Farmers who didn't have sufficient pasture last summer or winter for their grazing animals, should sow forage crops in late spring or early autumn, to avoid a recurrence.

Forage crops are one of the best solutions, provided yields are at least 12,000 kg of dry matter (DM) per hectare (11,000 lb per acre) for brassicas and at least 30,000 kg per hectare for maize.

The spreadsheet 'Pasture Silage Hay Crop & Nitrogen Costs' allows users to enter their own figures to decide which is best. New Zealand figures show that to grow a crop of turnips or Pasja costs about 30% less per kg of DM than making and feeding silage or hay, after allowing for the bare land value. The higher feed value of brassicas produces more milk or meat than from maize or any silage, or even pastures in late summer.

The cost of growing and feeding a brassica forage crop, after allowing for bare land valued at NZ \$30,000 per hectare (US\$9,000/acre), increases the crop costs, but a yield of 12,000 kg per hectare from the crops over their 21 week growing period makes them better value than pasture yielding about 6,000 kg over the same period.

The cost of growing, ensiling and feeding maize (corn) silage is about 44 cents per kg on land valued at NZ\$30,000 per hectare.

Buying maize for silage at average prices, ensiling and feeding it, costs about the same as home grown pasture silage and hay, but the maize imports organic matter which increases fertility and frees your land for pasture production, Growing grain on expensive dairy farm land is not economical. In New Zealand in the late summer or 2009, buying maize for silage was a really good deal, because too

much was grown, and dairy farmers were broke because of the low milk payout.

It is normal to crop the worst paddocks on the farm. To obtain the good yields above requires the paddocks' fertility to be improved by feeding out hay and/or silage on them, and/or using them as sacrifice paddocks when on/off grazing to avoid pasture damage on good paddocks and wasted energy from animals walking and grazing pastures to the ground for very less extra feed than they benefit from. Once they have eaten it down, remove them to a small area where they lie down, save energy and don't cause pasture damage.

Forage crop paddocks should have fertility increased by, if possible, giving them effluent. The higher crop yields possible will make the effort well worthwhile.

Most New Zealand North Island dairy farms have too many cows, accentuated by faulty promotion and the dry summer and wet winter, so on some farms they walk the paddocks for most of the day trying to get enough to eat. This wastes energy and ruins pastures, so both milk production and profit suffer. The excess of cows has meant that cows have been unsaleable, so owners should grow more summer forage crops.

If needed, based on 300 farms' pasture analysis, and soil and earthworm observation, lime should be applied for both summer and winter crops. Based on pasture analyses, only 1% of the 300 farms I've done or seen, had enough lime, boron and other essential elements. See Elements > Calcium, Boron, etc.

For crops and pasture sowing the soils should be chisel ploughed. See 'Cultivating' for how it improves the fertility, clover health and growth, AND reduces bloat. It can be better than organic farmers buying rock dust, and MUCH cheaper.

Another major benefit of cropping is the sowing of Trojan, Bealey NEA2 endophyte ryegrasses and new clovers such as Kotare 2, and Tahora 2 after the crop. The Gordonton five ryegrass trials I've been monitoring for five years, Bealey NEA2 has always been top on palatability with most of the cows on it, over grazing it, which, being a tetraploid, it should not have had to suffer, but it has come through five years or bad treatment, much better than the others. Commando AR37 is disliked by cattle so parts were uneaten, so were 30 cm (a foot) long while Bealey NEA2 in the same paddock was grazed to the ground. One farmer who wrongly recommended Commando AR37 in an advertisement, changed away from it.

Subsoil

I did this trial in preserving jars with Waikato Hamilton clay loam top soil and subsoil to show the benefits of bringing up some subsoil with a chisel plough - a lot better and cheaper than applying rock dust that some organic farmers buy and spread. They could bring up subsoil for much better results because chisel ploughing can bring up so much more. The left jar was all topsoil, the next 25% subsoil, the next 50% subsoil and the right 75% subsoil. As with rock dust, subsoil contains elements we don't even know about, but makes clovers grow faster and be healthier. Each jar had one clover and one ryegrass seed. This shows how clovers need the minerals in subsoils, and ryegrasses need organic matter. Look at the clover roots on the right. I've seen nodules 35 cm (14 inches) deep in correctly limed, chisel ploughed, fertilised and farmed soils on a Waikato farm.



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See Soils > Cultivation, because thorough deep chisel ploughing is essential for good crops, and good pasture afterwards. It shows that chisel ploughing, and cultivating fertiliser in, gives much higher yields than leaving it on the surface, or even than harrowing it in, as is done by most.

Any high producing, high-feed-value forage that extends the grazing season will provide

livestock with lower-cost feed than bought feed at usual prices; however, waste products such as brewer's grains, chaff, screenings, grain dust, palm kernel extract, reject vegetables and fruit can be cheaper, but are not always available, and incur buying, transporting and feeding costs. Feeding of some of them must be increased very gradually to avoid health problems such as acidosis. None have the volume and feed value of Pasja and Shirohie or Nutrifeed. See below.

Before deciding to crop on a long term basis, consider growing appropriate permanent pasture species to reduce the summer slump at a lower cost than annual cropping. Research summer growing species, such as NZ Grasslands Tonic Plantain or Lancelot Plantain for sheep, endophyte-free tall fescues, new palatable cocksfoots (orchard grasses), new phalarises, red clovers which have a limited yield and low persistence under intensive grazing. Try the new legumes, especially the grazing lucernes, oversown in paddocks at 1 kg per ha, and with grasses and clovers. Don't sow more than one or two paddocks of lucerne or other new varieties until you've proved that they are suitable for your farm. Over the years there have been failures such as Matua Prairie Grass, which all died in three years, costing us and many others a lot.

Puna II chicory and plantain seed oversown at only 0.3 and 0.5 kg per ha or per acre respectively, yield extremely well in some fertile summer-dry pastures. If the seedbed is rough and soft, sow more. If included or added to pastures they can reduce summer feed shortages and give animals more minerals, but not of ones not present in soils, such as selenium in deficient areas.

If not being sown in a firm cultivated soil, Chicory needs to be trampled in or drilled, but when growing it doesn't like being trampled or overgrazed down to less than 7 cm (3") from the ground, pugging, heavy clays or waterlogged wet soils, and will all be gone after three years. Some other chicories may not yield or last as well. Check and grow the ones best suited to your farm. Tonic plantain over-sows better and lasts longer than chicory, but as animals like both much more than pasture, preventing overgrazing is very difficult.

The cost of growing forage-crops is about 20 cents per kg DM for turnips, allowing for the lost pasture value is added on, but the value of the land is not added. Pasture silage is about 30 cents per kg DM, including feeding expenses. Grazed pasture is 9 cents per kg DM fed. Owning good Waikato land, at 8% interest, and rates (land tax) of \$100 per ha pa, adds about 15 cents per kg DM, making grazed pasture 24 cents per kg of DM. See Pasture, Silage, Hay, Crop & Nitrogen Costs for figures.

Generally the grass type crops (millets, maize) can't be sown until soil temperatures reach 18° C at 7 cm (64° F at 3"). They are susceptible to frost damage and grow slowly when temperatures are low. Brassicas are not affected by frosts, therefore they can be sown earlier in spring, so are better suited to cool climates.

Species

Some will not be available in some countries, but equivalents are likely to be available. Sow ones proven in your location and try others on small areas of your farm.

In the Waikato -	Sow per hectare	Days to graze	tonnes per ha	%Prot	Seeds/m2	ME*
Maize green feed**	100,000 seeds	120	15~32	9	10	10
Barkant turnips	1.75 kg	60	6~16	14		13
Berseem clover	5	if on own		28		
Chou-moellier	4 kg to stop stems getting too thick.					
Pasja (Leafy brassica)	2 kg	30	8~14	18	13	
Wairoa brassica***	3 kg	50~60	6~10			
Shirohie millet	25 kg	35	6~14	10	10	

* MJ of ME per kg DM

** Greenfeed maize figures vary depending on the variety. Generally fast maturing hybrids are best to allow feeding early when pastures start slowing before summer animal production slumps.

*** Wairoa is a grazing rape, better than Pasja in very dry areas, but has high nitrates until

mature, so should not be grazed until then, and not when flowering. Test it to be sure. See Nitrates. Pasja has none of these problems.

Some of the suggestions for winter forage crops may not apply in freezing, deep snow-covered areas. The word 'pasture' in GrazingInfo means a mixture of grasses with about 25% clovers, grazed when about 20 cm (8") high, so with a metabolisable energy of close to 12.

Something New Zealand farmers, establishment advisers and some consultants need to learn, is that when overgrazing is occurring, pastures are being abused so will produce less and deteriorate sooner, and animal production will be lower.

If a summer forage crop is to be grown, ensure that the area is large enough for the number of animals and to last for the extent of the short period. Usually about 2 ha (5 a) of maize are needed for each 100 milking cows, and/or 3 or 4 ha of brassicas or Shirohie millet or Nutrifeed with Pasja, (I like best), but Nutrifeed needs warmth as from the Waikato north or the summer warm areas like the warm parts of Hawkes Bay, i.e., no summer frosts or cold nights.

Nutrifeed is a Pearl Millet hybrid, high-magnesium grass-type summer crop, and like other tropical-type grass is very low in sodium. It has no prussic acid, so, unlike sorghums, is safe to graze at any stage. However, like most fast growing grasses, if forced with N under low boron, low molybdenum and/or low sulphur levels, it can have toxic nitrate levels and has killed cows that were allowed to graze short yellow re-growth on soils low in calcium and molybdenum. See Animal Health > Nitrates.

Nutrifeed is high in magnesium and sodium, while most grass type crops are very low in sodium, and average in magnesium.

Nutrifeed, a fast growing hybrid pennisetum (Pearl Millet) semitropical summer-annual, is late-flowering with high-leaf-content and doesn't contain Prussic Acid. It can produce more than millet in warmer areas. Being grasses, they can be fed at higher rates than turnips, and are good to grow in a mixed forage crop with brassicas.

Grass types of crops, such as maize and millets, can yield more per ha, but don't produce as much milk per kg of DM as the best brassicas, which is a reason for a mix of Pasja and Shirohie or Nutrifeed.

The mineral levels in the plants depend on soil levels and the fertiliser used. The more nitrogen, the lower some elements, and the more potash the lower the magnesium. See the spreadsheet called

All these crops need high applications of lime (3 to 12 tonnes per ha depending on soil type and need) and phosphate (500 kg to 1,000 kg of a good reactive phosphate mix), with whatever necessary trace elements, such as boron. Even soils with a pH of 6.4 will give good yields from the best reactive phosphate, if chisel ploughed in a few times to 20 cm in mineral soils, or deeper in peats. If left on top or just harrowed in it will be useless. Note that even water soluble fertilisers left on top or harrowed in lightly will be useless if not much rain falls. Chisel ploughing fertiliser in gives good contact with the soil and moves it deeper which is where the roots go.

They must have an excellent seedbed, and be planted in stages from early summer on, but not in mid summer, which can be too late if no rain falls.

Shirohie doesn't do well on dry soils and maize won't do well on wet soils, but must have well drained, deeply cultivated soils, so that the roots can go down to a metre.

In all cases, choose the best variety of the chosen species because yields, feed values and animal production can vary by up to three times. For example, Shirohie is better than ordinary Japanese millet, and Barkants out produce some other New Zealand turnips.

After the Shirohie or Nutrifeed, the soil will be full of root structure, and easier to cultivate for a firm seedbed. After turnips the soil will very easily go to dust, so wait for rain, or just harrow and sow the pasture. Alternatively, drill it in, which is not my favourite because of the thick lines and weed growth in between; or chisel plough, harrow, roll and sow within a day, doing small areas at a time to allow sowing within a day to avoid losing moisture and to beat weeds germinating.

Whatever you plant, get the best seed, order early, and germination test it on arrival. See Sowing.

Forage crop benefits

Even if ample pasture is available in summer, the increased stem and dry matter content in late summer pasture causes lower palatability (animals eat less), lower digestibility and lower metabolising energy (ME), making it impossible for cows to produce to their optimum. They can't produce well from pasture which has dropped to an ME of 10, so high producing animals lose weight.

Brassicas fed at about 4 kg DM per cow per day have given more profitable milk production than barley grain, even in Australian trials where barley is cheaper than in NZ. Feeding brassicas at more than about 4 kg DM per cow per day can lower the net return per hectare. (Turnips for Profit, Peter Notman of Agvise, Australia.)

- The grazing of grass type forage-crops such as Shirohie millet (shown here in 1972, growing in 6 metre deep peat that we developed from Manuka scrub 15 years before this photo) is much less expensive than growing, then ensiling and feeding out the same or similar crops. Profitable farm management means planning everything for a maximum of grazing and a minimum of mechanical conservation and feeding. The millet in this photograph was much too long for grazing, because it can be pushed over and trampled and not eaten, unless grazed in long narrow strips behind an electric fence. It is best grazed at between 60 and 70 cm, but this is not easy because it grows so fast, so stagger the sowings and start grazing at 60 cm or less.



- Summer forage-crops reduce overgrazing and perennial ryegrass pulling in hot dry weather. Frequently it is the overgrazing of pastures that reduces both the clover and palatable grass content, by killing them in heat or pulling them out, leaving bare patches for weeds. When pasture is chewed short, soil temperatures rise much higher than when protected by pasture cover. Soils then dry out more, and the summer pasture growth slump is lengthened, because these problems make autumn growth slower to start compared with when there is reasonable pasture cover. In some years dairy farmers can be well up in production by mid summer, and then drop behind during a dry hot summer and/or autumn - unless they have a forage-crop or buy a cheap supplement such palm kernel extract, which is more expensive than forage crops and is limited in how much can be fed.

- Forage crops can keep cows milking well and meat animals growing for tender meat through dry summers. Avoid taints in food products. See Taints in milk & meat below.

- If silage or forage-crops are not available, cows can milk well, but lose weight, which is not desirable. If too thin they can then lose their foetuses, suffer stress, more facial eczema (ryegrass harboured toxic spores), and increased endophyte toxicity where high endophyte grasses are grown.

