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Surplus pasture is not always the cheapest form of supplementary feed when made into silage or hay, but it could be the best to avoid pastures getting too long. The costs fed, including Waikato, New Zealand's, 2015 land values, at $35,000 per hectare (after building values have been deducted), in cents per kg DM **fed**, are, for forage crops like Turnips or Pasja with Nutrifeed of Shirohie Millet, 20 cents, silage 33, hay 34, and grazed pasture 12. Forage crops are cheaper per kg because they can yield 12,000 kg per ha in the time that pasture yields 6,800 kg per ha. Grazed forage crops also produce more milk or meat than late summer pasture. The cost of regrassing is recovered by the higher yields from new pastures - provided they are limed and fertilised correctly, something very few farmers do, to make up for the large amount of fertility removed by crops, especially maize silage yielding 33,000 kg per ha, where all is removed from the paddock. See the Pasture Silage Hay Crop Costs spreadsheet.

To benefit from the above, cultivation must be by chisel ploughing to bring up some subsoil, with its beneficial minerals.

The Western World countries with the lowest-cost milk (New Zealand and Ireland), make the most pasture silage on a percentage basis, despite them having easier winters than most.

The history of making silage and hay in New Zealand is that originally mostly hay was made, all with horses and manual labour. In about 1950 the very successful UK pasture farmer Rex Paterson invented the buckrake, for use on the just released Ferguson tractor with the revolutionary hydraulic three point linkage system. This increased pasture silage making dramatically in New Zealand.

Very big, costly mistake

In the 1970s, half a dozen New Zealand farmers, including the then very prominent Federated Farmers' chairman, Ralph Woolerton, visited USA and wasted tens of thousands of dollars buying tower silos there, some with conveyor feeders to barns. His son, Doug Woolerton, has told me many times that it was the mistake of their lives. The costs were so high that they lost their farm. Their barn and blue fibreglass silo stood empty for years. In USA many tower silos are no longer used.

Instead of allowing cows to graze and spread their manure, Doug and his brother put up silos and buildings, harvested pasture seven days a week off their hilly farm and carted it to the barn, and cleaned up and carted the manure away. It lost fertilising value into the air causing N and S air pollution. Pig farms have been closed because of the smell from N and S. Pastures deteriorated and machinery wore out. I've seen this on many Northern Hemisphere farms, as thousands of owners have gone broke.

These silos and the barn built in about 1975 at Patetonga, Waikato, are examples of the half dozen built and used for only a few years. Two were between Hamilton and Cambridge and one in Northland. Note the covered silage stack that replaced the silos within a few years of the silos being built.

None of the tower silos in NZ survived more than a few years because of the high cost of operating them, the poorer quality silage that towers produce, and the lower returns for animal products in NZ, compared with the northern hemisphere. Making silage in stacks has survived for a hundred years, and improved since the use of plastic and tyres.

Bunker or stack (clamp) pasture silage can be the best feed when pasture is insufficient, and usually costs less to make than other forms of conserved surpluses. Thousands of tyre covered stacks

are made in NZ every year, but this one on AgResearch Lye Farm is longer than most.

Baled silage came in with a rush and has a place on small farms, but, when animal product prices drop, many revert to the better quality, lower cost plastic covered stacks.

Because silage is sometimes made in stages, the question is asked whether stacks can be added to, and the answer is no, not satisfactorily, unless it is vacuum silage (see page 23) which has no waste on top, or is in a bunker. If driving over a stack to dump more silage on top, getting over the previously made silage will be slippery, and dangerous if the tractor slips off.

I think it is best to make a new stack. An advantage of several stacks is that they can be positioned closer to their source, or where they'll be fed out.

Stacks are best made long and narrow, so that, when feeding, there is not a wide face that grows mould.It is essential to add to a stack next to a barn, and then just keep extending it. Pits provide greater safely.

Some farmers built bunkers, but most continued with stacks, because of their low cost and the versatility of being able to be made anywhere. We must keep our costs down and not invest in capital items that deteriorate and need maintenance. In the past some bunker and stack loss figures were exaggerated by the people who owned towers, especially if one considers how much cheaper and better lacerated silage is than baled or tower silage. The latter has to be drier and cut shorter to blow up and compact without being able to be rolled. Today, farmers have ample proof of the high operating costs and poor quality silage from tower silos, so many towers in USA are standing empty and few, if any, are being built. In many cases animal health suffered when eating the precision-cut silage from tower silos, because it is so short that it can't be regurgitated. TMR was therefore developed, which is mixing hay and grain with the silage.

Before building a pad, bunker or stack, check the sizes of plastic sheeting available in your area and plan accordingly. In NZ the widths are 5, 10, 15 and 18 metres wide and from 50 to 300 m long (1 m is about 40 inches). There is a difference in the tear and puncture strengths of plastic sheeting, so check all that are available. See Covering.

The best form of conserving feed is on the animals' backs, so don't starve your animals to allow conservation of hay or silage. Either feed them better or reduce numbers, so that, if needed, you have genuine surpluses for conservation.

Over-fat animals can be a problem, especially when it is internal fat in the wrong places, and especially in dry cows, so, as in everything, add condition in moderation.

Most farmers today aim to farm with few supplements by timing their calving, stock purchasing, fertilising, marketing, culling and stockpiling of pasture. However, there are situations (severe winters and dry summers) where supplements are essential.

Growing a forage crop to graze during lean periods in summer or winter can sometimes be cheaper than the total cost of growing a crop and conserving it as silage and feeding it. However, when there is surplus pasture, which has to be removed to keep pastures growing for grazing, the resulting silage costs less.

Surplus pasture not needed for grazing or conservation can sometimes be sold, before or after storing it as silage or hay.

Every year one hears of farmers suffering milk production drops because of trying to conserve too much pasture, so, if necessary, graze saved paddocks, rather than lose animal production.

Balanced pasture is the best and lowest-cost milk and meat producer, and well made pasture silage is the best supplement. Unlike other supplements, a high percentage of good pasture silage can be fed without problems, whereas too much hay can cause binding of the bowels (constipation) or too much crop (maize, sorghum, millet) silage can cause digestive disturbances, especially if precision cut to less than 5 cm long. Recommendations in USA have been to cut silage in 1/4 to 1/2 inch lengths (6 to 12 mm), which is disastrous for digestion. Lacerated silage, being longer, doesn't cause the same digestive problems, so can be fed in higher quantities. When well made good pasture (grass

and legume) silage is fed with a crop, milk production increases.

Irish figures show that world dairy profitability relates to the amount of pasture grown and pasture silage made, and grain feeding is a negative.

Good silage (especially if vacuumed) from pasture can have very close to the same metabolisable energy (feed value) as the growing pasture.

Which to make

I'm often asked whether to make silage or hay.

An important advantage of making silage rather than hay is that silage can usually be made earlier in spring, in short breaks of fine weather, although lacerator cut hay can dry in two days. However, this silage advantage should not be abused. Silage should not be cut or harvested in wet conditions or while covered with dew, or before four to five hours of sunshine. This is because the sugar content decreases overnight and during cloudy weather, and increases with sunshine, whereas nitrates increase over night and decrease with sunshine. On dull days pasture sugars decrease, so, if the day before planning to cut has lacked sun, then wait a day and the quality will be better.