- The latest high nitrogen-fixing and high producing clovers and new grasses can be sown after summer forage-crops. Some new pastures on many farms have out produced some old pastures, especially during difficult growing periods such as winter and summer - provided correct cultivation, liming and balanced fertilising are carried out before and after sowing. If not, pastures can revert to what they were before resowing. The pasture one ends up with is more the result of management than of what was sown.

- Pastures after a grazed crop establish far better than ones drilled into sprayed or old pasture, because of the well chisel ploughed soil with some subsoil brought up, and agricultural lime mixed in thoroughly which mouldboard and disc ploughing don't do. Pasture parasites such as grass grubs, porinas, slugs, clover root weevil and clover root nematodes are reduced.

- If grass, clover and a few weeds grow with the Pasja and millets, it can all be grazed and will balance the feed instead of being all brassicas. See Forage crops > Maize for grass growing with maize and adding to the diet.

- The cultivation for a crop reduces weed and soil seed population and reduces infestation of new pastures with seed from the old lower yielding pasture cultivars, something which happens after grass to grass sowings more than after crops.

- Cultivation allows paddocks to be shaped to improve natural drainage by filling hollows with the knobs, which makes fertilising, silage and harvesting easier and silage is of better quality if no soil is included from machinery scalping rough areas.

Know your costs and yields

An Australian survey of 14 growers of turnips in Gippsland, Victoria, in 1991 by Peter Notman gave an average yield of 9,500 kg DM per ha with the top crop achieving 15,000 kg on a peaty soil. Its yield of MJ of ME was 160,000 per ha. In the part of the paddock where grazing started early, the yield was obviously lower. Average ME in MJ per kg DM was 13 with 11% protein. Their figures for Shirohie millet were 10 ME and 10% protein which go well with the typical high protein of the increased clover in summer pastures.

It doesn't pay to own equipment for limited use once or twice a year, so if a contractor is not available, buy second-hand equipment in conjunction with neighbours. If a contractor is used they should have a chisel plough to bring up subsoil, not a subsoiler as shown at the front of this cultivator/roller. After this implement for making the surface smooth, use a Cambridge or V roller which makes the seedbed firm. The paddock was trampled (see the grass still growing in top left of the photo), which saved spraying or hoeing. The costs of growing crops and pasture, including the value of bare land at \$30,000 per ha (US\$9,000 per acre) without buildings, and allowing for the loss of pasture that could be grown at 14,000 kg DM per ha pa (worst paddock figure) over the same time are in the spreadsheet called Pasture, Silage, Hay & Crop Costs, which you can use to calculate yours exactly. The spreadsheet adds the lost value of pasture not grazed. You can enter your figures over mine.



Some farmers achieve yields of 33,000 kg of DM per ha of maize silage (See Maize) and 15,000 kg per ha of Pasja and Nutrifed or Shirohie millet, while some get only 20,000 kg from maize and 8,000 kg from others. In the late 1980s Ruakura got only 5,000 kg because they don't know the benefits of lime and chisel ploughing, so rotary hoe. They, and others in the 'establishment' group, then used that yield figure to tell farmers that forage crops were not profitable.

Mouldboard ploughing inverts the soil so lowers the surface fertility. In New Zealand, with our later and cooler springs, mouldboard ploughing also lowers the soil temperature. This, coupled with lowered soil fertility, slows the initial growth of crops and gives weeds an advantage. Chisel ploughing keeps the topsoil warmer, can go deeper without losing the top fertility. It allows sowing within two days of starting the cultivation, which reduces the soil's unproductive time and weed growth substantially. See Soils > Cultivation.

See the Pasture, Silage, Hay, Crop & Nitrogen Costs spreadsheet.

Tri-Fix previously called N-Fix

One liquid product (not a fertiliser) is Tri-Fix, which is a liquid soil conditioner imported from Texas and improved for New Zealand conditions.

In New Zealand, trial figures and photos are available from the New Zealand importer, Adrian Balle, Box 491, Pukekohe, New Zealand. Email: balle@paradise.net.nz Phone +64-9-236-8094.

Tri-Fix is not claimed to be a fertiliser, but retains soil moisture and N and gave better, higher yields and feed value in brassica and maize crops, and a profitable return on all the four comparative trials that I organised in the Waikato in the 90's. Soils drying out in summer reduce crop yields.

Tri-Fix seems to reduce the leaching of nitrogen, making it available to the crop for the whole growing period and it conserves moisture. Two litres per hectare costs about \$140 per ha plus applying costs, and can increase the value of maize yields for green feed or silage by \$500 per ha. Tri-Fix increased maize protein by 29% and yield by 40%, so the total protein yield was up by 80%.

This makes it a better milk and meat producing feed. Metabolisable energy figures are about the same, but there is more feed available due to increased yields. More calcium (up 37%) and magnesium (up 24%) help to make maize a better feed. Two litres per hectare (one per acre) is now recommended.

Peat farmer/contractor, Jennie Lornie at Orini, Waikato, used it with their maize and got higher yields than others in the area. You can do your own trials.

Pasja on David Webb's Eastern Waikato, mineral soil sprayed with one litre of Tri-Fix per ha yielded 15% more, and the soil was damper by holding moisture, which is so important. In all cases using Tri-Fix showed a profit on costs.

5.7 ha of Pasja and Forager chicory were sown on 25 November on David Webb's farm, Wardville Road, Waharoa, and received only a few millimetres of rain until 10 January when 25 mm fell. 4.7 ha was sprayed with Tri-Fix and 1 ha left as a control.

The Tri-Fix yield was noticeably higher and wilting in the hot dry weather was less, so on 13 January four one metre square quadrants were cut to 7 cm residual, and weighed. Weights are in dry matter (DM).

The first grazing yields 50 days after sowing were -

Yields: Tri-Fix 3.2 and Control 2.4 tonnes per ha. This increase of 33% or 800 kg DM per ha at NZ\$0.20 cents per kg was worth \$160 per ha. By March the increase was \$300 per ha against a cost of \$50 per ha giving a net profit of \$250 per ha.

See Forage Crops > Maize for more on Tri-Fix.

Brassicas are better for animal health, because of supplying variety, but don't apply too much sulphur. With Single Superphosphate (0-9-11) it is impossible not to apply too much. However, the best reactive phosphates must have the optimum amount of elemental sulphur added with other elements as required by a pasture analysis, and be cultivated into the soil. See the Fertiliser and Lime Based Planner spreadsheet for details on quantities.

Chisel ploughing the fertiliser into the soil makes the reactive phosphate become available more quickly, and puts all fertilisers where they are needed. For crops, lime must be chisel ploughed in twice and fertilisers once to about double the depth of topsoil, or to 40 cm, especially for deep rooting crops like maize. Shirohie millet yielded nearly twice as much when the fertiliser was cultivated in 20 cm, compared to an adjacent paddock where it was just harrowed in to 5 cm.

If the soil is 'dead' (hard, compact, with few earthworms, few microbes and low humus) and the pH is above 6.5, use Triple Superphosphate rather than reactive phosphate. See Elements > Phosphorus.

Seeds

In Australia, cows gained access to a heap of discarded chou-moellier seed that had been stored in a barn for 10 years. Within 24 hours two cows were dead and one was acutely ill. The toxicity was attributed to damage to blood vessels in the rumen wall, resulting in marked loss of fluid oedema of the wall of the rumen.

Some seeds are treated with poisons against insects and birds, so be careful when handling them. Children became sick after playing with pink treated grass seeds.

So store them safely.

Buy your seeds from a reputable company and keep a handful incase of mistakes.

Seeds start cooking at 25 degrees C, so buy them from cool stores and keep them in a cool building, such as the middle of your house. Good seed companies keep them in cool stores until despatch.

Typical research mistakes

I include the following, because SOME researchers like to think that if a researcher does something it is always right. This is not the case. Some research institutes in New Zealand have criticised the growing of forage-crops outright, without taking all farms and locations into account, or

how well the best farmers do by growing them.

A Ruakura Animal Research scientist reported no benefit from Tri-Fix after trying it on a poor, un-fertilised Bermuda grass/Twitch (*Cynodon dactylon* L.) lawn behind his office! Trials done by myself and other farmers showed good profits. See the maize on the Home Page and in the Maize chapter on our farm, both yielding 33,000 kg of dry matter per hectare for silage.

NZ AgResearch changed their stance on summer crops in 1994, when they stated that they could be profitable, after having said in 1987 that they weren't. Then in 2002 they promoted how useful forage-crops are at carrying good feed forward into lean periods.

The worst summer crop I have ever seen was on Ruakura Agricultural Research Centre in 1996, on Tramway Road, Hamilton. Ag consultant, Dr Koos Baars, and I estimated the yield at about 5 t per ha. It looked as if the preparation was shallow rotary hoeing only, instead of chisel ploughing, and that no lime and little fertiliser had been applied. Drainage was poor, but germination was good (plant population was high). I took a photo of it, and included the buildings in the background so there can be no argument.

Another time when I was looking at Ruakura trials with a scientist, there was a paddock that had been rotary hoed until the soil was fluffy powder. I was driving and wanted to stop and look at the mess, but the scientist with me said, "No, no, keep moving!" because he knew it was a disgrace, and didn't want to be seen looking at it, in case there was an investigation and he was asked to get involved. He wanted to be like Schultz in Hogan's Heroes, so 'had not seen anything and knew nothing', when he should have been like Hogan and worked out a solution. The solution would have been to chisel plough deeply to break the hard pan that rotary hoeing causes, and bring up a little subsoil to give the fluffy soil some structure, as well as minerals for the white clover that thrives wherever deep cultivation or ditch cleanings have brought up subsoil. I wish I knew why clover does so much better in subsoil and with deep chisel ploughing that brings up subsoil; if you know, please tell me. It could be the silica in some soils that has been use up in topsoils. Subsoil analyses I've done showed more magnesium and sodium.

In New Zealand, the best farmers are a decade ahead of the scientists and don't give us the screeds of wrong information that comes from science.

So don't think that all researchers know more about farming practices than you do. Most are way behind the best farmers.

Reasons for many NZ forage-crop failures are that AgResearch and LIC still don't recommend enough Ca, P or boron, nor chisel ploughing deeply, as is beneficial on most soils. Ruakura Research Centre rotary hoe - the biggest soil destroyer there is, but OK for one shallow cut before chisel ploughing. The soil gets powdery so dries out and can't be consolidated so germination is poor.

Good forage crops can yield more DM in four months as some pasture does in a year, so crops have to be fed well. The worst paddocks are usually the ones cropped, so need feeding more than ever.

The US Forage Research Centre at Madison University, Wisconsin, did trials with grazing brassica crops in about 1982. They tried grazing a four-acre paddock of different brassicas, by allowing cows to have the whole paddock from day one - to see which brassica they preferred. I saw the report, which stated that animals didn't like brassicas because they walked all over them, ate very little, and preferred grass, based on the fact that they ate all the grass round the edges of the field first! The animals had previously never eaten or even seen brassicas. It is lucky that they ate the grass first and not too much of the brassicas, or there could have been corpses from redwater and nitrate toxicity. Changes must be gradual.

Another USA researcher criticised growing brassicas and showed complete ignorance by reporting, "It's too hard to justify the machinery for harvesting brassicas." They are ALWAYS grazed. How can you harvest turnips from underground. He must have visualised a potato harvester! Animals don't have to have food taken to them. They have four legs that need stretching, and have an automatic manure spreader, that earthworms seek.

Another wrote that brassicas tainted milk, so should not be fed to dairy cows. There is NO milk

taint if grazed **after** milking, not before. With beef, weeks are needed to remove all the brassica flavour from meat.

NZ AgResearch scientific, and one commercial researcher on summer forage-crops, wrote in 1997 that turnips are not an economic crop to grow because of low yields (6 t per ha), and the length of time paddocks are out of the grazing rotation, subsequent regrassing costs, etc. However, yields can be double their 6 t, and with correct cultivation methods (mine, as published in the NZ Dairy Exporter in 1959), there is little wasted unproductive time, and they did not allow for -

1. The improved pasture that follows a crop.
2. With chisel ploughing one can cultivate and sow within two days, saving "lost pasture" time, keeping the early spring warm soil and fertility on top, and beating the weeds because they then only start germinating at the same time as the crop. Pasja and its mixes can be grazed after 30 days and then six times in three to four months.
3. Good yields. To grow 12 t of DM in five months, 1,000 kg of mixed fertiliser per hectare (900 lb per a) is required. Provided fertiliser is based on a pasture analysis, the profit more than returns the cost by a long way, and saves over-grazing pastures.
4. It is usually the worst paddock on a farm that is cropped, not the average that AgResearch used to calculate their "lost pasture".
5. After a crop, the new pasture can be sown and then grazed five weeks later in temperate areas, and will out-yield even good pastures in winter and from the first year.
6. Less facial eczema, less overgrazing of summer pastures, which is a perennial ryegrass and clover killer, and less stress on farmers who have nothing to feed their stock, and when animal production drops.
7. Cropping before sowing new pasture removes more of the old pasture and weed seeds so is better than sowing new pasture straight from existing pasture (grass to grass). In peats, pumice and other shallow poor soils, pastures after a grazed forage crop do far better than ones sown straight from old pasture, because the second cultivation goes deeper and brings up more subsoil.
8. If Pasja and millets or Nutrifeed are sown, grazing can be within 25 days and if 5 paddocks are sown, each one is sown about 4 days after the previous one, less pasture grazing time is lost.

In 1997, AgResearch and many LIC consultants had a campaign to discourage the growing of summer forage-crops - despite an El Nino summer drought forecast. The result was farmers overgrazing pastures, hungry cows, low milk production and more facial eczema than ever on some farms.

I repeat that the above applies to SOME researchers, but certainly not all. Sir Bruce Levy, Dr McMeekan (being a farmer helped him), Frank Hupkens van der Elst (peat), Dr Doug Philips (inventor of low impedance high power New Zealand energisers, bloat control oils and the Peta dispenser), many Dairy Board consultants and some in other countries such as Tapani Kunelius in Canada, Dr Burt Smith in Hawaii, Dr Jim Green in North Carolina, all of whom attended conferences I ran and became sold on controlled grazing, lime, trace elements, etc., and became friends.