Clovers are less suppressed by long grass, than when left longer waiting for the weather to make hay. Also, some fast growing grasses such as fescue, cocksfoot (orchard grass) and prairie grasses, if closed for hay too frequently, can suppress clovers, to the detriment of quality and future pasture growth and animal production.

Most pastures re-grow faster after harvesting for silage than after being grown for longer to make hay.

Rain falling on cut ensilage does about as much damage as rain falling on hay, because ensilage is living, breathing and deteriorating until ensiled. Try to avoid ensiling wet material. The aim should be to convert the pasture into silage as quickly as possible.

Silage from weedy pastures doesn't spread the weed seeds, because they won't germinate after ensiling, while hay does spread seeds.

You should make silage rather than hay if -

- Faster pasture re-growth is needed. Re-growth will not occur after harvesting for hay, if one has to wait too long for dry weather to make hay.
- Large amounts are able to be fed, which is safer than feeding large amounts of hay, which can bind ruminants and, if of poor quality, can even kill them if not careful.
- High animal production is needed.
- Hot dry weather occurs at the time of feeding.
- No green feed (pasture or forage crops) is available to feed with hay.
- Calves or deer have to be fed during pasture shortages.
- The material is thick stemmed, so too slow-drying for hay.
- High moisture levels in soil and pasture will slow the making of hay.
- Wet weather is possible.
- Weeds and/or poor pasture species are about to set seed. Silage prevents weed germination before and after harvesting.
- Hay storage facilities are not available.
- Hay equipment and/or contractors are not available.
- It may not be fed for more than a year.
- Hay dust is a health or pollution problem when in a barn.
- Hay is a fire risk. See below.

General tips on making silage

- Surplus pasture should be ensiled and fed when needed, but not if the pasture can be left standing and carried forward, and then grazed, as in early winter, and in summer when dry weather sets in.
- Clear paddocks of debris and mark any hazards.

- If paddocks are rough, smoothen them while the soil is still moist and before closing them. This will avoid future harvesting any soil, which decomposes silage and encourages mould, and, even in hay, can cause animal health problems. Bad, mouldy silage, baleage or hay can cause animal sicknesses and death. Mould in haylage killed about 100 horses in Florida, USA in 2008. See Silage > Mould.
- Don't apply any fertiliser, or especially lime, for a month before making silage, because any stuck to leaves can raise the pH of silage and cause mould decomposition. Never apply nitrogen before making silage, not even poultry manure, because nitrates will get high and animals won't like the silage or can suffer nitrate toxicity. Milk production will drop when nitrate toxicity is present in silage and can't be removed.
- Nitrogen forced pastures and crops can have low sugars and high nitrates.
- Measure or estimate the pasture quantity, and plan the stack size.
- Site stack on centrally situated, dry, well drained ground in a sheltered position.
- Silage should be stored well away from waterways, and not seep into them. Silage waste leaked into a river in Leicestershire, UK, in 2002 and killed the river's population of native brown trout, which cannot be replaced because of their unique genetic make-up (AnimalNet). The farmer was fined heavily. There have also been cases in other countries. Anyway, silage should be made so that effluent doesn't occur.
- Bad, mouldy silage, baleage or hay can cause animal losses. Mould in haylage killed 100 horses in Florida in 2008. See Mould.
- Purchase enough thick, black/white (white or light green top) plastic sheeting, or enough thin black for two layers, well in advance. The black/white plastic reflects heat and prevents UV rays and heat affecting the silage. In cold areas a black top can reduce freezing a little in winter, but the silage will have got hot in summer, after being made.
- Have tyres, soil or sand on hand for weighting, and to prevent the plastic from billowing.
- Harvest by pasture or crop quality and weather, not by the calendar, and within six weeks from the last grazing, unless it is a low fertility pasture. DRC 1996 Proceedings showed that the ME content of pasture declined by 0.3 MJ per kg DM per week after closure for harvesting. If for milk or beef production, harvest sooner, if for dry cows it can be later, but after six weeks clover suppression increases and the rate of pasture regrowth decreases, partly because of summer heat, dry weather, and grasses starting to seed.
- Harvest before seed heads set, because at seeding the feed value of the leaves goes into the seed, which is not as digestible. Also, ryegrass and Paspalum (Dallis grass) seeds in hot humid conditions can develop a fungal toxin, which causes infected seeds to double in size, and sometimes become mouldy and dark in colour. This toxin can cause severe hind limb lameness, which progresses to gangrene, with severe sloughing of the skin, ears, tail switch and tissues around the hoof. In severe cases animals have to be euthanised. Ergot is caused by a fungus known as Claviceps purpura or Claviceps Paspalum. It is so rare that most veterinarians have only seen it in textbooks. Large quantities of the infected seeds, when grazed or fed in conserved feed, can be dangerous.
- Aim to change the pasture into silage quickly (in one day if possible). Rain falling on mown ensilage does nearly as much damage as on hay, because ensilage (material before it is preserved) is living, breathing and deteriorating. Try to avoid ensiling wet material. If rain starts, stop harvesting and cover the stack, unless nearly finished, in which case it may be better to finish and then cover it.
- The most important thing about any supplement is to make it in the best possible manner, to achieve top quality. The cost of doing this is usually no more than the cost of making poor quality hay or silage, but the animal production differences can be immense.
- After mowing, pasture or crops breathe and live off themselves until completely dry or ensiled, when all air is removed. While these are happening, the quality deteriorates. If either are left out for a week they'll have no feed value. Both sun and rain burn up quality by leaching.
- After harvesting silage or hay, graze paddocks immediately, to eat the edges and dropped and left over material, to reduce the chances of facial eczema spores growing in the dead material. Don't leave the animals in for too long, because the stubble (yellow base of mown pasture) is high in

nitrates and low in feed value, so if they graze it they can scour, and in some cases become sick.

- If the same paddocks are harvested each year, then give them more fertiliser and lime, as decided by a pasture sample - but not within a month, or preferably longer, before ensiling.
- Crown the top of the stack to prevent water pooling.
- Use an electric fence against large walking birds, cats, dogs, children and animals. Lay rat poison in short 100 mm (4") diameter pipes.
- Poison all rodents because they spread diseases. The trick of laying a white border around the silage, to keep rats away, fails once feeding the silage starts.

Pre-wilting

The first mechanically made pasture silage was mown with an ordinary mower then buckraked into a stack or pit. It was therefore slightly pre-wilted. Seepage was rare or only slight.

Precision chopping pasture into small lengths increases moisture leakage out of the cut stems and leaves, so many pre-wilt it to reduce this. Lacerating does the same to a degree. Compressing the ensilage with wheel or crawler tractors or excavators also increases moisture release, so seepage under these modern systems is higher.

No one wants wet silage with effluent leaving the stack or pit, so wilting of lush pasture has become the norm in many areas, but is not always the best solution. There is evidence that wilting pasture before ensiling gives lower animal production than direct cutting.

If pre-wilting, try to leave the mown pasture well spread out so that it dries quickly. The longer it takes to dry before ensiling, the greater the loss from respiration, and the poorer the quality. If necessary, use a tedder to spread it to speed drying.

Breakdowns or contractors being late can result in too much wilting, which lowers the feed value and makes compaction difficult, resulting in over-heated, poor, and sometimes mouldy silage, which can cause scouring, decreased animal production and abortions.