Despite farmers being advised by the establishment to the contrary, summer crops are still grown in summer-dry areas such as from Walton to Patetonga in the central Waikato, which being in the middle of the North Island don't get much summer rain from the easterly or westerly winds, and get very short of summer pasture. As is often the case, the farmers know best. The "pasture only" brigade didn't have figures for the areas, but still told farmers not to grow crops. Wherever you farm, beware of this sort of advice that might not apply to your farm and area. One point they made to try to prove their point is the time the paddock is out of the grazing rotation. However if it is chisel ploughed and sown within two days, and the crop is grazed within 25 days, it compares to the time out of the grazing round for pasture for silage, hay or summer deferred grazing, where the paddocks have to be closed for at least 35 days.

Pasja and millets can be grazed about 25 days after sowing and every 18 days, provided all the suggestions made here are done correctly. See Soils > Cultivation because thorough deep chisel

ploughing is essential for good crops and good future pastures. See page 2 above, Subsoil.

Some recommended direct drilling into existing pasture or into sprayed pasture without cultivating, but this has given very low yields in New Zealand and in Australia, as shown by Australian farmer Peter Notman, who quoted a loss of \$1,200 per ha in his booklet, Turnips for Profit, so don't even try it. Chisel ploughing deepens topsoils, brings up subsoil that clovers especially thrive on, makes animals healthier with less bloat (see Bloat) and have given forage crop yields more than double that of wrong shallow cultivation.

Some say that in a summer and autumn with ample rain the crop may not be necessary, however, in most summers and autumns, if the farm is fully stocked, a crop will be beneficial. If there is any doubt about the need for a summer forage-crop, then sow Shirohie millet in cool summer areas (from Te Kauwhata south) and Nutrifeed from Te Kauwhata north, where it is warmer. If in doubt so half of each. Both can be grazed if required, or wilted and put into silage. If extra feed is likely to be needed in early summer and maize will not help, because young maize is too sappy (described by one very good farmer, who now grows brassicas, as 'just green water') and some sorghums are dangerously toxic until mature, accentuated by their high tannin levels. I would not grow them, except where others won't grow such as in hot tropical, dry, arid areas.

On the green water comment, brassicas can be just "white water" with their 88% water level (about the same as milk), but animals love them so much that they will eat plenty and produce well. They make good supplements with dry summer pasture, silage or hay.

Some may ask, "Why grow pasture at all if crops are so good and can yield so much?". The answer is because good pasture costs less to grow and feed, is of better quality and a more complete long term feed, less susceptible to droughts (dry weather for a month after sowing a crop can be disastrous), floods, hail, weeds and pests, and is needed to be grazed with crops or fed as silage or hay with crops. Pasture is also much kinder to the environment than fuel consuming cropping.

Forage crops are good for evening out the pasture growth curve, and allowing the latest and best pasture varieties such as Bealey NEA2 and white clovers like Kopu II and Tahora II to be grown. Tahora makes more nitrogen than any other clover and withstands the high stocking rates some are using.

Avoiding failures

Before destroying an established permanent pasture to grow a forage-crop, do your research thoroughly. In difficult areas it takes a long time to re-establish a good dense sod of pasture, so you may later regret the decision. Also, the crop yields can be lower than hoped for, and the costs of re-sowing pasture are high. Inadequate rainfall at the critical times can end up in failures, something that is not so severe with established pastures in the same conditions. If feed is required for lean periods, making hay or silage can be a better bet.

Both my and agricultural contractors' surveys of crop failures showed that failures, in order of seriousness, were caused by the following.

1. Poor soil preparation and insufficient rolling to firm the seedbed.
2. Poor sowing methods - seed too deep or too shallow.
3. Insect and bird damage.
4. Fertiliser not cultivated at least 20 cm into soil, and being the wrong kind or insufficient.
5. Paddocks too wet to cultivate and sow on time because of inadequate drainage.
6. Contractors being late.
7. Nitrogen not used when required.
8. Diseases.
9. Weeds.

See below for more information on each one.

1. Soil preparation



Failures can occur following prolonged cultivation that gives weeds a start, and causes the soil to dry out and become difficult to compact - both before sowing so the seed goes too deep, and after sowing which reduces germination. This is more likely after mouldboard ploughing and taking a week to sow, because the soil can dry out.

Every year many crops are planted too late, so produce much less than those planted on time, so plan, and if necessary book contractors early. If the paddock is wet, cultivation can be delayed, so drain, shape and level the paddocks during the previous summer or autumn. An important reason for cultivating paddocks can be to make the surface smoother and deepen the top soil, bring up some topsoil and work lime in. Therefore, when preparing for the crop, make every endeavour to chisel plough deeply and thoroughly.

When shaping the paddocks, mound up around gateways and troughs. Shaping should include pulling banks off ditches and making wide V surface drains to the main drains. If major earth moving is necessary it should be done when it is dry, even during the summer before. If necessary, use a contractor. The cost can be more than paid for from the extra feed grown when crops are sown on time. If a large area has to be shaped and levelled, sow a winter rye-grass with clovers such as Berseem and/or Kopu 2, or winter-feed dry animals on the still-in-grass parts of the paddocks, which will also build up fertility and lower slug, cutworm and springtail populations.

In early spring, soil temperatures can be a limiting factor in getting some crops to germinate, and soil temperatures can be several degrees higher near the surface than at the mouldboard plough depth, so, after ploughing and bringing up the colder soil, germination can be delayed. The old way of waiting a few weeks after ploughing and before sowing comes partly from this. With chisel ploughing soil temperatures hardly drop or can rise, so sowing can be done immediately, in fact the sooner the better, to save losing moisture, and to beat weed germination. Chisel ploughing also leaves some vegetation on top that protects the soil from the sun burning up humus (decomposed organic matter in the soil) and soil organisms, destroying the structure. Wind erosion, and heavy rain creating a seal or film or a crust are reduced.

A good seedbed is essential, but impossible if there is long grass on it, so use the paddock as a winter sacrifice one, then chew the pasture down to under 5 cm. With milking cows it may seem impossible to graze a paddock really short in spring, but it is possible, unless the paddock is at the back of the farm. To do so, start a month before the sowing date by grazing the paddock fairly short, then graze it a week later for a few hours, after which, give the cows another paddock in the same 12 hours. Also use the paddock as a holding paddock until all cows are milked, then move them into their new paddock. They will gradually chew down the paddock to be cultivated. Doing this can save you the cost of nitrogen, which crops otherwise need if the paddock is not fertile and didn't have strong clovers.

If it is not possible to use animals to kill the turf or surface cultivate (rotary hoe or cross disc), or if creeping grasses (Kikuyu, Bermuda, twitch, couch) are present, pre-spraying a month before with glyphosate will be necessary, and will reduce cultivation costs and achieve a better seedbed. A beauty of forage-crops is that, if some grass grows with them, it is not problem and balances the feed.

Spraying 20 cm (8") or longer pasture with glyphosate is useless, takes more spray and doesn't kill the roots, compared with spraying it at 10 cm, so graze or mow to 5 cm, wait a few days then spray. After a week, check and re-spray any green patches. Couch, Kikuyu, Bermuda and other underground creeping grasses can be difficult to kill, so up to nine litres per ha may be needed. Decreasing the pH of the water improves the effectiveness of some sprays. Contact long time market gardener and cropper, Adrian Balle <adrianballe@elisionz.com> or see www.elisionz.com

Wait ten or more days after the last spraying (for roots to also die), graze the dry grass (this is claimed to be safe) then cultivate.

Don't rotary hoe or power harrow excessively, because they are expensive to operate and destroy the soil structure, encourage soil drying out and cracking in subsequent dry weather. Don't mouldboard or disc plough, because they turn the warm fertile topsoil down.

Apply lime (if needed), chisel plough, apply fertiliser, chisel plough once or twice more,

depending on the width of the tip (5 cm wide tips need more passes than 8 cm wide tips), then roller cultivate. If the chisel plough hasn't a roller behind it, roll, sow, then roll once or twice, depending on soil type and moisture level. If two rollings are going to be needed because the soil is dry or rough, double roll by taking half the width each time. This will bring up more moisture, reduce evaporation losses, make turning easier on the corners because the outside wheel will be on the firmer rolled ground, and the operation will be less dusty for the operator. The corners may then not need rolling.

In almost all soils, deep cultivation is essential to obtain a good crop, to deepen and improve the soil for future pastures and to bring up minerals which are in subsoils, but have been leached or used up from topsoils.

If cultivation is rough (lumps of turf on top), Argentine stem weevil and other insects can survive for as long as the lumps of turf are there, and even if you chip hoe there will still be some Argentine stem weevils in areas where they live.

Do all the cultivation within one or two days to avoid losing moisture and to beat the weeds. If the area is too large to do in this time, do a smaller area each time. Lack of moisture and weeds can cost dearly.

The final seedbed should be crumbly, not powdery, which is susceptible to blowing away and crusting after rain. Don't worry about a little dead or even growing grass and clover, unless planting maize for harvesting. It will grow into feed, will reduce wind drying and wind chill. If you are worried about poor germination because of the turf, it is much better and cheaper to sow a little more seed than to cultivate again. Delaying planting to get a better seedbed will lose moisture. The cleaner the seedbed, as after mouldboard ploughing, the more damage from hungry springtails and slugs, and the more sun, heat, wind and rain damage.



2. Sowing methods

Milletts need to be buried between 2 and 3 cm deep. To achieve correct sowing depth of brassicas and millets, sow onto a Cambridge or V roller firm seedbed, and then roll with brush or scrub behind the roller. If dry, double roll before and/or after as required. A seedbed is firm enough if, when walking over it, only a boot mark is left, not an indentation.

Turnips drilled too deeply (3 cm) and without fertiliser (bottom left corner of photo) yielded only a fraction of the 1 cm deep drilled ones with fertiliser on the right and top of the photo. Luckily I visited this client when he had just started drilling and checked the sowing depth, and noticed that there was no fertiliser in the soil because the fertiliser part of the drill was not working.

If a drill is not available, the seed can be mixed with lime or a safe fertiliser and broadcast onto a V Cambridge rolled surface, then buried with scrub or brush dragged behind and rolled again. Never mix bare seeds with fertilisers that have Superphosphate, potash, boron or nitrogen, because seed-burn can occur unless the seed is coated, or mixed, sown and buried into moist soil with a few hours. Serpentine Super or reactive phosphates are usually safe, but the other elements can adversely affect germination. Slightly damp agricultural lime (to save dust) can also be used. Sowing into very damp soils, or getting rain immediately after sowing, reduce seed burn.

Sow coated seed to benefit from its many advantages at no extra cost, because the better germination rate and better establishment means that no more need be sown to allow for the extra weight of the coating.

3. Insect and bird damage

If sowing after pasture, there can be insects galore waiting to eat the seedlings. Ploughing doesn't eliminate them because some hop across to the ploughed soil from under the tractor as it goes over and disturbs them, and some crawl out through the turf layer. In fact, damage can be worse after

ploughing, because insects have nothing else to eat. Watch for them, and treat as required. Maize and turnips are more susceptible to insect damage, and maize seed more to bird damage, than millets, which have a higher plant density. Small birds can eat millet seeds if they are not buried to at least 2 cm (0.8"). Coated seed can be bought, or coating the seed in diesel discourages insects from eating them and the young plants, but nothing gives 100% protection against all insects, so walk the field when germinating and then spray the insects if necessary.

Turnips can suffer from springtails, cabbage butterflies and leaf miners. The last two are less of a problem in Pasja because it is grazed frequently. Cabbage (white) butterfly caterpillars eat holes in the leaves and can eat all the leaves, especially if growth is slow. Healthy fast growing plants can sometimes feed the caterpillars and still thrive. Leaf Miner, a 2 mm long maggot with a very small black head (use a magnifying glass to see them) crawls over the leaves and sucks the juice out of the leaf. The damaged parts then turn brown.

Nysius Fly (Wheat bug) attacks brassicas by ring barking them.

Insecticides can control the above, but may not be economic unless the damage is extensive.

Treated seed doesn't stop the insects from eating a few plants before the insects die. Replanting is expensive and sprays are offensive, so preferably use diesel and/or your animals as suggested above, but monitor damage twice a day to take action before severe damage occurs. Dampening seeds with a little diesel before planting has helped many farmers reduce springtail damage, but Superstrike coated seeds can do a better job and provide instant fertility, can aid germination and help avoid springtail damage. It takes more moisture to germinate coated seeds than bare seeds, so, if dry and rain is not imminent within a day, roll the paddock well to bring up moisture reduce evaporation.

Turnips can suffer from springtails and slugs shown here, which can eat seedlings as they come through and hardly be noticed, until after a couple of weeks it is realised that the weeds are plentiful, but there are not many brassica plants growing. To check for springtails, lay a white hankie or cloth on the ground, and then walk slowly up to it from the other side and watch for springtails hopping on to it. When checking germinated plants, mark each plant in a square metre with a match and check twice a day. It is necessary to check in several square metres over the paddock because some areas can be attacked and others not. Slugs can come in from adjacent paddocks and from under fences where trampling didn't occur. Dean Gilbert of Southbridge in Canterbury did trials, and found that slugs would not cross a 10 cm wide strip of Superphosphate, and developed a hopper and pipe to lay it.

Early sowing of seeds in cool weather results in less insect damage than late sowing when more insects have hatched.

With Pasja and millets, early grazing can be a way of reducing insect leaf damage, because it regrows.

4. Fertiliser - not cultivated in, wrong or insufficient

If little rain falls, which can occur in late spring and early summer, the fertiliser will sit on top and not be used. To avoid this, apply lime, chisel plough twice, apply fertiliser and chisel plough it in once, always in different directions. Plant roots go down faster than fertiliser washes in, even with adequate rain. Fertiliser must be cultivated in because comparative trials have given 50% better yields, than when left on top. Pumice farmer Grant Sefton had to graze his turnips, which didn't have the fertiliser cultivated in, before they wilted away in the summer heat, while where he had chisel ploughed it in the turnips continued growing into the dry weather. Pumice and peats are opposites - sandy and organic, and yet similar, by having little topsoil and low fertility, that should not be turned down. Also, both need lime, boron and copper.

If boron is low, Ulexite* or Boronate32 (11% boron), should be included at between 10 and 20 kg per ha (9 and 18 lb per a) depending on pasture analysis levels.

Crops yield two to three times the DM of pastures over the same period, so must be well fed.

Trace element deficiencies can be a cause of crop failures. Get a herbage analysis of the 16 main elements from the paddock or similar area (if soils are similar and fertilising has been the same there

will be little difference) to ensure correct fertilising. Most soils are low in some elements and most crops, including maize, need boron. Most soils need up to 1,000 kg per ha of a balanced fertiliser mix. Costs, other than fertiliser, are similar and low yields can be from low fertility, so the extra fertiliser is worthwhile. If the crop doesn't use it, the new pasture will. Crops need lime, serpentine, N, P, K, S, salt and boron.

If the paddock had clover and grass pasture and was wintered on or fed out on, N should not be applied until it is seen to be needed. With Pasja and millets this is easy after grazing.

5. Poor drainage

Paddocks too wet to cultivate on time result in late sowings. Maize grows very poorly on cold, wet soils. Shirohie millet does tolerate wetness, but future pastures will need good drainage. Deep drains are seldom necessary. Half metre deep spinner surface drains are usually adequate, and in some cases just shaping the paddock and forming V depressions is sufficient. These surface drains get rid of the clean rain water as it falls, so leaching and aquifer pollution are reduced.

6. Contractors being late

Book them a year ahead and contact them every four months and every week for a month prior to needing them. Some contractors are not good record keepers and most get over-booked.

7. Nitrogen not used

N is not usually necessary and certainly not if the paddock was wintered on or received effluent, however if N is needed and not applied, it makes the whole exercise of growing the crop a waste. Applying urea at sowing doesn't give as good a result as applying it about three to four weeks after sowing, but sulphate of ammonia (SoA) (22 N, 0 P, 0 K, 24 S) at 150 kg per ha can be applied at sowing and roller cultivated in, as it lasts longer. N needs S to work and is one reason why SoA works better than urea, but, if applying SoA, you should reduce the elemental sulphur in the fertiliser mix. Use elemental sulphur and reactive phosphate if the pH is below 6.4, otherwise use elemental sulphur with Triple Super and trace elements based on a pasture analysis.

8. Diseases

Aphids, viruses and fungi can be spread by aphids, which kill off leaves.

A Sclerotinia rot (soil fungus) can affect brassicas and chicory.

Clubroot causes root swelling and death. Liming reduces the incidence. Leave several years before growing brassicas in the same paddock.

Turnip and swede heart-rot is easily avoided by including about 8 to 10 kg per ha boron with the base fertiliser.

9. Weeds

Applying the above should reduce weed problems, but if weeds are a known problem, then Pasja is a better crop than turnips (with or without a grass crop), because its early grazing consumes and/or tramples weeds. If Amaranthus is a problem, then one has to be aware that nitrate toxicity can adversely affect animal health, and if a lot is eaten it can kill. Grazing in the late afternoon when nitrate levels are lower reduces its danger. See Animal Health > Nitrates.

Which paddocks?

The paddocks to be cropped should be decided on a year before, shaped and used as improvement ones by feeding out on them over winter, to build up fertility and trample insects such as slugs, cutworm and Argentine stem weevil, then, well before cultivating, graze them hard, or mow short three days before spraying with glyphosate. Getting the paddocks shaped for better drainage will make spring cultivation easier and on time.

Lime and base reactive phosphate if pH is below 6.4 can be applied in dry weather even six

months before cultivation to avoid hold ups. It can be difficult spreading them on cultivated soil if wet.

Which forage crop?

Grow safe crops, but even with comparatively safe crops, when molybdenum is deficient, or excessive, nitrates are more dangerous to animals and can kill. A 200 cow herd had 15% die within hours of eating a high nitrate forage crop short regrowth with some Amaranthus (a very high nitrate weed), without sufficient lime. Many cows aborted. It happened after rain (which contains N) had fallen following a dry spell. During the dry spell N would have built up, and helped boost the regrowth after rain fell. It occurred after the crop had been grazed for weeks without problems. Crops and pasture can be tested for nitrates. Levels in late afternoon are usually half those at 9 am and are higher in cloudy weather.

Always apply adequate LimeMagPlus and correct Phosphorus Nutrient Planner fertiliser, and minimum or no nitrogen, until there are signs of needing it, such as going yellow, and slow growth.

Puna is increasing in popularity, but is not suited to raw peat because its tap root will turn at right angles when it reaches uncultivated acid peat. Some peat farmers on fertile consolidated peat are happy with it, and in trials I did on the Gallagher farm, on 2 m deep poor peat in mixed pasture, the Puna in a pasture mix out-yielded all other pastures in total, especially in summer, which is when DM is more valuable.

It has to be buried when sown, so needs to be harrowed, trampled or drilled in. It dislikes wet acid heavy soils, being pugged, and flat-weed sprays that kill it.

This Puna chicory was growing in summer after perennial ryegrasses had stopped. Note the increased yield in the shade of gum trees.

The biggest mistake some make is to have insufficient area of crop to keep the cows milking well during summer dry periods. Sow at least three to five hectares per 100 cows, depending on the crop and the other feed available. Use the worst paddocks, half towards the back of the farm and half towards the front, to save cows and staff walking further than necessary. If you do all back paddocks in one year the cows would have to go to the back every day .

Animals eating any of the summer grass type crops such as maize (10% protein, or millets) need more protein for optimum animal production. Brassicas (19), Nutrifeed (20%), clovers (30%) based pasture or pasture silage (25%), are the best and most economical suppliers of protein and higher metabolisable energy. Bought feeds give no profit.

Aim for no more than 40% maize and 60% pasture and/or brassicas, to give an overall protein of about 18%. The more stems of maize the animals are made to graze the lower the protein and feed value, because most of the value is in the kernels.

Avoid feeding more than 75% brassica crops. Even at that level, monitor the animals health daily. Pasture, silage and hay or straw must also be fed to prevent digestive problems. If a shortage of other feeds is predicted because of regular summer droughts, see below about mixing in Nutrifeed or Shirohie millet with Pasja.

In warm summer areas that are frost-free try Nutrifeed. It is a late flowering, leafy, high feed-value, hybrid pennisetum fast-growing summer forage, but needs warm soils and weather. In cooler areas Shirohie millet can be better, while in colder areas brassicas (turnips, swedes, Pasja, Wairoa, etc.) are the safest bet on their own. They are not killed by frosts.

The best turnips, and especially Pasja, are good at producing milk, but cows can lose condition if on them and fed insufficient pasture, although no more than on pasture without a crop. Animal condition can be maintained by also feeding grass type crops and/or silage.

It pays to start grazing crops early in summer to reduce summer milk slumps and loss of animal condition. When cow condition drops, the milkfat percentage also drops.

Pearl millet, as grown in some countries, is nowhere near as productive as Shirohie millet as grown in Australia and New Zealand, where Shirohie is the best variety of Japanese millet.

Table 1 **Feed Quality for Forage Samples**

Feed Type	Dry Matter (%)	Crude Protein (%)	Acid Det. Fibre (%)	Neutral Det. Fibre (%)	Digestibility (%DOMD)	Metabolisable Energy (MJ/kg)
Mixed Pasture	12 – 25	20 – 30	20 – 30	30 – 45	65 – 80	9 – 12
Pasture silage	25 – 30	14 – 20	20 – 35	30 – 45	65 – 75	9 – 11
Cereal Silage	35 – 40	8 – 12	25 – 40	35 – 60	55 – 65	9 – 10.5
Maize Silage	25 – 35	6 – 9	25 – 35	35 – 50	60 – 70	9.5 – 11
Lucerne Foliage	15 – 25	20 – 30	25 – 30	35 – 45	60 – 70	9 – 12
Lucerne Hay	85 – 90	18 – 25	25 – 35	35 – 45	55 – 65	8 – 11

Sorghum

I would not grow sorghums because of their high nitrate and high tannin levels. Purdue, USA animal scientist Layi Adeola found that livestock are slower at gaining weight on a diet of tannin-rich sorghum.

In parts of Africa and Southeast Asia, sorghum grain is the staple diet for many people. Some farmers in the southern and central United States use the grain for livestock feed, because it's available and fairly cheap, but not as nutritious as tannin-free grains. One reason the above grow sorghums is because they are hardy, and will grow and yield in dry, hot and low fertility conditions where some other grass types won't.

Winter Crops

Tapani Kunelious, with Kale he sowed on Prince Edward Island, Canada, Department of Agriculture demonstration farm. I took this photo in mid October when it was ready to graze, just days before snow was due. It fed the animals well into winter, even when snow covered it. Note the economical two-wire high-power fence.



In the New Zealand South Island high-country in some winters, farmers have to brush thick snow off the brassicas to allow grazing animals to eat them. If heavy snow is possible, sow chou-moellier, which is a tall growing very strong-stemmed brassica. If the ground freezes early, don't sow a root brassica such as turnips, because animals may not be able to get them out of the soil. Apply the correct amount of potassium to give strong stalks, so that hopefully they don't break or bend under the weight of snow. A problem that can occur when grazing brassicas in freezing conditions is that, if animals eat too much frozen crop, their livers can freeze.

Some farmers grow winter ryegrass instead of a winter brassica, and some grow winter ryegrass after a forage crop. Growing it between annual maize crops works well, especially if grazed, therefore returning organic matter and animal manure. If harvested rather than grazed, the soil organic matter levels will decrease at an even faster rate and reduce maize yields. If perennial ryegrass and clover pasture is sown after a few years of this double harvesting, soil organic matter levels will be so low that the perennial ryegrass will not do well and will even die, leaving clovers on their own which is low producing and a bloat nightmare.

Applying animal or poultry manure will help increase organic matter levels. Apply it before the maize, not before the winter ryegrass, or nitrates can kill animals grazing it and silage made from it can be rejected by animals.

Disadvantages of growing winter ryegrass after forage crops

Clover based pasture is more productive of milk and meat, preferred by animals and more profitable.

Nitrogen has to be applied usually before the second grazing because there are no clovers.

Nitrate toxicity is more common, often killing animals. This can occur even without applying N.

Soil organic matter content decreases. This reduces cobalt levels and crop yields and increases rust in plants.

Most pasture farms have old pastures that are not as productive as new ones. Cropping and resowing the worst pastures improves the farm and farm yields. Some of the criticisms of new (2008) grass varieties is usually because modern pastures are grown and selected in high fertility conditions, and grown on most farms in lower fertility soils.

Mixed forage crops

Chicory

Ask several retailers and local growers about the best varieties for your area. Yields on one trial were Chico 2,722 kg/ha, Grouse 2,686, Puna 2,053, Plantain 2,261. Graze down to 4 cm, not lower, and avoid back grazing of young regrowth. Graze again no longer than 25 days or stems can bolt to flower and reduce future growth. I would sow 3 kg/ha with 0.5 kg of Kopu white clover which is the fastest growing clover in its first year, but doesn't last.

Chicory has potassium, calcium, magnesium, sulphur, zinc, and sodium, which are essential for animal nutrition. It is clean (no soil eaten) and easy to graze without toxic effects. More on summer forage crops

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The beauty of growing and grazing mixed forage crops of grasses (Nutrifeed, Shirohie, etc.) and brassicas such as Pasja is that it can be fully fed without having to feed pasture, hay or silage with brassicas. Adding Puna Chicory, Tonic Plantain and a red clover gives a superior feed and higher yield.

Cows on mostly brassicas can produce well, but can lose condition. However this doesn't happen on the mix below, which gives good milk or meat production, and little loss of condition.

A safe (allowing for a bad seed bed) mix is 12 kg of Shirohie millet or Nutrifeed in warmer areas (or 6 kg of each if uncertain) per hectare, and 3 kg of Pasja per hectare. Less can be sown into a perfect seed bed (see Soils > Cultivation) with adequate moisture or rain imminent. Unfortunately there is no such thing in the Waikato because from late spring on, one area can get 20 mm and an adjacent area one none.

If grazing from the crop might be needed well into autumn add 0.5 kg of Puna chicory, 0.5 kg Tonic plantain and 1 kg Multicut Berseem clover (see page 14 for information on these four) or a fast growing red clover. The legumes must be inoculated.

This mix must not be grazed to lower than 10 cm (4 inches) or regrowth will suffer.

A mineral supplement should be fed through the drinking water, because an iodine deficiency can occur. If milking cows are being sprayed with iodine, a deficiency should not occur.

Trials I did mixing Pasja with Shirohie in about 1995 gave the best of both worlds by providing a high metabolisable energy feed. Cabbage butterfly damage was less, because the millet leaves were well above the Pasja, making it difficult for the butterflies to get to the Pasja as shown on Grant McGregor's Waikato crop.

Grazing must start about 30 days after sowing, to avoid domination by the grass type, and lodging, and be repeated about every 16 days. Animals must be removed once it is grazed down to no

less than 15 cm. This will give four or five grazings. After that, the millet and Nutrifeed will stop growing, and the grazing round on plantain, clover and chicory should be lengthened. If you plan to continue cropping the paddock, drill in an annual (winter) ryegrass, or sow permanent pasture. If this period can be short of feed, then sow Green Globe turnips that grow more slowly and keep for longer, so the grazing period is longer.

This forage mix can be far better than brassicas on their own. Advantages are -

1. Because it is ready to graze sooner than turnips, it can be sown a month later which gives more pasture to graze at a time when pasture can still be in short supply. Sow each paddock within two days of starting cultivation to conserve moisture and to prevent weeds. Roll until firm. See Soils > Cultivation.
2. This mix is a more balanced diet than turnips or grass crops on their own, requiring less time for animals' stomachs to adapt from pasture. Even so, start with just ten minutes, increasing until they eat all they are allocated (1/16th of the total crop area) down to about 10 cm for maximum regrowth.
3. The Pasja, plantain, clover and chicory will help produce more milk and meat than just Shirohie. Nutrifeed produces a lot of milk.
4. The Shirohie or Nutrifeed will help maintain cow condition.
5. The Shirohie or Nutrifeed will help suppress weeds.
6. If brassica pests (springtails and cabbage butterfly caterpillars) are bad and not controlled, the Shirohie or Nutrifeed will still provide feed.
7. Bird and insect damage is not as severe on mixed crops. Wintering and/or mob stocking on the paddocks before cultivation reduce insects.
8. It can be fed without having to feed pasture, silage or hay, but with some pasture is better.
9. If a summer frost kills the Shirohie or Nutrifeed, the Pasja and chicory will still be there will do better with the reduced competition.
10. When the Shirohie or Nutrifeed stop growing in early autumn, the others will continue growing.
11. If autumn rains are late and pasture is limited, the Pasja and Puna chicory will continue growing, but not as well as with ample moisture.
12. There are no bulbs to worry about the rare possibility of choking.
13. Animals are not eating soil, as occurs with turnips, and there is less dust or mud after rain.
14. A surplus can be made into silage once mature and after wilting (this mix has extremely high moisture levels). They can be difficult to compact, so vacuumise them for best quality silage. See Silage. There are better crops for silage, so this suggestion is only for any surplus not grazed.
15. Pasture seeds can be drilled in after autumn rain without cultivating, however grazing must be frequent, to prevent the Pasja and plantain from swamping the new pasture.
16. There is no lost time before grazing again in autumn.
17. No cultivation means that there is no soil moisture loss from cultivating.