Frequent rain can make wilting impossible. Making vacuum silage (see page 23) may be the only solution. It sucks the moisture out.

Both precision-cut and pre-wilting cost more than direct-cut.

Correctly wilted silage is lighter to cart and feed, and fully fed animals can eat more of it, as opposed to high moisture silage. A balance is obviously the aim.

Short stubble (cut too close to the ground) increases losses if pre-wilting.

Seepage seldom reaches one percent loss of the total feed value, which is far less than what occurs from over-wilting losses, which are aggravated by poor compaction, heating and mould, and feeding-face mould.

UK researchers claimed that milk from pasture is better for people than from wilted silage because grass contains Conjugated Linoleic Acid (Omega 3) which is beneficial, but 50% is lost during two days of wilting.

Direct cut

New Zealand (1982 NZ Grasslands proceedings) showed advantages of direct cut pasture silage over fine-cut wilted for sheep and beef.

Irish (Hillsborough) figures showed that direct flail mown silage gave only a third the wastage, and gave better weight gains in beef cattle than wilted precision chop. In Ireland direct flail mown silage produced up to 26% more milk than wilted. These comparisons allowed for losses at harvesting and feeding out, which are greater with wilted and fine chopped silage.

There are times when direct harvesting can mean getting the silage in before rain. To make good direct-mown silage, it must be mature enough not to seep much effluent, be mown after at least one sunny day, and after at least six hours of strong sunshine on the day of harvesting.

It is not always easy to achieve these conditions in spring, so wilting may be necessary,

Direct-cut short lush pasture in wet conditions can end up as mush, so let it mature.

Lacerated silage

Flail forage harvesters have been around since about 1960, but some have light steel V flails and no lacerating bar. The benefits of heavy flail foragers and lacerating compared with silage chopped very short include -

- Material is lacerated rather than cut, reducing power requirements and giving a better silage.
- The wax coating on the skin of grass is lacerated, giving faster drying and easier compaction.
- Less wastage when feeding out.
- Lower capital cost.
- Low operating costs.
- Low maintenance costs.
- Not subject to smashed mechanism when wire, posts, steel, stones, etc., are picked up.
- Can be used for cutting weeds and light scrub and brush.
- Is excellent at stripping the skin and leaves off stems of Californian (Canada) thistles which after few times, kills it.

A disadvantage is that the flails are seldom sharpened, so become blunt, requiring more power and are less efficient. Cutting hay, in particular, with blunt flails is slow, and blunt flails tear the grass off, rather than cut it off, which can slow down the re-growth.

The only benefit of the massive rotary knife type forage harvester is that the material can be blown up into tower silos.

Disadvantages include -

- High purchase cost.
- High operating costs.
- Inability to break the wax coating on the skin of stems.
- Guzzling by animals, reducing the intake of saliva, which is the first and most important digestive juice.
- Poor regurgitation of fine cut material.
- Displaced abomasums.

Fine-chop is bad for many reasons

A large New Zealand dairy operation, with several farms, has gone away from precision-cut silage because of the wastage. There is a lot less wastage with longer cut silage fed on pasture, and less pasture burning.

Some NZ farmers, influenced by some (but not all) contractors and large expensive fine-chop silorator sales people, still chop their silage too short (less than 7.5 cm or 3 inches), despite the problem of poor digestion and wastage being known in New Zealand, where 90% is pasture-fed. Fine-chop silage is one reason for poor digestion and acidosis, because it can't be regurgitated. A contractor in the Waikato who has two lacerator flail-type forage harvesters can't keep up with demand for his longer lacerated silage making each spring.

Excluding air from silage is a way of preserving it, so cutting it as short as possible was developed for tower silos where tractor compaction and vacuum are impossible. Also silo blowers and some feeding mechanisms can only handle short material.

Swiss figures show that the top of tower silo silage is not compacted as it should be, and that the cost is higher, and the quality lower, compared with bunker or stack silage. Swiss trials showed that well compacted bunker silage is best, and tower silage the worst - and more expensive. In Holland the silage figures are about 75% made in clamps, 15% in bunkers and 10% in big bales. They have only just over 100 tower silos in the whole country, because of the high capital and running costs and poorer quality silage.

When half the knives have been removed from fine chop foragers, animal production has increased. Many comparative trials have shown that silage 5 cm (two inches) and longer encouraged chewing and regurgitation, without which ruminants suffer digestive disturbances and displaced

abomasums.

USA and UK length recommendations are now longer than a decade ago, and getting longer. Trials in the UK showed that animal production was lower when silage was fed on bare soil than when fed on frozen ground. Soil damages animals' gut and lowers the digestibility of their food. Silage, hay and other supplements, including concentrates and palm kernel extract (PKE), should be fed close to fence lines on the clean soil that is adjacent to them as on this Waikato farm, so stock stand and eat it, rather than walk over it which they do when feeding is all over the paddock as shown below. Walking wastes energy and damages the pasture.

Another waste with feeding all over pasture, is the killing of pasture by the acid fine cut silage shown below.

Promotion by me and then Jon Gammon in Texas have increased flail lacerated silage in USA using US made New Zealand designed foragers and wagons which avoid most problems.

Feeding any silage on listeria or similar polluted ground can cause animal infection. This is less likely along fence lines and is far superior to using round hay and silage holders that animals eat from and waste feed. See Silage and Hay. Building and using bins on concrete where animals mill around in flies and manure that has to be stored, pumped and spread to environmental regulations, are another cost.

The wastage from covered silage bunkers and covered open stacks have been exaggerated by vendors of other systems, especially if one considers how much cheaper and better flail harvested bunker and stack silages can be.

Dry stock farmer Phil Taylor, when short of pasture, fed grain or concentrates along fence lines where all feeds should be placed. The waste is not as large as the promoters of bins claim, and there is no pollution. Most importantly all animals, being spread out, get the same amount, and earthworms eat the rest. Earthworms, especially Terrestris, the very important deep (more than a metre) burrowing earthworm, increase in numbers when PKE is fed along fence lines because they eat what is left.

Bun shaped stacks are safe to make (no sides to collapse, tractor and all) and waste very little, but the centre has a high feeding face that can be too high for self feeding. For large amounts of silage, long bunkers are best.

The top subdivision design allowed animals to access piped water from ten fenced areas. Fine-cut fed out silage that could not be licked up, shows its waste and the killing of pasture. Fed under fence lines would give less waste and and no pasture damage.

Quality

The first thing to remember is that it is total feed value per hectare that is important, not getting as much bulk as possible. Bulk costs money to grow, harvest, store and feed, for little extra production. Whatever the reason for making silage, it is important to make a top quality product.

The closer pasture is harvested to the normal grazing height, the higher the feed value. The yield

will be lower, but the higher quality and better regrowth compensate for this. Late harvested stemmy pasture cut too close to the ground can never have as high a metabolisable energy or feed value as shorter leafy pasture.

To produce high quality pasture silage for calves, for high milk and beef production, harvest it close to the optimum grazing stage, before it gets longer than 30 cm. Cows don't produce well on 40 cm long pasture, so they won't milk well on silage made from pasture that long. Each week's delay in cutting after early May results in a milk yield reduction of 0.6 litres per cow per day.

It is better in every way to close and cut a larger area earlier, with a low yield per hectare, rather than a smaller area later, for a higher per hectare yield. The reasons are that it can be cut earlier, wilts more quickly, gives faster regrowth, makes better quality silage, causes less damage to the pasture, and is easier to change back to grazing if a feed shortage occurs before cutting.

Lower the pH rapidly, to achieve a high acid content to reduce spoilage. This is achieved by excluding the oxygen as quickly as possible. Fermentable soluble carbohydrates, which are mostly plant sugars, as found in maize, millets and other grasses, help. This is difficult with lucerne compared with maize silage, because lucerne lacks the high content of fermentable carbohydrates, has high protein which slows rapid acid formation, and its hollow stems make it difficult to remove all the air. Lacerating lucerne can lose too many leaves. The best silage preservatives help improve the feed value of lucerne silage. Also ensure that it is mature, but cut before too much is flowering, and dried to about 40% DM. If too wet, it will become a black smelly mess, caused by protein giving off ammonia.

A UK farmer found that finishing beef cattle on 11.2 ME pasture (grass and clover) silage in winter, when there was no pasture, cost less, and gave better finished animals, than when fed concentrates as well. Animal growth rates averaged 0.9 kg per day. Silage quality has to be good to achieve this.

Good silage has lactic acid, which is sweet smelling. See Vacuum silage below for sweeter, better silage that eliminates many of the above problems. Good pasture silage on its own can produce a lot of milk and meat and can 'finish' beef cattle.

Consumers are now showing a preference for healthy food, so Irish researchers divided beef heifers into 3 groups, one was fed maize silage, one grass silage and one a 50/50 mix. The maize silage meat had the worst colour stability and the grass silage had the best colour stability, five times more vitamin E, and 9 times more Omega 3.

Make silage quickly, apply vacuum or roll it down with tractors until really firm, cover it well with white plastic, and place old tyres touching each other. Don't make the stack too wide or too high, because the large face grows mould if exposed for too long when feeding out. If possible, aim to feed at least 300 mm off the face each day, or if tearing it out with a front end loader, a metre each day. Cutting loaders are best.

If pre-wilting pasture silage, leave it spread out for quick even drying. If in a windrow, the top gets too dry and the bottom remains wet, and as a whole it dries too slowly. When put in the silage stack, pockets of mould can occur in the dry parts, and sludge in the wet parts. Don't leave it wilting for long. Four to six hours when spread out, or, if in windrows, turned once, is usually long enough in good drying weather. Once cut it starts living off itself, and losing feed value. Try to mow in the afternoon, when energy levels will be higher than in the morning, and during fast drying weather, and have it in the stack within 12 hours. After 24 hours feed value drops rapidly. Northern Ireland's Hillsborough Research Station found that fast wilted pasture silage increased cow intake by 25%, and milk production by 10%, more than slow wilted.

While hot air is rising off the stack, cold air is being drawn in, so deterioration is occurring. For this reason it is advisable to cover the stack each night.

Poor quality silage can have many problems, such as mould, nitrates and listeriosis. It can also cause poor quality milk. Some countries won't make cheese from milk from silage-fed cows. Rotten silage in paddocks, or anywhere cows can eat or even lie on it, can cause bacteria to go through the animal and come out in the faeces. If cows lie down on this, or on bad silage, teats become polluted. Normal washing doesn't remove all the bacteria spores, and even teat sprays don't kill them.

As always, prevention is best, so make good quality silage, and spread, roll and cover it thoroughly, to avoid a black mouldy layer. Before feeding, dispose of all black and mouldy silage so that cows can't get to it. Vacuum silage prevents bad pockets forming, provided the stack is well covered and then weighted to prevent air entrance and billowing. Vacuum silage is the best quality by far.

Most poor quality silage is from -

- Harvesting over-mature material, rather than at the milk and meat producing stage.
- Mowing too low and harvesting the base material and some soil, which no high producing animal would be expected to graze.
- Over-wilting. Plants breathe and live off themselves until all air is excluded, or, with hay, until dry.
- Inadequate compaction to exclude all air.
- Contractor delays and break downs.
- If the weather changes its mind after you've cut for hay, then remember that you can change yours too and put it into silage or haylage. Good farmers are versatile, and change previous decisions to match the circumstances. An anti-mould additive may be necessary to ensure a good haylage.

Patches of pure clover will not ensile as well as when mixed with grass, as happens when flailing it into a silage feedout wagon and spreading it out over the stack from the chain floor.

Top quality silage (and hay) can save feeding so much grain, and give high and profitable animal production from healthier animals. However, where grain costs are low compared with animal produce prices, it pays to feed some grain. When short of feed, buying grain can be better value than buying hay, but ruminants must also have bulk.

Surveys show that the weather plays a major part in achieving good quality silage. Two weeks continuous rain, just when ensilage is ready to be cut, reduces the quality, and of course rain on cut material lowers the quality.

When not carting in ensilage and not rolling, cover the stack. When hot air rises from the ensilage, cold air is drawn in, breathing continues, and so does deterioration.

Don't cut before six hours of sunshine to raise sugars, but not on a day following rain or heavy cloud. Wait another day, unless the forecast is for more rain and the pasture is already over mature.

A measure of good silage is that there is no effluent, no mould, and it is not too hot. Pasture silage with 30% dry matter has no effluent.

Most farmers and contractors know what it takes to make good silage, however some farmers skimp things by not harvesting at the optimum time, or not rolling well enough, and some contractors, keen to use their precision and fine chop machines, cut material too short. The cost of making top quality silage is usually no more than the cost of making poor quality hay or silage, but the animal production differences can be immense. Good pasture silage can have an ME of 12 MJ, while too much has only 8, which is 33% worse, meaning that much more has to be made, and that for the same animal production that much more must be eaten, which can be impossible. When quality drops by 33%, animal production drops by much more.

No more than 10% of the grass should have seed head emergence. Wilting, cutting short, additives, etc., will not improve the quality or digestibility of over-mature pasture. Cutting at the right stage (before seed head formation), rolling heavily and covering properly will.

Some people in the USDA have said that hay puts more weight on beef than silage. I'll bet they were comparing short 25 mm (1") fine-cut silage from tower silos with good hay. Fine or precision-cut silage is hard to regurgitate and chew thoroughly, so is not well digested. Also, a lot of silage is poor quality whereas farmers usually know how to make better hay than silage, and mouldy or wet silage reduces animal intake and can cause ill-health.

For summer feed, strip grazing of stock-piled saved pasture for deferred grazing is even cheaper, but, in typical dry summers, there is usually no regrowth for quite a while after deferred grazing,

however the seed from it does thicken the pasture.

Saving pasture and grazing it standing is common in winter, but until recently not in summer, despite Sir Bruce Levy writing about it in his book Grasslands of New Zealand in 1951.

Different systems each have their place.