Shirohie millet developed in Australia is a lot better than ordinary Japanese millet.

The last three points don't apply to peat soils, because they should be chisel ploughed three times again to make the cultivated soil deeper, so it will last longer before having to cultivate and resow it again. If the mineral soil was not cultivated deeply enough to bring up 50% subsoil, chisel plough it again, but don't make the top fluffy. It may be necessary to remove some tynes to go deeper.

Apply 3,000 kg of lime or LimeMag per hectare before sowing and harrow it in. Deficient trace elements should be with the Gafsa.

This photo shows metre high Nutrifeed and Pasja 18 days since the last grazing. Dairy farmers Brendan and Tania Fernyhough are squatting.



They sowed it on 28 November. The first grazing was on December 28, then January 22 (25 days because of cool dry weather), then February 10 and 18 day rounds on the 28th, then on 18th March, giving five grazings.

The yield was 13,000 kg per ha at a cost of NZ 30 cents per kg of dry matter, including the land value for 22 weeks.

Brendan can't speak highly enough about the crop and the way the cows have milked on it. "It is obviously a much better summer feed than maize," he said.

The soil is rolling, low fertility volcanic with almost no earthworms from not having had enough lime for 50 years. They plan to grow 12 ha next summer and grow less maize. Brendan can't speak highly enough about the crop and the way the cows milked on it. "It is obviously a much better summer feed than pasture and maize," he said.

Spread the sowing over about 16 days or longer to prevent the crop getting too long before grazing the last break. The paddocks are best semi-permanently fenced with polywire and spring gates into 16 blocks off lanes.

As always, feed the best soluble mineral mix through the water. If you don't, cobalt, sodium and iodine deficiencies can occur. Lambs won't grow and finish on cobalt deficient feed. Lamb growth rates on Pasja in the Manawatu, NZ, averaged only 162 grams per day when 300 is possible, due to a lack of humus which retains cobalt, and it not being applied with the fertiliser.



Pasja

This is a highly palatable early maturing turnip-rape hybrid, with a high percentage of leaf, and a very small bulb, that is well anchored to the ground for repeated grazing without pulling out. If on its own, sow it at 1 kg per ha or 2 kg if broadcast. With millets, yields vary from 8,000 to 15,000 kg DM per ha. ME is 12, crude protein about 20%, with 90% digestibility. It is so palatable that animals, once they know they are going to it, run to it. Cows milk well on it, dropping by two litre a day without it and increasing by two when on it again. Deer fawns in two trials grew about 50% faster on Pasja than controls on pasture, over a six-week period in late summer. Hinds gained weight in summer while the controls on pasture lost weight.

Sow it any time from spring to early autumn, as long as rain is assured. The higher rate is when broadcast, and when weeds are likely.

A light grazing can start as early as 25 days after sowing if necessary. If more than one grazing is required, don't leave it too long before the first grazing and don't allow the crowns to be damaged. It can then be re-grazed up to five times about two to three weeks apart. Don't graze it to below 15 cm (6"). Graze it for a short time to reduce hoof damage, so fence off one day's requirement that animals can eat in two hours. It must be back-fenced to allow regrowth. Don't allow animals to walk over the previously grazed areas.

Never allow Pasja to flower because the nitrate levels increase to dangerous levels when it is in the reproductive stage. If grazed correctly, flowering will not occur; however, early spring sown Pasja can shoot to flower and seed quickly, if a cold spell makes it think that winter has arrived. Graze it immediately, even if the feed is not required. Nitrate levels are higher in the mornings after cloudy days, so graze all suspect species at the end of the day. Pasja, being a brassica, is a milk-tainting crop, so graze it after milkings, and not just before milkings.

An advantage of repeated grazing crops like Pasja and Shirohie shown below is that weeds are grazed, rather than take over and seed. If weeds or insects are a problem, graze the crop early to knock them, especially the weed *Amaranthus* (Red shank), which has highly toxic nitrate levels, more so in the mornings and when molybdenum is low. Measure the pasture Ca levels before cultivating, and if necessary apply lime to increase molybdenum. See Calcium and Earthworms for more information on when lime is required. Grazing must be soon enough to stop the Shirohie or Nutrifeed

from swamping the Pasja as Shirohie did on page 16.

There is plenty of evidence of mixed species doing better overall than either species on its own, even with prairie grass and ryegrass. Another example is that autumn sown brassicas and a winter ryegrass produce more than either on its own. Lucerne tolerates some insects better when with grass, than when on its own, and perennial ryegrass and clover pastures produce more dry matter and milk in cool weather when a winter (Italian) ryegrass is included, or oversown each autumn, except in snow covered areas.

As with all brassicas, Pasja is a very high feed-value crop which ruminants are not quite comfortable with on its own, so, if not in a mix with millets, feed at least 25% pasture, silage, hay or straw with it. See below. Perennial ryegrass straw (after seed is harvested) fed with Pasja increased lamb weight gains. Possibly barley straw could do the same, however, in practice Pasja is usually fed during dry summers, when there can be dry pasture available to achieve the same effect.

The analysis of Pasja Leafy turnip from PGG Wrightson Seeds is -

% DM	12.9
% Crude Protein	17.2
ME (MJME/kgDM)	13.1

Brassicas

Some NZ farmers have believed that milking cows grazing turnips produce well, but lose weight. They certainly produce more milk than when fed grass type crops, and do get thinner, however, Ruakura April 1995 information showed that cows lose no more condition when grazing turnips than when not being fed turnips and on insufficient pasture.

Brassicas (turnips, swedes, rape, kale, giant stem kale, Pasja, Chou-moellier) on their own should not exceed 75% of the total diet, which, if pasture is available, can be 12 kg, and 4 kg of pasture, but, where enough pasture is available, feeding only 4 kg of DM per cow per day of brassicas is more profitable. More than that is a bit wasteful in digestion, and milk production, and cow condition.

Choosing the best brassica for your farm and stock can make the difference between profiting from the crop or not. Before deciding on the one to use in your area, do as much research as possible from all quarters, such as neighbours seed suppliers, consultants, research centres, veterinarians, etc. Ask about the possible yield, feed value, animal growth, animal health problems and growing techniques.

In wet soils (winter in Mediterranean climates) sow a brassica at three quarter rates and add 12 kg per ha of a winter ryegrass, to reduce mud problems and give more, and more balanced, feed.

Health

All brassicas are low in iodine, with kale being the lowest, so with its other problems it is not recommended. Supplementing animals with iodine when feeding a large percentage of brassicas is essential for optimum conception rates and animal health. A good soluble mineral mix through the drinking water is the easiest way. Fertilising with iodine is not economical because it costs \$40,000 per tonne and leaches, but for a brassica crop is better than nothing. Spraying it on the crop can be done. Discuss it with your vet or one who knows about the problem.

Brassicas are also low in Cu with levels between 4 and 6 ppm which is okay for sheep, but not cattle, which need 13 ppm or higher. In a typical summer dry period, when a high percentage of brassicas are being fed, and zinc (which depresses Cu) is being supplemented against facial eczema, a good soluble mineral mix is important, and solves many problems some suffer when not feeding one.

Farmers who grow Barkant turnips (12,000 kg per ha) or Pasja (13,000 kg per ha) and have successful crops and grow them annually, especially Pasja, because it can be grazed up to five times, and well into autumn, after which it stops growing.

If you have a brassica crop and silage, feed both together, because too high a percentage of brassica can cause animal health problems such as excess sulphur and insufficient roughage. Grass forage crops (Shirohie, Nutrifed, etc.) with Pasja reduce problems and give a more balanced diet.

Some animals, unaccustomed to brassicas, can take longer to accept them, while others eat too much. If desperate to get animals to eat them, try spraying soluble mineral mix over some for the non-eaters. Leaving them on it for longer also helps, but I've seen a cow on turnips stand at the back of the break and not eat a thing, even after being on them for months and being hungry.

Graze all brassicas and chicories soon after milking, never just before, to avoid tainting the milk.

They are not affected by frosts, except to slow their growth. It is best to graze them after a frost has thawed, or after the afternoon milking.

Artificial nitrogen may be necessary, unless the soil is highly fertile from having animal manure spread on it, or having been wintered on, with hay or silage fed out on the paddock. The nitrogen is best spread about three weeks after sowing, or as soon as nitrogen deficiency symptoms (yellowing and slow growth) show.

Chou-moellier (*Brassica oleracea* var. *acephala*)

Sow at 4 to 5 kg per ha (lb per a) to ensure that the stems don't get too thick to eat. It is a very large slow growing thick-stemmed brassica, best suited to winter grazing because it is very slow maturing, but keeps growing into winter. In well-cultivated fertile soils it can grow to 2.1 m (8') high with 10 cm (4") diameter stems, so can then be difficult to feed by grazing. Being tall reduces the bad effects of frosts. This is the highest yielding brassica. We stopped growing it because after we got drainage right and fertility improved pastures grew more in winter than in summer, and with improved fertility the stems became too thick for cattle to eat. We continued growing summer forage crops.



At the stage of growth in the photo it is not a high milk or meat producer, but is a good supplement to good grass and clover pasture, and for dry cows and beef, as long as minerals including iodine (I) are supplied, and some other feed is fed with it. Grass and clover pasture is best to provide protein, or pasture silage, alfalfa (lucerne) hay, or pasture hay.

Barley straw, if really cheap, can help avoid the excess of brassica problems, however good hay, even if quite a bit dearer, will produce more milk. Check their qualities and feed values.

Some farmers in Southland, NZ, where winter pasture growth is minimal, grow Chou for yields of 12 tonnes per ha or more for beef cattle and dry dairy cows. This practice saves conserving so much winter hay and silage, saves damaging pastures, and is part of their renewing pasture programme. Because the animals graze it, there are no tractor and labour costs of hauling feed around in muddy, cold conditions. Animals can tolerate cold as long as there is reasonable shelter and minerals (especially salt and magnesium) are provided with ample feed. Being bunched up for grazing crops keeps them a bit warmer. In winter graze on the sunny side of tall crops.

High-power fencing allows the fence to be moved forward half a metre at a time to allow the cows to reach under and over for the Chou. Watch for shock-timid cows that won't go near the electric fence. They may have to have some Chou thrown over the fence to them, or be put in a square block at one end, or you can roll the crop before moving the fence in over it. See Feeding.

If insufficient lime is applied, and the pasture tissue molybdenum content is too low, Chou can contain excessive nitrate levels that can kill stock, and may require iodine to be fed to prevent goitre. It is tall growing, so well suited to snow areas.

With all brassicas, change animals to them gradually, or redwater can occur.

If grazing summer brassica forage crops, ensure that animals are changed to and from them gradually over two weeks, and that the percentage of brassicas doesn't exceed 75% of the total diet. a Maximum of 50% is better.

The green crops grown under these names are both members of the kale family; Chou-moellier is known in England as marrow-stemmed kale, and there is giant stem kale. The crop grown as kale in

New Zealand is known in England as thousand-headed kale. Stock relish the stems of chou-moellier, but it tends to drop its leaves during winter. Kale, while having a fibrous, unpalatable stem, is more hardy, and carries its leaves well throughout the winter.

Kale

This is grown mostly in Southland and Otago mainly for winter feeding. Crops of chou-moellier and kale that are not needed for late-autumn feeding can be reserved for use in winter. Crops lightly grazed in early summer will recover to provide winter feed. Kale and chou-moellier crops are more resistant than other brassica crops to Clubroot and dry rot, and are not so subject to insect attack, although I have seen a neighbour's chou-moellier crop eaten severely by white cabbage butterfly caterpillars, because the crop was sown into rotary hoed soil (shallow cultivation) without enough lime or fertiliser.



Heavy crops of Chou-moellier are best cut and fed out as required, though less labour is needed if the cut crop is left to be eaten where it falls, and the standing portion protected by an electric fence. If it is intended to feed the crop in breaks, fencing is made easier if swedes are drilled in the lines where the fences will later be placed

Rape

Sow at 5 kg per ha (5 lb per a) and graze within 3 to 4 months. This Titan Forage Rape was sown at only 4 kg per hectare, so the stems were too thick to eat. 5 kg would be better. This crop grazing on a more fertile soil than the Nutrifeed and Pasja above, didn't yield as much and was sown earlier.

I would not grow this because of its toxicity problems. Some cultivars (varieties) may be safer, but other brassicas such as Pasja and Barkant turnips achieve what is required without worry. Wairoa is a grazing rape that yields more than Pasja in dry conditions, but has high nitrates until mature, which takes time and plenty of sunshine, so it should not be grazed until mature, when it is also more palatable. In field trials Bonnar rape has produced higher animal performance than some varieties because of its palatability.

Maximum profits from grazing relate to palatability, so crops and pastures should be selected for this quality, provided no yield or other negatives don't override the palatability benefit.

Mixed Pasja with Nutrifeed in warm areas and Shirohie in cooler areas, is even more palatable without the risks, but always be careful of nitrates and avoid back grazing of yellow regrowth. An advantage of this mix is that being half grass type it takes less time for animals to adjust to it.

Swedes

Sow at 1.5 kg per ha (1.5 lb per a). Graze within 5 to 6 months. They grow and mature very slowly, but keep growing for longer and yield more, so are better when summer sown for grazing in winter. As with turnips, there are big variations in the yields, so check every detail before sowing. One variety in New Zealand had 10% protein in the bulb which is the main part of the swede, while another on the same farm had only 6%. Hoggets gained 100 grams a day on one, and only 40 on another, on two trials over two years. The high weight-gain swede had more leaves that have 20% protein and ME 10. Check the varieties available.