Make hay if -

- It is required to balance sappy pasture.
- Needed for calves to develop their rumen.
- Only a small amount is to be fed each day, because the silage face could grow mould from long exposure, and cause animal health problems. Baling silage could be a solution, but baled silage is costly and some is poor in quality, especially in round bales.
- The crop is a legume or high legume content pasture and low cost molasses is not available to give the high protein silage energy.
- Storage or handling equipment for silage is not available.
- Very small quantities are to be made and fed.
- All will be fed within a year. Hay feed value halves after a year.
- It is required to control bloat. Most farmers know that providing one kg dry matter of hay per grown animal per day will significantly help with bloat control. The value of one dead animal is equal to a great deal of hay. Lacerated silage also helps, but not as much as hay, because hay takes more chewing and releases more saliva, which is a bloat inhibitor.
- You've cut ensilage and have a breakdown.

Silage making for self feeding

If not using vacuum, roll for an hour or two with tractors weighted front and back on single (not dual) wheels and cover it immediately, so that acids form to preserve the silage. Weight the plastic with soil, sand and/or tyres edge to edge. When a perfect airtight seal is achieved, gas will build up under the plastic. This should be sucked out daily or let out after the second or third day. This gas can be poisonous so don't breath it in. Warn others of its risk.

After resealing the plastic, it should fit in tightly around the silage. If using sand or soil on the cover, avoid allowing it to end up in the silage or in next year's silage from the bottom of a pit. Tyres are safer, and in the long run easier to remove and replace bit by bit.

Adding to a stack

It is best to make long narrow low stacks that can be added to at the ends if necessary. They have small faces from which to feed, so mould growth is less.

If using a silage pit, opening the plastic to add additional pasture after it has started is not a good idea, because it will allow air in with the possibility of a mouldy layer, and the ensiling process of heating slightly will be interrupted. The ensiling process needs at least two weeks, and even after that it is not a good idea to open and add ensilage. Opening can damage the plastic, and opening the stack makes more work.

If you have to, and use a self loading wagon and drive over the pit, take a quarter full first load to ensure you can get over without getting stuck, which you are less likely to do if the previous cut was not too wet, was well rolled and well sealed and the stack is not too high. Beware of slipping.

In freezing areas

- Wilting the pasture or crop reduces the degree of freezing of the silage.
- Adding salt when making it reduces freezing, and reduces mould on the face slightly because salt is a preservative. It also increases animal consumption and reduces waste. Maize has only about 0.03% so needs salt to be added when making silage so as to mix it in thoroughly to reduce waste from rejection when feeding it in paddocks. Bad mixing increases waste because some has too much salt that cattle like, and some gets none, so cattle don't eat it. See Silage.
- Applying vacuum to the stack makes moisture run to the bottom from where it is sucked out,

so reduces the degree of freezing.

- Make stacks on areas that are slightly raised in the centre so that no moisture gathers in the silage at the bottom of the stack.
- Ensure that the top of the stack is even (no holes or knobs) and raised in the centre before covering it to prevent water collecting in hollows and freezing.
- Tapered shallow ends can freeze the most and be a problem, so before covering push the ensilage in at the ends.
- Bark, chips, shavings, sand or soil over the plastic are insulators, so reduce freezing. All except soil can be thrown off to where the animals stand if self feeding, to reduce mud and make up for mud carted away on hooves.
- A black cover absorbs warmth, so can be best in cold areas while white or light green on top are best in hot areas, to reduce protein and enzyme losses when heated. Black plastic can get up to 60 degrees C in summer sun.

Harvesting

This is nearly ready for harvesting to make a milk or meat producing silage. It is best cut in the afternoon with a flail system or is wilted.

The limed farm of client Max van Geest (on left), after which clients Ben Bergs (back) and Brian Mathis (right), then applied more lime. Maurice Thomas (centre), applied 6,000 kg per hectare on his whole farm. He is now farming 600 hectares in Victoria, Australia, and applied correct amounts of lime where neighbours weren't applying any, and grows clover when they can't.

Choose smooth (to avoid soil in silage rotting and polluting it) and fertile paddocks which are handy to where the silage is to be stored. If paddocks are to be fertilised, the longer it is applied before harvesting the better. Don't apply nitrogen fertilisers such as urea, poultry or animal manure within six weeks of harvesting (preferably longer), because nitrate levels will be higher and sugar levels lower, and silage will be sour. Obviously the higher the amount applied, the worse the effects. A rule some use is to allow one day for every unit of N before cutting. Some allow half a day per unit, but I prefer a month and one per one.

Cultivating releases nitrogen, which increases nitrate levels in newly sown pasture, so avoid making it into silage.

Avoid low wet areas and exposed windy ridges, where keeping the plastic secure can be difficult, and in freezing areas wind chill will accentuate freezing the silage face, making it hard to feed. Keep away from trees where branches can drop and damage the cover.

Harvest a larger area for shorter, better quality young silage, rather than a smaller area for longer, old, poorer quality silage. The metabolisable energy (ME) decreases from 13 in three week old pasture to 9 in 9 week old pasture, and even good silage lowers it slightly. Also, short pasture doesn't hold the surface moisture like long pasture does, and is easier to direct mow or wilt, and re-growth is faster.

Maize and millets should be flowering, temperate pastures should be no more than 10% flowering. Tropical grasses should be harvested when short and young (Kikuyu and Bermuda 12~15 cm, etc.), and be wilted or have a suitable preservative. Legumes should be mature and, as with immature pasture and some crops, need molasses or a preservative. The drier the material the harder it is to get the air out. Sucking it out from under the plastic with a vacuum pump may be necessary. Paddocks fed out on or wintered on usually have plenty of fertility, or even too much, so are ideal for harvesting. If required, applying normal balanced fertilisers to silage paddocks some months before

harvesting can increase the yield of quality pasture; however, applying too much nitrogen beforehand will increase the ammonia level of the silage, and result in a poorer quality higher nitrate product. The pasture will be lower in sugars, which are essential for good silage. Low sugar, low energy silage is poor silage. For these reasons nitrogen fertiliser should not be applied to pasture within a month prior to harvesting for silage, and then should be at low rates (below 50 kg of N). Artificial N boosts the grasses at the expense of clovers, so the quality of the harvested material is lower, because there is less clover and more moisture, so lower mineral levels in the grass. The result is silage with lower magnesium, calcium, sodium, copper and boron. Also clover N fixation is halved by the amount of N applied, so its cost is more than double that imagined and quoted.

Poultry manure applied to pasture a month before harvest causes high nitrate silage, which can adversely affect animal health and milk production.

The percentage of clover or lucerne should not be too high, or, if it is, molasses, Molvinate (a molasses based product which has additives and is easier to handle) or another suitable additive should be added at rates to suit the amount of legume. Molasses suppliers should be able to advise on quantities.

Alternatively, make high percentage clover and lucerne pastures into hay, which will be of high feed value. The extra time not grazed will increase the percentage of grass and lower the percentage of clover for future bloat-freer grazing. More than 30% clover in a pasture can lower its annual production, because the clover yields less than grasses, especially in frosty conditions, and clovers are more subject to going to mush after frosts. If the same paddocks are harvested for silage or hay each year, give them more appropriate fertiliser and lime, based on analysing the tissue.

Pure grass silage is nowhere near as good at making meat and milk as that with > 20% clover.

The typical New Zealand farmer uses one tractor to operate a three point mounted flail forager to blow the ensilage into a multi-purpose silage making and feedout wagon, and tows the wagon over the stack. The tractor and wagon can also be used to roll the silage between loads.

If a flail harvester is not offset, and not picking up that pressed by the tractor, change direction each time, i.e., clockwise then anticlockwise.

Silage can be made in a pit (trench dug into a bank with soil, concrete or timber sides), a stack (heap of silage with no sides built in a paddock), or bunker (silage in between concrete or timber walls).

Rolling & compacting

One person, with a 45 kW tractor and a New Zealand flail lacerator forager with a silage wagon towed behind, can cut, lacerate and stack 8 hectares (20 a) a day, depending on the transport distance.

If a second tractor is available, it should be used to roll the stack. Quite often neighbours in New Zealand work in together to help each other with silage. In this way two tractors are available, one to harvest and cart, and one to spread and roll. When finished harvesting, both roll the stack until tight, then cover it with plastic and weights.

The rule is for every tractor or vehicle carting, there must be one rolling, otherwise compaction is inadequate.

An hydraulic excavator can be used to lift the ensilage up on to the stack, spread it and consolidate it.

Effective rolling is important. Dual-wheel tractors don't compress as much as single-wheel ones. To increase their weight, rolling tractors should have water-filled tyres and have a loaded front-end loader and a heavy implement on the back.

If two tractors or trucks are being used to cart ensilage in, two tractors should be used to compress the ensilage. Silage can't be compressed from the top down except by vacuum. It has to be rolled layer by layer, from the bottom up.

If more than one tractor is rolling a stack, use driving rules, or one tractor can dodge to miss another and go over the side. It is best if they each have one end, and stay in their own area going forward and back.

Silage making is not finished until the top of the stack is smooth, to avoid humps and hollows

holding water, especially in freezing areas. This may have to be done manually with a hand fork or rake while a tractor is rolling it.

If you have a breakdown, and the material gets too dry, make it into hay.

Silage effluent

This can occur with -

• Direct cut silage from high moisture pasture or crop.

• Short or precision cut material, because more moisture comes out of this than out of longer cut silage.

• Rain, making the ensilage (before harvesting) wet or falling on the stack. If rain is forecast, stop ensiling and cover the stack. Use old tyres to hold the cover down.

Less effluent occurs with silage flail-cut and harvested in the afternoon on a sunny day, after a few sunny days.

Effluent must not be allowed to get into waterways or create a wet area where flies can breed. It should be collected in a pit and spread on an area to be cultivated, or diluted with water and spread on pasture.

Contractors or self made

As reported in 2006, New Zealand contractors now make a lot of the silage because it seldom pays a farmer to own all the equipment required. A contractor can arrive and make all the silage in a day or two and all the farmer has to do is open gates and cover the silage. Some contractors have excavators that sit on the stack and lift the ensilage up, spread it and pack it down.

To calculate the cost of your making the silage and/or hay, add up the cost of the machinery, including your tractors, and multiply the total by 18% (8% interest and 10% depreciation). In subsequent years reduce the total value by 10% per annum. These calculations are best done on a spreadsheet or use VJ Farming Software > Tractor, Silage & Hay Costs.

New machinery will not be profitable to use, because the total value with tractors could add up to $100,000 for silage, and more for hay, so you would need to harvest 50 hectares (125 acres) pa. Neighbours may be able to combine.

A $100,000 precision-cut forage harvester would be out of the question, but owning a second-hand $10,000 flail-forager with a haybar can be highly profitable, and make far better quality silage and hay.

A common complaint against contractors is lateness, causing silage quality to suffer. This complaint seldom applies to flail forage harvester users because of reliability. One contractor harvests about 1,000 hectares (2,500 a) a year for four years before replacing it, with no problems except hard facing and sharpening flails once a year. A farmer user has done nothing to his - not even sharpened flails - in 12 years of regular use. However, flails should be kept sharp to cut cleanly and save power.

If your contractor is repeatedly late, remember, “Each week’s delay in cutting after the start of May results in a milk yield reduction of 0.6 litres per cow per day." (Northern Hemisphere)

Lateness could justify you owning your own machinery. If so, consider working in and sharing with neighbours. If not, help to get the best out of your contractor by booking a year ahead, and keeping in contact until the silage is made.

For small farmers on fully developed farms, it is generally more economical to use a contractor to cut, pick up, cart and stack the ensilage, but quality is likely to suffer because of the difficulty they have in timing everything right. Consider owning a second-hand mower ($500) and a buckrake (it would have to be made for about $3,000) as were used in the 1950s for decades and made excellent silage. Alternatively, mow the silage for the contractor to pick up and stack. A contractor can put in 20 ha (50 a), stacked ready for covering, in six hours, for about NZ$2,500. The contractor can phone the day before coming.

Contractors use big American, European or New Zealand flail foragers. Useless contractors go

broke, but good ones can make extremely good money, led by the flail forager owners, because their investment is only 4% the cost of the big self propelled machines. However, the latter can be converted for maize silage harvesting. I was doing contract hay and silage lacerating in the 1960s, and it was profitable then, in fact more so than farming, which had the colossal capital outlay, and returned only an average of 2% on the value, unless owner operated with no labour, and long hours were worked.

Most farmers comment that contractor made silage is not as good as that which they themselves make, because the contractor has to keep moving, so farmers can't choose the weather as carefully, and contractors can have six farmers ahead of them with grass cut, so, if there is a breakdown, six farmers have over-dry silage, or, if it rains, there are six lots deteriorating. Compaction is not as good as it should be when contractors have several machines harvesting with only one compacting. The rule is equal numbers harvesting and compacting, unless carting from a long way.

Increasing numbers of NZ farmers are using contractors to make their silage to save the outlay in machinery, and because they are kept busy running large numbers of livestock. Unfortunately many contractors talk farmers into sloppy practices, such as not tedding or turning silage, chopping too fine, using acid additives, etc. Farmers understandably believe them, thinking that they must know.

Working in with neighbours

The days of owning all the gear necessary to do all farm jobs are gone, because farm profits don't allow it, and because today's labour-saving machinery has become so big and expensive. Working in with neighbours is a way of solving the problem. It allows all of you to own less but better and bigger equipment.

Seepage

Seepage should be kept to a minimum, because it is a sign of a soggy silage. It creates a breeding ground for flies unless led to tanks for feeding or to a sump for correct spreading with water. Silage effluent is many times more polluting than even the strongest animal effluent. If running into a waterway it can kill water life, which is illegal in most countries.

The loss of nutrients is not as great as sometimes implied, but it should still be kept to a minimum. It can leach from under the stack into the soil and underground water without being seen. Lacerating reduces it and both wilting and vacuum silage can eliminate the problem. It sucks moisture out into a drum. Long-cut vacuum silage has less than short-cut rolled silage, because cutting short lets more out of the plant and rolling squeezes even more out.

Mould

Mould in silage can be so serious that it deserves special mention, because it lowers animal intake, reduces animal production, causes abortions within one to twenty days of feeding it, lowers conception rates and can cause other animal health problems. Cows have lost foetuses or aborted and dropped in production after being fed mouldy silage, which occurred in only a small area of the stack. Hundreds of cows abort each year because of mouldy silage, especially maize silage because it is usually drier.

Within two days mould can grow on the face of a silage stack being fed, and affect their health without your realising it. Wide stacks and faces can make this a problem, whereas narrow ones don't. So long narrow stacks are better than short wide ones.