Turnips

We, and some of my best and most profitable Waikato dairy farmer clients grew the best variety of turnips for decades to reduce the summer milk slump, with less endophyte toxicity and less facial eczema, but the new Pasja has changed that, so I now recommend growing it with 12 kg per hectare of Shirohie or Nutrifeed and the best Chicory and the best Plantain both at 0.5 kg per hectare, which

is 25 seeds per m².

Good turnips can yield 12 tonnes DM per ha for grazing, shown here on Paul McDonald's 700 cow two metre deep peat Waikato dairy farm three months after sowing, which is as much as poor pasture can produce in a year; green-feed maize can yield 30 tonnes per ha of DM in six months, which is as much as some pasture can yield in two years, but both must be correctly limed, fertilised cultivated and sown to achieve this. See Cultivation. There are a few weeds in this crop, which can be a problem with turnips, but not with Pasja and grass crops because of the earlier and frequent grazing.

Sow most turnips at 1.8 kg per ha (1.6lb per a), Appin at 2 kg (1.8lb per a). Sow at least three hectares (7.5 acres) per 100 cows, depending on the region and the other feed available. Graze after 8 to 12 weeks.

Barkant is a fast growing palatable turnip developed for grazing, so has about a third of the bulb above ground level to make it easy for animals to pull out. Barkant is from Holland and has been grown in New Zealand since about 1986. In that time they have superseded the old York Globe as the most popular. Yields are between 6 and 15 tonnes DM per ha. Digestibility is 90%, ME is 13. In 1993 about 8,000 hectares of Barkant were sown in New Zealand. In 1994 it shot up to 20,000 ha.



Sowing should be staggered from early October to mid November, to avoid over maturity, but if planted too late they may not get enough rain to grow properly.

Barkant turnips are the best for summer and autumn use, Appin for late autumn, and Green Globe for early winter. Appin has more leaves and can give a second or third grazing if grazed lightly.

With turnips the area can be divided into the number of days required for the turnips to last, say, 60 days, from mid-January to mid-March, and then a sixtieth of the area grazed each day.

Turnips planted more thickly can give a higher yield and be eaten more easily by the grazing animals than fewer larger turnips. If sown so thickly there can be egg to tennis ball size bulbs, increasing the possibility of choking, although I have never known anyone have a case of animals choking.

Green Globe

Sow at 1.8 kg per ha (1.6lb per a). Graze after 3 to 4 months.

It is a slower maturing and longer lasting turnip that keeps longer into autumn and winter, so sow it if needed then.

Appin yields less, but grows many leaves, and can be planted at 2 kg per ha (1.8lb per a) for still more leaf. If not grazed too hard, it can be grazed three times (60, 90 and 120 days), chewing it out completely the last time. If planning to graze three times, graze early and lightly the first times.

Grass Type Crops

Winter feed annual Italian or winter ryegrass such as Tabu can be sown at 10 kg per ha with a brassica at one kg to give variety, reduce brassica problems, give regrowth for feed later from the ryegrass and to reduce dust and or mud.

Shirohie and Nutrifeed

The dense root systems of grass type forage crops leave a lot of organic matter in the soil which is beneficial for mixed pastures, however they take a lot of nitrogen out of the soil, so the new pasture will need light dressings of N after starting to go yellow until the clovers are making it.

They must not be sown until there is no danger of frosts, which can kill them. In the cooler parts of the Waikato frosts can occur at any time, even in mid summer, so growing Pasja with them is an insurance to prevent a total loss of crop. However, if they do suffer a frost (the cooler and low parts of the Waikato can get frosts even in mid summer), mow off the frosted material immediately, and

they may recover.

They are best grazed four weeks after sowing to start them tillering. They grow much faster after the first grazing, and later in the summer when warmer. If repeated grazings are required, don't allow them to get taller than 60 cm (24") before grazing. If left longer the stock will trample them down rather than graze them, which can kill them.

They must **never** be grazed lower than 10 cm (4") from the ground, to prevent chewing out the base, which will reduce regrowth. Overgrazing, trampling and under-grazing all halve subsequent growth rates. Grazing too short will also pull some plants out.

The easiest way to get about six grazings with a minimum of work is to fence the area into 16 paddocks off lanes in each paddock with a single electrified wire and spring gates.

Prior to regressing, remove the temporary fences and put the stock on it for an hour each day. They love it so will eat the stems to the ground making cultivation easier. Don't leave animals on for too long on any one day, because growth or milk production will suffer and nitrate intake from the stems could be dangerous.

The shading given by Shirohie or Nutrifeed leaves the soil more moist than after maize or brassicas, and cultivation is easier than after maize with its stems and coarse roots, and than after brassicas which leave no roots and a very dry soil through lack of cover after grazing, so the soil can go to powder. The grazing of millet returns animal manure, so combined with the root mass gives more organic matter and better new pasture than after a harvested crop, or after maize and brassicas which don't have a fine root mass. Maize roots and stems are fibrous and take time to decompose.

Trials comparing Shirohie millet with Nutrifeed, a semitropical summer-annual, late-flowering with high-leaf-content and doesn't contain Prussic Acid. It can produce more than millet in warmer areas. Nutrifeed is slower growing in cool weather, but faster in warm weather when it can grow at nearly double the rate of the Shirohie and continue growing for much longer, without going to seed which Shirohie does from early March.

Nutrifeed is a late flowering Pennisetum (Pearl Millet) hybrid that does not contain Prussic Acid. This means it can be grazed at lower plant heights (30 cm). However, for best results graze at approximately 50 cm. This will allow plants to tiller, maximising protein and energy content, boosting animal productivity. It needs warm soils and conditions so don't sow Nutrifeed until the soil temperature is up to at least 18 degrees C at 7 cm and rising.

If on its own, sow Nutrifeed at 15 kg per hectare.

Nutrifeed has been grown on 1,000 farms in New Zealand's North Island and found to be an excellent milk producer.

Later sown crops can grow much better than those sown too early in cold weather.

Its late sowing requirement means that cultivation is easier in less wet conditions, however don't waste moisture, it is "money" in summer, so chisel plough on one day and sow the next. This form of cultivating will mean that you needn't start doing it until planting time, which gives you more use of the paddock in spring, when with spring calving, pasture can be needed. Also, doing it all in one or two days reduces evaporation and reduces weed germination. Do your own trial to convince yourself by cultivating and sowing one area within two days, and compare with cultivating an adjacent area for two weeks, then sowing it.

Seeds should be buried only deep enough to make contact with moisture, but must be in a firm seedbed, something impossible if the soil is over-cultivated and/or allowed to dry out. In many cases better germination is seen in wheel marks which is a sure sign of inadequate rolling.

Nutrifeed does well on most soils, but not on poor light soils that dry out.

A good Nutrifeed crop's total yield can be 15 tonnes per ha (6.6 t per a), with a higher feed value than maize and easier to establish, with no duck or cutworm problems and can be planted later.

It doesn't suffer the failures of brassicas (spring tails, heavy rain beating seedlings into the ground) or failures of maize (ducks, cutworms, and wet feet), has no prussic acid as contained in sorghums, and is easy to graze. It doesn't discourage earthworms like the prussic acid sorghums do. See Sorghum.

It allows early regressing compared to maize, which is important, especially if a fescue is to be sown. Plan for Nutrifeed finishing by mid March. If you believe feed will be required after this, keep some to strip graze, or grow some maize for feeding later.

Nutrifeed silage, unless mature and pre-wilted, has a very high moisture content, and to make it into hay can require 10 good drying days, so neither is recommended.

Some growers miss the full benefit of Nutrifeed, which is achieved by subdividing and rotationally grazing it like pasture, and grazing the leaves, which grow under two week rotations, not the stems that develop under longer rotations. Start grazing four to five weeks after sowing, irrespective of its length. It is best grazed at 60 cm, but the first grazing may be shorter if the weather is dry and cool. If further grazings are required, don't allow it to get longer than 60 cm before grazing. It must not be eaten to below 15 cm from the ground, to prevent grazing out the base, which will reduce the regrowth. Don't leave stock on for too long, because excessive trampling reduces subsequent yields, and back grazing the short stubble which is higher in nitrates can cause animal health problems, especially if molybdenum is low.

Nutrifeed keeps cows milking, and in good condition for winter which is important in dry autumns.

Those who followed the Nutrifeed instructions correctly, i.e., spraying out flat weeds, especially *Amaranthus* which is extremely high in nitrates, grazing it after four to six weeks and then every two weeks and lightly to about 12 cm, were very happy with it.

Those who tried mowing it to achieve the 12 cm level, found mowing of no benefit, because it was hard to control the mowing height, the animals didn't pick up all the mown Nutrifeed, and the tractor wheels killed some, so wastage was higher than when grazing.

Happy Users of Nutrifeed

It is a warm weather (no cold nights) summer forage crop. If you get cold nights in mid summer, grow Shirohie millet with Pasja. If you get summer frosts, grow Barkant turnips.

Most users are absolutely delighted with its ease of sowing, speed of growth, especially into autumn, and its milk producing ability.

One farmer at Kaihere, Central Waikato, who ran out of Nutrifeed had the fat test drop 0.2, and then go up 0.2 after starting Nutrifeed again. The value of this drop is 10 cents per cow per day, or \$3 per cow per month.

A farmer at Paterangi who stopped feeding it for a while had his cows drop 4 litres a day, which is 80 cents per cow per day, or \$24 per cow per month.

A farmer at Walton was feeding silage, then started grazing Nutrifeed, and the milk went up.

Some are saying that in 30 years of farming they've never known a summer crop to increase milk as much as Nutrifeed has.

In 1990 there were nitrate toxicity problems in a Shirohie crops when the *Amaranthus* (red root) content was high. The same farmer grew Nutrifeed and had no nitrate toxicity, although there was some *Amaranthus* in one of his Nutrifeed paddocks.

I've seen Nutrifeed improve mediocre under-fed calves very quickly after feeding it.

Unhappy Users of Nutrifeed

A few of the thousand farmers who grow Nutrifeed annually in New Zealand have been a bit unhappy with it sometimes. Those I checked had low calcium levels and some also had low molybdenum levels (also through insufficient lime). Both elements are essential for growth and are buffers against nitrate toxicity.

Most South Auckland farmers acknowledge that the 2008/9 season was a bad one for all summer crops, especially late planted ones. Virtually no rain in December and none until late January is rare in the Waikato. As a result there were also very poor maize crops. Farms in cold areas also had poor Nutrifeed crops. It was developed in Queensland, Australia, so needs warmth.

Surpluses of Millet or Nutrifeed

If making millet or Nutrifeed into silage it must be mature and must be wilted or the silage will be a useless slimy mess. They need no additives, but repeat, do need wilting (unless harvested very late in life), and need packing down well. Wilting and then vacuumising are best because it sucks surplus moisture out. See Silage.

Maize is chopped fine in USA to blow it up into tower silos and in New Zealand to cut the kernels so that animals can digest it, however, if it is harvested before the kernels get too dry, and also cut long (7 cm or more), the animals will be able to regurgitate and chew it several times, so cutting short would not be necessary. If cut too short the animals can't regurgitate it, which means that it is not well digested and ruminants are then more prone to digestive problems.

Sorghums

This fast growing hybrid increased in popularity rapidly after its release in the 60s, then declined because of its danger and because better and safe grass crops were available and more were developed later.

They are still grown by some, but are a dangerous stock feed. Grazing them too soon, or after a frost or rain in a drought, or when stressed, can make sorghums lethally toxic. They also become very unpalatable in cool weather. On a farm, I saw earthworms in the soil under sorghums affected by the cyanide (prussic acid) in them. They were sluggish, looked sick and stopped breeding. The farmer near Paeroa, Waikato, never grew sorghum again.

I don't recommend sorghums because they can be so treacherous and farming has enough problems without buying any. However, a few warnings may be of use for those who do grow them in arid areas where they grow better than some others.

Nitrate accumulation is a problem with short (immature) and even long sorghum, especially if over-fertilised with N. Even when cut for hay, nitrates can be a problem, not the cyanide which dissipates during drying and is minimal in sorghum hay over half a metre tall, unless stressed. Some sorghum hay can contain from 3% to 6% nitrate which can kill cows in a couple hours. Samples should be tested for nitrate levels.

If high nitrate sorghum is made into hay or silage, it will remain toxic. In hay it takes a lot for drying to lower it. See Animal Health, Toxins, Nitrates.

Prussic acid (cyanide) toxicity is also a problem of some sorghums such as Sudan grass. It occurs when grazed before they are tall enough (shorter than 60 cm or 20"), after frost or even cold nights, heat or drought stress (wilting), herbicide spraying or trampling, after which they become high in cyanide.

When made into silage the cyanide remains, but most of it evaporates when fed out.

Cyanide symptoms can occur within ten minutes and deaths within an hour. Symptoms include anxiety, restlessness, groaning, convulsions. The blood is bright red, whereas with nitrate toxicity it is brown through lack of oxygen.

Levels of both nitrates and cyanide can vary across a paddock so you must test all the different areas such as low flats, northern and southern slopes.

Never let horses graze dangerous sorghums or they can be killed very quickly.

If you do grow any of the toxic sorghums (Nutrifeed, Shirohie and maize are not sorghums) check the earthworm population. I have noticed when digging in soil under some sorghums that the earthworms were adversely affected and had not bred at all. Symptoms were un-natural greeny blue sluggish earthworms and no small ones because they had not bred.

The solution is to grow other crops which are safe. However, some will no doubt still grow sorghums, so to avoid cyanide and nitrate poisoning -

- Don't graze (or 'feed', in all references below) until over 50 cm (20") high and don't allow it to exceed 1,300 mm (52") in height.
- Don't graze it to shorter than 200 mm (8").
- Don't graze it with hungry animals. Ensure they already have enough (the more the better) feed

in the rumen to dilute it. Legumes are best at this.