Try to undermine the face so that the top of the stack and cover protrudes and stops rain running down the silage face. Make the stack or pit so that the feeding face faces away from the sun to reduce mould growth. In freezing areas where mould is not a problem, face it to the sun.

There are some farmers in NZ (quite often Dutch immigrants who have been brought up not to waste pasture, and to make quality silage from which to produce milk) who make excellent silage, using concrete bunkers with grooves to press tubing into, over a plastic cover, to make a vacuum seal. Once organised, it takes little longer. Removing waste silage when feeding out can take longer.

A few farmers use silage additives to try to improve the silage quality, whereas removing more air by more rolling or vacuum would give better silage. A Waikato contractor talked a farmer into buying an acid "preservative" from him for his maize silage. The result was a silage so acid that the cows didn't like it and milk production dropped. I smelled it and the smell burnt the inside of my nose. I got the farmer to spread bicarbonate of soda and Diamond V Yeast over it, which increased milk production by a litre per cow per day.

To reduce mould forming on the feeding face, cutting the silage from the face is better than pulling it out. Today's loading equipment includes cutters to achieve this.

In our young days, when we loaded and fed out silage by hand, we used a silage knife to cut down the face of the stack. It left a clean smooth face which didn't breed mould.

Maize silage is worse at going mouldy at the face, so needs a very small face.

Silage which is too dry, even if well compacted, runs the risk of heating. It cooks the protein and lowers enzyme levels and digestibility, makes a silage which smells nice, like a sweet tobacco, and which cows can relish once they become accustomed to it, but it will not produce as much milk or meat. If it is very dry there is a risk of mould, partly because dry material is impossible to compact adequately. Again vacuumising achieves more compact silage.

One of the causes of mould is that past recommendations have been for harvesting for maximum yield, rather than maximum quality. The result has been late harvesting and dry, sometimes over-heated, mouldy, and even "beery" silage. Silage not as dry would be better, even if a little effluent did run out.

Check the reasons for the mould, which include the material being too mature, too dry, cut too long, not well enough spread or compacted, made over too long a period; time delay in covering, and not well covered. If the feeding face is large, mould can develop on it in one day. For this reason stacks and bunkers to be fed out are best to be long and low, and, when self feeding, have only sufficient opening to allow the required access.

If all the ensilage is too dry, compaction is more difficult and mould more likely, especially when feeding. Mould is the worst thing that can happen to silage, so you should consider continuing to dry it, and making it into hay. Haylage is another possibility, but takes a lot of skill to make it without it heating too much or going mouldy. Mould in haylage has killed horses and makes cattle sick.

Mouldy lucerne (alfalfa) silage has damaged cow livers causing some to die from damaged livers a week to two weeks after the additional strain of calving.

Avoid cutting in shorter lengths than 5 cm (2"). Aim for most to be over 10 cm (4"), or, better still, use a flail forager which, with a fine-cut bar, can be set to cut short, but lacerates or crimps the whole crop without cutting it too short. To help with compaction, over-dry ensilage needs to be cut shorter than when the moisture content is correct. Material which will not be rolled, as in a tower silo, needs to be cut shorter, because it has to expel the air with its own weight. When vacuum is used to compress the silage it can be cut much longer.

If the pasture is too long and is needed to produce milk, cut it higher than normal, to leave plenty of the low feed-value stems behind.

The opposite extreme to being too dry is being too wet. If the ensilage is too wet, it will compact easily, but could end up a slimy unpalatable mess, and silage effluent will run out.

Feeding

When opening the stack there should be absolutely no mould, but be careful to discard any there is, and watch for it right through to the end of the stack. Black and very mouldy silage should be spread as compost where animals can't get to it. Small amounts of slightly mouldy silage can be fed to animals not in calf and not due to be mated, but keep the proportion low.

Less mould will grow on the feeding face if it faces the cold not the sun, and is not recovered, because mould can grow more in the hot conditions under the loose cover. Some staff who have been taught to cover the feeding end will need to have the mould problem demonstrated to them.

Don't feed out on pasture more than will be eaten within a few hours, or it can become mouldy.

If self-feeding, have the feeding face on the sunny side.

Salt was the world's first preservative and additive to improve the flavour, and both are still used. Lettuce and most greens need salt to make them more palatable to humans. Maize is the same, and is even worse because it doesn't absorb much salt - See the free Pasture Mineral Analysis row 18 Na and columns L, M (0.03%) and N. Also look at perennial ryegrass in S (0.25%) which is. I've seen where salt was added by throwing it over the feed-out wagon. The animals ate the maize that was salted and left that which wasn't. The farmer had not worked out why some maize was eaten and some wasn't. If mixed in evenly at making, it partly overcomes this waste and deterioration.

Nitrate toxicity

This has been touched on, but see the chapter on it in Animal Health.

Wait before harvesting after drought-breaking rain until several days of sunshine have occurred and cut the plant higher than normal.

Nitrogen dioxide gas can form within hours of filling a silo and may last for weeks, so don't get into the silo, or firstly blow a lot of material into it to remove the gas.

Be on the alert for bleach-like odours and/or yellowish brown fumes at the base of the silo. It is advised that people and animals stay clear of the silo for at least three weeks after filling. After this time period, the danger of nitrogen dioxide gas is greatly reduced.

Steps should be taken to adequately ventilate the silo before entering to feed out. The silo chute door closest to the level of silage should be open. An observer should be stationed on the silo blower platform and visible contact with the person entering the silo maintained.

Levels can be excessive if the ensilage was cut when levels were high (such as in the early morning), after prolonged cloudy weather, after applying nitrogen, poultry or animal manure to the paddock within two months of harvesting, or if there are high nitrates, weeds or pasture, such as new pasture. Cultivating releases nitrogen, which increases nitrate levels in newly sown pasture. Oats and other fast growing crops can be high in nitrates.

Better still, don't use silos.

Nitrogen

Never cut nitrogen-applied pastures for silage less than four weeks from an application, as the fermentation may be affected. High potassium applications before harvesting can cause grass tetany problems when fed.

Listeriosis (Listeria monocytogenes)

Listeriosis is a bacterial infection of animals and birds. It affects the nervous system and can cause low conception rates, abortions and sudden deaths. See Animal Health.

Symptoms -

Animals sometimes walking in circles, hence the name "Circling disease".

Another name is "Silage disease" because it occurs with poor quality silage.

Causes -

- Poor quality, mouldy silage, especially if the pH is not low enough.
- Poor quality, mouldy hay.
- Feeding them on polluted soil.
- Dung infected silage. Avoid harvesting pasture where animal dung can get into the silage. If earthworms are not spreading the dung then there is a case for harrowing (dragging) at the time of closing the paddock for silage or hay.

Silage and/or bought feed sometimes get the blame for listeriosis, when it can be from feeding it on polluted soil or on very short pasture, so, when they lick up the last of finely chopped silage, they pick up enough listeria bacteria to infect them. When feeding silage, animals are usually short of feed

so are stressed. This can contribute to listeria. Make the change to silage or bought feed at an early stage, before pasture has finished, and do it gradually over ten days. This means feeding very little on the first day and increasing by 10% of the total quantity per day for ten days.

Incorrectly conserved feeds can cause animal health problems other than those caused by mould. Listeria is one of them.