- Don't graze it for at least a week after it is frosted.
- Graze in the afternoon (after 4 pm if possible) when nitrate levels on a sunny day can be half the 9 am levels.
- Limit the sorghum initially to about ten minutes. If animals ever walk around indicating that they don't like it, remove them until it is less toxic.
- Don't graze it when drought affected (stunted or wilted). Wait for fresh mature growth.
- Prevent back-grazing of new short growth, it can be extremely dangerous.
- Provide DeLaval Feedtech soluble minerals in the drinking water because it has ample sulphur (S).
- Sorghums have to be grazed and/or harvested when mature, and before a frost which will kill them and/or make them toxic.
- Keep nitrogen fertilising to a minimum.
- Ensure fertilising is correct with adequate lime.
- Always feed it with care.

Even if animals are not killed, livers and other organs can be damaged, so preferably grow safe crops such as Shirohie, Nutrifeed and brassicas. However, an excess of any crop can cause problems, because they are not as balanced as pastures.

Triticale

This is a wheat/rye hybrid which can be grazed and harvested for grain. Seeing we are primarily grazers, we are more concerned with grazing than harvesting grain, but if you feel it is the best for you then try some.

Oats

In winter and in cool areas where millets can be frost damaged, oats and/or wheat can be useful.

Oats can produce 5,000 kg DM per ha grazable in about 3 months from sowing. Sow at 125 kg per ha and drill or harrow in to about 7 cm to avoid bird damage. If it is dry, large seed such as oats is less affected about dryness than small seeds like brassicas.

Beware of nitrate toxicity accentuated by too much artificial N. Grazing in the afternoon reduces the risk.

Wheat

Grazing grain wheat can give feed, but bad weather can reduce the normal grazing period, and grain yields can be reduced substantially every day wheat is grazed beyond the first hollow stem growth stage. Yield losses can be much greater than the value of the grazing. To identify this critical stage, cut stems just above the roots and split them open. If the growing point [rolled leaves and leaf sheathes] is just above the roots, then jointing has not begun. However, if even 6 mm (0.25") of hollow stem shows between the roots and the growing point, then stock should be removed immediately.

The first hollow stem stage varies each year and by variety. Do the test on ungrazed plants.

Wheat is not a profitable crop to sow just for grazing, but when it is autumn sown for grain, grazing it a few times before harvesting for grain is profitable. Its tissue analysis shows that it is not a good feed, so if grazed solely for a long period, extra mineral supplements would be necessary.

Grazing it with milking cows within a few hours of milking can taint their milk.

Other Plants

Over the years various plants have been promoted as wonderful forage-crops. One of these is Comfrey (*symphytum officinale*), but be careful. It is a fast-growing plant with a vigorous root system and large, coarse leaves. It has been promoted as a high-yielding forage-crop, but few

mention that it has several pyrrolizidine alkaloids, some of which can cause liver damage. They are in all parts of the plant, including the roots that some herbalists recommend for Comfrey tea. Some of these alkaloids are similar to the alkaloids in ragwort (*Senecio jacobaea*) that is toxic to cattle, but not so much to sheep unless in large quantities.

Soy herbage can have a molybdenum level of 20 ppm, going by a sample I got measured for a Wisconsin farmer. Sulphur and copper were at normal levels, so were not high enough to counter the bad effects of extremely high molybdenum.

Search for “Toxic plants”+”your area” on the Net for others in your area.

Annual clovers, chicory and/or plantain that can be grown with some forage crops

Berseem Clover (*Trifolium alexandrinum* L) 400,000 seeds per kg equals 40 per m².

Commonly called Egyptian Clover, it is a fast growing, 60 cm (24”) deep rooting, erect-growing temperate winter annual legume originating in the Mediterranean region, and yielding up to 17 tonnes per ha (7.75 t per a) with multiple mowings or grazings at four week intervals on deep alluvial soils. It has oblong, slightly hairy leaflets without a watermark. Its thick stems are hollow and flowers are yellowish white. It looks a little like lucerne, but has a white flower.

One kg per hectare (2 lb per acre) gives 40 seeds per square metre. Why sow more?

It can be added to mixes at 1 kg per ha in autumn where winters are mild, or in spring, to give clover as well as nitrogen fixation. It establishes so quickly that it can suppress grasses. Inoculate the seed.

Most animals prefer grazing it to lucerne, and will grazing Berseem to the ground before eating lucerne and cows produce 10% more milk from Berseem than from lucerne. It has a large number of big nodules and can produce up to 400 kg per ha of nitrogen, but less in high N soils or when N is applied.

Preferred Conditions

Berseem prefers light loam soils and pHs between 5 and 7, and doesn’t grow as well on tight clays or loose sandy soils. Its long root system enables it to withstand droughts reasonably well, but it grows better in cool weather and stops in hot weather. It does not withstand extreme heat or cold and should not be grown where winter temperatures go down to 5 degrees C (40 F). It has masses of nodules.

Sowing and Management

Berseem grows well with winter annual ryegrasses and other crops. Aim to cover it with 1 cm of soil and roll to achieve good soil contact. Berseem can, however, germinate from deeper than white perennial clovers.

It tolerates close grazing and stools well after a first grazing at 20 cm (8”). Fertilising should be similar to lucerne. In low phosphorus areas 70 kg of P per ha could be required. It doesn’t re-establish, so requires annual sowing.

Bloat is not severe with Berseem.

If mowing, cut at 7 cm from the ground.

Cultivars - Bigbee and Multicut vary in attributes depending on their source (USA or Australia). Inoculation is essential with the appropriate inoculant for Berseem.

See Establishing Pastures After Crops.

Adding 0.25 kg per ha of the best plantain most suited to your farm, adds variety, which animals like, and increases the mineral content. The chicory will be less of the total in the beginning, but more in the later grazings.

Tonic plantain

This Tonic was the only green I saw in pastures during a two hour drive around the Waikato in late March in the 2008 drought.



Measuring crop weights

Knowing how much crop you are feeding is important. It is no good finding out after the milk drops that you were not feeding enough, or after redwater tells you that you were feeding too much.

The PastureGauge was developed and programmed for pasture, so is not accurate on crops, but can be used and corrected by a percentage which is calculated by cutting, drying and weighing an average square metre, after having measured it with a PastureGauge. A plate meter will not work. If a PastureGauge is not available, then the measuring of pasture and crop yields can be done by harvesting a square metre and weighing it when dry. To make a square metre measure, take four metres (160 inches) of 4 mm (8 gauge) wire and make a square by forming a right angle at each metre (40").

Most forage crops have about 90% water, so you can also use that to calculate dry matter more quickly.

If measuring a root crop, clean off all the soil before weighing. Weigh the amount in a square metre, then take a tenth by weight to dry until it stops losing weight, then divide the dry weight by the wet weight and press %, e.g., 5 divided by 50 equals 10% DM. To get the DM weight per hectare, multiply the wet weight of 1 m² by 10,000 (10,000 square metres in a hectare, or 4,000 m² in an acre).

Drying can be by leaving in the sun, placing in an oven at about 80° C (180° F) for 12 hours with the fan going (if it has one), or in a microwave in short 2 or 3 minute bursts on high, then a few times at the lowest setting (defrost) to avoid charring. Drying is complete when weight loss stops.

Feeding grazed crops

No mechanical machine can turn plants into blood, milk, meat, hair or wool, energy or even fat to be stored by humans for when required. Plants extract minerals from soils while most surpluses and toxins are discarded. However, animal stomachs need a week to adapt from pastures to grass type crops such as oats, millets, Nutrifeed, maize, etc., but two weeks to change to brassicas.

When Westerners go to Asia or Asians go to Western countries, the same gradual food change has to occur, or digestion can be upset quite severely.

To minimise waste, the first area to be grazed needs to be long and narrow, not in a square block as is best for pasture. To achieve this the temporary fence may have to be set up in a U shape to allow the animals to go left and right from the entrance.

The first break has to be large enough to allow all animals to get in, so has to be a larger than normally fed area, but leave them on for only ten minutes on the first day. They can have the same break on the second day, then move the fence in a little each day. There will be more wastage in the first few days.

A problem with grazing forage crops is that if cows go straight from milking to the crop, the first get more than the last. The best is to let them go to a paddock of pasture and then take them all together to the crop.

DON'T leave them standing in the lane wasting manure and getting hungry or in a sacrifice area getting hungry. Doing so will make them more hungry so they will eat faster, and will be more inclined to blow on the crop, because fast eating takes down less saliva so digestion will be upset.

It is best, but not always possible, to have crops supply no more than 70% of the total and with brassicas no more than 1% of their live body weight. Grass type crops (millets, maize, etc.) are less of a problem in this respect and mixed crops of grass type and brassicas are seldom a problem.

If the paddock has to last 20 days, then give them a twentieth each day.

Change Slowly

Brassicas in particular should be started well before getting short of feed.

A sudden change, especially to brassicas, can kill animals, and to avoid scouring and production drop, the rumen micro flora for digesting crops have to change and increase in numbers. As with all changes in diet, break the animals to it gradually by starting with only ten minutes on the first day. Always make the feed change on to and off crops over **10 to 14 days** to avoid scouring and milk production drop. The rumen micro flora for digesting crops have to change and increase in numbers. A sudden change, especially to brassicas, can kill animals.

To minimise waste the area to be grazed needs to be long and narrow, not in a square block as is best for pasture. To achieve this the temporary fence may have to be set up in a U shape to allow the animals to go left and right from the gate and then to the back down each side. The first break has to be large enough to allow all animals to get in, so has to be a larger than normally fed area. This is another reason for only allowing them ten minutes the first day. They can have the same break on the second day, then move the fence in a little each day. If the paddock has to last 20 days, then give them a twentieth each day.

When cows are being fed a crop behind an electric fence (strip grazed) they need not be locked in the paddock, unless they are to remain there until the next milking. If they are to move to another paddock with pasture in it after they have finished their crop, the gate out of the crop and into the pasture can be left open, and they will soon learn to find their own way. I have seen a herd of cows do this, even when they had to come right back up to a gate next to the milking yard to get into the new pasture, soon after milking. Normally cows would not come back up to the yard just after having been milked, but these were trained to find an open gate after the crop, so walked up the lane looking for an open gate, which happened to be right next to the milking shed.

Many animals have a lot more intelligence than some people, but the animals' intelligence can be used if they are allowed to.

To train animals new to the crop, the gate may have to be closed for the first week or two.

Waste

There are times when strip grazing is not the best.

A farmer in Oregon State requested a visit when I was in the area, because he was strip grazing a tall crop and the sheep were trampling most, eating only a little and losing weight. I suggested allowing them access to the whole crop from after midday, which surprised him, but he did it with excellent results. They made paths through the tall crop and ate leaves at head height, put on weight, wasted less. They were taken off with a good dog each afternoon for water and to lie down on pasture.

DON'T use this system until the animals have been well adapted to the crop, which is after about three weeks, and check all animals daily as they enter and leave the crop (you'll need a good dog to get them off), because some may not eat much for the first week or two, then eat too much. If you don't have a dog, then give the animals very narrow breaks and move the fence metre by metre.

Use a high-powered Gallagher type energizer, or you could get break-ins and problems. It is a good idea to put up the fence for the next day, so that if one or more do get through, the next fence stops them. Doing this takes no more time and could save a lot, especially in the beginning.

Another way is to give a narrow break so they keep facing forward, and then if necessary move the fence several times a day.

Taints in milk & meat

To avoid tainting the milk, feed all brassicas and tainting feeds just after milking, never a few hours before. Land Cress growing on the lane and eaten by just a few cows on the way to milking can cause all the milk to be downgraded. It causes a musty flavour in dairy products.

Meat can also be tainted, so avoid feeding brassicas, pastures with tainting weeds such as Land Cress and Pennyroyal, wheat, seaweed products, flax oils, or other tainting feeds to animals for several weeks before slaughter. The taint problem depends on the number of days fed before slaughter, and on the feed (brassicas are the worst tainters), the amount fed, the length of time fed and what else was fed at the same time. To be safe, animals should be taken off brassicas at least three weeks before slaughter to avoid adverse flavouring - unless your client wants flavoured meat!

Hormones in bought feed can cause an illegal taint. On 17 July 2002 Reuters reported, "Thousands of furious farmers across the European Union were, according to this story, being prevented from selling their animals or milk as investigators scrambled to trace animal feed tainted with a banned hormone."

Potential problems associated with grazed crops

Sheep and cattle on brassicas (especially kale) can get red blood cell damage from high sulphur, which restricts copper uptake. Use low sulphur fertilisers, e.g., reactive phosphate with limited elemental sulphur, not Superphosphate. Ensure that trace element status is satisfactory. Applying mineral mixes of copper and cobalt didn't lift brassica levels of the same much, because brassicas have poor uptake of trace elements other than sodium and selenium. Feed trace elements through a dispenser in the water.

Brassica leaves and stems can concentrate nitrates, which can kill animals, particularly if too much nitrogen fertiliser has been applied. Cultivation releases soil nitrogen so seldom is more required at sowing time.

Photosensitisation. Many species of brassica contain photodynamic agents which may lead to skin damage, so avoid feeding to high a proportion of brassicas.

Glucosinolates. Brassicas contain a variety of glucosinolates which block the production of thyroid hormone, so can cause goitre. They have been associated with poor fertility. The roots of the crop tend to contain more than the tops or leaves. Grass crop with brassicas reduces this problem.

S-methylcysteine sulfoxide (SMCO). This amino acid accumulates in the plant while growing, and can cause goitre and anaemia.

Sulphur - The previous 2 toxicities can be from sulphur-containing compounds. Additionally, on their own high sulphur levels in brassicas can reduce the absorption of copper and selenium, causing deficiency of these minerals. High sulphur diets have also been associated with the nervous disease cerebro-cortical necrosis (CCN). Fertilising with Superphosphate can cause high S problems. Reactive phosphate and elemental S are much better. See Elements > Phosphorus.

Clinical signs

As there is a wide range of potential problems, there is also a wide range of possible clinical signs. If you're feeding brassicas and you get poor productivity or unusual diseases, get your vet involved. The two most important are summarised below -

Nitrate toxicity. Difficult breathing, blood cells brown instead of red (check vulvas or eyes), frothing at the mouth, frequent urination, muscle tremors and disorientation caused by high nitrates, usually in over fertilised pasture or crops such as oats and sorghum. It can be accentuated by low sulphur and/or low molybdenum levels in soils. Cattle can continue eating high nitrate feed that can cause death from a lack of oxygen. Pregnant ones that survive nitrate poisoning, may abort up to two weeks later due to lack of oxygen to the foetus. Symptoms include, abdominal pain, scouring, weakness, muscle tremors, drooling of saliva, blue discolouration of the mouth, mouth breathing, reluctance to move, collapse, coma, death.

SMCO poisoning. Weakness, Haemoglobinuria (red urine) particularly if the animals are grazing kale, reduced appetite and reduced production, reduced fertility, goitre (swelling of the thyroid gland).

For more on the above see Animal Health > Symptoms

Diagnosis

The clinical signs, along with the grazing history, are generally sufficient to provide a diagnosis of brassica poisoning. There are no routine tests for brassica poisoning.

Blood and a postmortem can be used to confirm nitrate toxicity, SMCO anaemia, and goitre. See Animal Health > Nitrates.

Brassica poisoning varies between species. Some can cause photosensitisation, bloat and a range of problems. They can cause polioencephalomalacia (an inflammation of the brain caused by high plant sulphur levels) and blindness, but this is extremely rare and is only mentioned for the record and to be cautious. Animals can tolerate a lot, if changes happen gradually. Changing too quickly, or feeding too much too quickly, can cause problems as mild as mild acidosis, and mild Redwater and red blood cell damage from the high sulphur levels in some brassicas. However, stock can die if fed too much or for too long, so watch for symptoms such as red urine. If seen, remove stock from the crop immediately, feed other feeds to reduce the effects and call your vet.

If going back to feed the crop later, break animals in to the crop very gradually, unless it is extremely dangerous, in which case feed only small amounts with other feeds. When grazing brassicas over many decades I and thousands of others who make the change gradually, have had no problems whatsoever. This said, immature brassicas, especially kales, can kill cattle, and can cause scald on the bare parts of sheep, especially lambs.

Feeding 100% brassicas, maize, or maize silage, can lead to all sorts of animal health problems such as twisted bowels (displaced abomassums), scours and low production so should be supplemented with feeds like clover based pasture or silage or lucerne when feeding only grass type forages.

Brassicas contain goitrogenic agents, that can cause iodine levels to drop and cause goitres in animals, especially ewes and lambs. Supplying potassium iodate or potassium iodide reduces this. Providing an SMM with iodine all year round can reduce or even eliminate the problem. However, sheep, because they don't drink, have to be dosed at the correct time. Ask your veterinarian. A rare problem when grazing brassicas is Haemolytic anaemia, which is more likely on kale, when excessive levels of S-methyl Cysteine Sulphoxide (SMCO) decrease haemoglobin levels, causing a loss of appetite and decreased animal performance. Levels of SMCO vary between kales.

High nitrates in crops can kill cattle, so avoid doing anything to increase this, such as applying nitrogen at sowing, or too much later, and grazing susceptible crops in the mornings, especially during cloudy periods. Nitrates can be three times lower at 4 pm than in the morning. Dairy farmers should graze high nitrate crops after the afternoon milking.

The lethal levels of nitrates relate to the quantity eaten. Every year during fast growth periods animals die from nitrate poisoning, but it is seldom publicised, partly because a few animals dying is not news, and partly because most people don't publicise their mistakes and misfortunes. Most fast growing plants (oats, winter ryegrasses, sorghums, brassicas, hybrids) take up high amounts of nitrates if available from excessive use of nitrogen, as well as when rain falls after a dry spell, especially if mineral levels are wrong. If Boron is low, sugar levels will be low, so nitrate levels can be higher. If molybdenum or sulphur are low, nitrates will be higher. Nitrates increase overnight and decrease during sunshine, so graze problem crops in the afternoon, and keep observing animals for at least ten days. See Animal Health - Nitrates. If there is no pasture to feed with brassicas, feed 25% of the diet as hay or silage to aid digestion, and reduce scouring and the possibility of nitrate toxicity.

Try to avoid brassicas, or any crop, becoming more than 75% of the diet, although some say don't exceed 33%. Feeding 25% hay with turnips in USA improved the rumen function. Theory is fine, but when pasture is non-existent what does one do? Grazing grass crops as well solves the problem. These include maize, millets and Nutrifeed, as long as minerals are fed.

Now that you've read the above, you'll ensure that your animals can't break into a brassica crop.

Fertilising crops

A reason that a paddock is being cultivated and then resown is mostly because it has become

unproductive because of insufficient lime, and or fertiliser. Therefore, a base fertiliser should be worked out from a pasture analysis, and include lime if needed (which should be spread before starting cultivation), Sechura RPR, salt, and borax for brassicas. Apply the base fertiliser of Sechura, the fastest release RP which contains many marine elements including salt (brassicas need salt to thrive) at 1,000 kg per ha, and, depending on the herbage test results, maybe include potash (may not be needed after wintering on a paddock, and never on effluent paddocks), about 40 kg of salt (the amount in Sechura at 1,000 kg per ha), about 15 kg of Borax (11% boron), and 1 kg of selenium chips, all per hectare. Se chips have increased maize selenium levels by five times, to the optimum level.

Soils low in boron must have it added or most crops will not grow as well. Turnips can get heart rot, and maize cobs won't fill completely on the stem side. See Fertilisers-Elements-Boron.

Lime is an important fertiliser and essential for many soils, but check by taking a pasture sample beforehand and knowing the soil's requirements. Brassicas definitely need lime in most areas, and salt and boron in almost all dairying areas, even first time sowings. Lime raises the molybdenum level. If brassicas are deficient in molybdenum they can get Whiptail. If the calcium and soil pH levels are adequate, but molybdenum is low, then a coated seed which has molybdenum will reduce the chances of Whiptail.

Turnips, millet and maize grow poorly in low calcium acid soils. They do very well in soils where the correct amount of lime is well mixed in deeply by thorough chisel ploughing.

The establishment's standard liming recommendations for high producing pastures on many soils is one tonne of lime every three to five years, but is much too low. On most New Zealand soils, before chisel ploughing deeply for a crop, apply about 6,000 kg per hectare (depending on the pasture analysis) and double that on most peats, then before regrassing in the autumn apply three tonnes per ha and roller cultivate or harrow it in.

In a 75% ryegrass and 25% clover sample, calcium should be close to 0.8%, sodium 0.2% and boron about 20 ppm. Deep cultivation, which is beneficial, lowers the levels so don't skimp the crop fertiliser mix. It should be chisel ploughed in to 300 mm or deeper. If the fertiliser is left on top or just harrowed in it will result in a shallow rooting poorer crop, especially if there is little rain.

If the paddocks are run out ones and have not been wintered on, spread effluent on them, otherwise apply 100 kg of DAP per ha and roller cultivate in to about 100 mm. A good brassica crop can remove 70 kg of phosphorus (P), and a good maize crop 100 kg. If plenty is not applied the crop won't yield well and will leave a P deficient soil. See Elements > Phosphorus.

The most important thing is to sow within a day or two of starting the cultivation, to avoid losing moisture and to beat the weeds. If the area is too large to do in this time, do a smaller area each time. Lack of moisture and weeds cost many dearly. This gives staggered sowing, which is a good idea because the grazing will be spread over two to three weeks. ..

Apply and harrow in Tri-Fix (discussed on page 4), at one or two litres per hectare.

If the soil is heavy and wet, roll once before sowing and once after. If dry, double roll before sowing and double roll after sowing. Double rolling is taking half a width each round. This brings up more moisture, causes less dust and gives better germination, especially with coated seed, which needs more moisture to penetrate the coating.

Maize can yield up to 30 tonnes of DM per ha (12 t per acre), which is as much as average pasture yields in two years. To do so it must have a well drained, deep, fertile soil, and be well fertilised, including all the necessary elements as based on tissue analysis.

The paddocks to be cropped should be used as sacrifice or wintering ones to build up the fertility and to save damaging good paddocks. When this is done, nitrogen should not be applied to the crop at sowing or the resultant high nitrates can affect and even kill animals. As applies also to pastures, sulphur, calcium, molybdenum and boron levels should also be adequate, to provide healthy palatable feed and to buffer high nitrates.

The applying of nitrogen depends on the fertility of the soil, effluent applied and the grazing or mechanical harvesting history. If nitrogen is seen to be needed (yellow, slow growing patches), apply

N-rich Ammo (30% N, 14% S) at 50% Sulphate of Ammonia with 50% Urea, in small amounts (100 kg per ha) to supply some sulphur, as it is a buffer against nitrates.

Remember that all commercial “Crop” and most “Pasture” fertiliser mixes contain nitrogen, so **should not** be used for summer grazing crops on fertile paddocks.

Don't allow Superphosphate, nitrogen, boron or potassic fertilisers to come in contact with seeds, because germination will be impaired.

Liquid potions (most are not fertilisers) get much publicity from their promoters. Some farmers use them a few times, usually to attempt to save money and in the hope that there is some magic in them, and then after yields decrease they go back to solids.

Sowing grass type crops

Don't sow until frosts are over and the soil is about 18° C at 70 mm (64° F at 3”). If for grazing, plant in two blocks one week apart. As with other summer crops, late plantings can fail to germinate through lack of moisture.

Sow 25 mm (1”) deep at 27 kg per ha (24 lbs per a). Seed is best broadcast onto a firm seedbed and harrowed, followed by two or more rollings. It can be drilled in 150 mm (6”) rows, in which case reduce the rate to 22 kg because of overcrowding in the rows.

Sowing all seeds

Direct drilling into sprayed pasture will usually give only half the yields of proper cultivation.

Germination failures occur frequently. They can be from low germination of the seed, dryness, mould caused by insufficient moisture, burying too deeply, or too shallowly so that seeds dry out or are taken by birds or insects such as crickets. Apparently poor germination can be caused by insects eating the seedlings as they germinate. Usually the seed gets blamed.

Superstrike coated seed reduce some of the above.

Purchase the seed in good time and check its germination by placing, say, 100 seeds on a paper towel on a plate. Lay another paper towel over them and keep them moist. Place the plate where it is seen daily to avoid allowing it to become dry. Good seed should have a 90% or better germination rate. 100% is rare because most seeds are mechanically harvested on one day when some seeds will be over mature and some under mature or green.

Seeding rates are not always recommended in this book because of the large variation between seed sizes, soil condition, rainfall and costs. For example, maize for green feed in the Waikato is sown at 100,000 kernels per ha (40,000 per a), whereas in some areas this rate would result in plants competing for moisture and fertility. Use local knowledge for things such as seeding rates. If unsure, do your own trials.

Seeds must not be allowed to make contact with fertilisers except rock phosphates, serpentine superphosphate or lime. Nitrogen, potash and trace elements such as boron can adversely affect germination. If the seed has to be mixed with a carrier to allow even broadcasting, use slightly damp lime (to save dust) or sand.

Brassicas are best sown in spring for a summer crop or early autumn for winter. If two paddocks are to be planted, put one in softs and one in Green Globe. Green Globe turnips are slower maturing, heavier yielding and keep longer. Sow all at 1.25 kg per ha.

Brassica seeds prefer to be almost on the surface, so sow and double roll by taking half a width of the roller at a time. Doing it this way gives better compaction, reduces dust and saves having to roll out the corners.

Coated seeds

Superstrike coated seeds can aid germination and help avoid bird and springtail damage, and rotting, at no extra cost. The weight increase is 25%, however the improved germination means that the sowing rate per hectare need not be increased. Plants from Superstrike coated seed should not be grazed until at least six weeks after sowing.

When moisture levels are low, Superstrike seed can take much longer to germinate. Fast and correct cultivation and extra rolling after sowing reduce this problem.

With all brassicas it is imperative that the soil is well compacted around the seed by rolling. Good seed drills have a heavy roller which achieves this after the drill, but additional rolling with a Cambridge or V roller may be necessary. I've seen a turnip crop failure where the farmer was rolling the seed for the second time after sowing and stopped because he had to go to another job and didn't get back to finish the second rolling. The twice rolled crop was excellent, the once rolled was a write off.

Coated maize seed is advisable, but may not help avoid some insect damage such as Argentine stem weevil damage completely because the weevils have to eat through seedlings before being killed. Even when using treated seed, insects can damage older plants after the effects of coatings wear off. Damage can be patchy, so monitor the whole crop daily and spray if necessary.

Weeds in crops

There are selective sprays which control some weeds without harming some crops, but prevention by fast cultivation and overall management are best. To achieve optimum weed control sow within two days of starting to cultivate. The reason for this is because some weed seeds germinate after seeing light and they start swelling as soon as cultivation starts, so they get a start on the crop.

To reduce weeds in crops, some organic growers in Germany cultivate at night without a rear light on, or cover their cultivation equipment with black plastic sheets to prevent light getting to the seeds which starts the germination process.

Treat every weed like a noxious poison and don't allow any to seed on your farm. Poorly grown turnips can have many weeds, which then become a problem in new pastures and with future crops in the years ahead.

Shirohie and/or Nutrifeed and Pasja have advantages, because they can be grazed about a month after sowing and then every 16 days, allowing the grazing animals to eat and control weeds. Nutrifeed in particular is a good mix because it has 0.65% calcium (provided lime was applied) and 0.34% magnesium, provided the soil has enough, and variety is always better than monoculture.

Seedling stage

Dampening the seed with a little diesel before planting was the old way to reduce spring tail damage, because they would not eat any of it. Crops should be monitored daily while germinating and at least weekly thereafter for the pests described below.

Brassica seedlings can suffer damage from spring tails, which are black 3 mm hopping insects that eat the seedling leaves. If present, you'll see the eaten parts and see them hopping away from you. If difficult to see, spread a white handkerchief on the ground, walk backwards and around about two metres on the other side, then get down on your knees with your head down and crawl towards the handkerchief. If they are present you should see them hopping onto it. Some parts of a paddock can be infested and others not, so check all areas.

Nysius fly (wheat bug), lucerne flea, grass grub and slugs, can hardly be noticed until after a couple of weeks, when it is realised that the weeds are plentiful, and there are not many brassica plants. Walking over the whole paddock is the only safe way of checking.

Grass type foragers are less prone to suffering at the seedling stage, but watch maize for cutworm, Argentine stem weevil and ducks. If the paddock is wintered on or used as a sacrifice paddock, most insects will be trampled to death and the manure will give a better crop.

Vaughan Jones

Agricultural consultant & journalist

GrazingInfo Ltd