Avoid over-wilting ensilage because mould can occur which, combined with a high pH, can allow the silage to harbour the bacteria. Good vacuum silage is safest as it seldom gets mouldy, but it must also be free of pollution. Avoid having a wide silage face which takes days to feed across, because moulds will grow on the face. Long narrow stacks are best. Round bale silage can have mould on the ends. If ensilage is over-dry, use a mould inhibitor.

Lacerated silage is good. Some moisture is beaten out and the material is limp and easy to pack tight to exclude the air. Thorough rolling is imperative - silage can't be rolled too much. If an excavator is available, it can spread the ensilage evenly and make a good job of compaction, and speed up the silage making operation because the ensilage can be dropped on the ground next to the stack, to save the time spent in driving over the stack.

Vertical stack sides are not recommended because they require a lot of work to get them smooth, and they will always cause waste. Sloping sides are far better and quicker to make.

Additives can't improve over-mature and dry material, but they can save it from mould and deterioration.

Good material well conserved hardly needs a preservative; however, when conditions are not perfect, mould inhibitors help to reduce deterioration, especially with maize, because it is coarse, hard to compact and susceptible to mould after opening. Silage inoculants, preservatives and mould inhibitors won't improve the original material, but can save further deterioration.

There are many silage inoculants and mould inhibitors, so ask users and shop around for the best one and the best prices. Highly expensive ones may not be that much better.

Additive trials with temperate grasses have shown that silage quality improved in people's minds, but not in animal production. Before buying additives, ask for independent figures showing that animal production improves after application.

There are many additives available from many competing companies, all claiming to have the "best" one, so it is hard for potential users to decide whether they should use one, and, if so, which one to use. Commercial claims of certain silage additives giving 60% increases in liveweight gains have been made in the UK, but while many have been used in New Zealand, I've not seen dramatic increases in animal production recorded. It may apply to tower silo silage, which may need it because compression is not possible. The Swiss Maize Silage Association and February 1993 Agri-Holland both stated that only 10% of their farmers used a preservative in bunker silage. Surely more would use them if 60% increases in live weight gains could be achieved. Some responses could be from very high producing animals on confined feeding where about 75% maize silage is fed, rather than from animals grazing pasture with silage just as a supplement. Because there are no definite answers, farmers should assess their situation and requirements.

While additives won't improve poor quality material, some additives will definitely reduce wastage and mould formation on poor material and on exposed feeding faces, especially if not well compacted, and of even the best made silage at large feeding faces, where only small amounts are removed daily. Mould inhibitors are more important with maize, and where bunkers are large and only small amounts are being fed daily, allowing the face time to deteriorate.

If reasonably priced, molasses achieves good results in raising sugar levels in silage from lucerne and pasture. Marketers of the dozens of special inoculants will possibly criticise, as old fashioned, the use of molasses. If one makes this comment to you, ask for independent comparative trial results.

I'm not keen on strong acid preservatives because stock don't like eating the silage, so intake decreases. However, the silage protein and metabolisable energy can be higher, because of the fast acid preservation. A farmer who made some silage with acid and some with a conventional preservative, achieved a milk production increase soon after changing from feeding the acid

preserved silage. In USA some feed bicarbonate of soda with it at 1% by wet weight to neutralise the acid, but can still have severe digestive problems, especially if chopped so short that ruminants can't regurgitate and chew it properly.

A survey of top silage makers in New Zealand in 1995 found that only 3% used additives.

February 1993 issue of Agri-Holland reported that Dutch dairy farmers aim to make good quality pasture silage for producing milk, but only about 10% used additives, despite their harvesting it short at 180 to 300 mm (7 to 12") height. However, they cut it when dry (free of dew), and wilt it with frequent turning to achieve about 35% dry matter. This takes one to two days, depending on the weather. Additives are sometimes used if the dry matter gets above 35%, to improve keeping quality with less over-heating and mould.

They favour lacerated silage and aim to mix pasture species. Wide cut machines do this. Patches of pure clover will not ensile as well as when mixed with grass. Molasses is their main additive, which is an advantage when clover percentages are high. Low sugar crops such as short tropical grasses, clover and lucerne (alfalfa) need an additive.

There is every possibility that additives will improve. A new one claims that livestock eat more treated silage (profit from animals on pasture, hay and silage depends on high consumption) and that dry matter digestibility is increased by 4%. However, as is common with many trials, they didn't state "compared with what". There are many management ways of improving silage quality to increase animal consumption and digestibility.

Avoid strong acid preservatives, because, while they may aid preservation, they can make the silage unpalatable and result in lower digestibility, unless a buffer like bicarbonate of soda is fed. If, when smelling it closely, it burns your nose, it is too acid. Silage should be analysed as a guide to improve that in subsequent years.

Molasses

For silage making add about 10 kg per tonne (20 lbs per ton) for temperate pasture and crops, 50 kg per tonne (100 lbs per ton) for fresh crops (less for wilted) and 75 kg per tonne (150 lbs per ton) for short 150 to 250 mm (6 to 10") high green leafy tropical pastures. Longer tropical grasses are not worth ensiling.

In New Zealand, where most silage is made for dry cows, it is usually cut longer and even less pasture silage has an additive, but more maize silage has one, mainly to avoid mould, especially on the feeding face.

To sum up, if the material is drier than it should be, if there is a large feeding face with little fed daily, or if compaction is not going to be good (as in silos and with drier material), use an additive. Low cost sugar is sometimes available. Whatever additive is used, keep added moisture to a minimum - just enough to achieve an even spread.

% Dry matter

The dry matter content of direct-cut pasture silage is 13-18%, wilted pasture silage 20-30% and mature maize silage 30-35%, but there are large variations in DM between crops and farms. It is easy to measure by weighing and drying, then weighing again. An example is 100 wet and 20 dry is 20% DM.

The correct percentage of moisture is important. If you use a moisture meter, follow its instructions and take several measurements over a wide area of the paddock to get an average.

If you don't have a moisture meter, it can be measured by weighing, drying in an oven at 60° C (140° F) (or microwave on low or defrost) until weight decrease stops. Enter the dried weight, press the divide key then enter the original wet weight and press the % key. Or you can learn to assess the moisture content by taking an average sample, and wringing it tightly in your hands. If it is still too moist, it will leave moisture on your hands. If it is just right, you will feel the cool moisture after wringing it, but there won't be any on your hands. If it is too dry, you won't feel any moisture or coolness at all.

Crops for silage

It is not just the cost of growing a silage crop that has to be considered. There is also the cost of harvesting, storing, feeding and resowing the paddock. Oats and peas have achieved 17 tonnes per ha of high quality silage. Oats should not be harvested until full head and not later than the milk stage. Barley has yielded 8 tonnes per ha in 65 days. All these can be sown earlier than maize because they are not killed by frost. Barley has a feed value many may not yet appreciate. The special silage variety barley should be used.

Maize, millets, temperate grasses, mixed temperate pasture, tropical grasses, clover, lucerne and other legumes can make good silage in the order listed. Red clover can have high oestrogen levels. Maize and millets can be flowering, temperate grasses and mixed temperate pasture should be no more than 10% flowering, tropical grasses should be cut when very, very short, and clovers, lucerne and other legumes should be mature. All legumes need molasses or a suitable additive.

Many weeds make good silage, including even thistles, but beware of toxic weeds such as ragwort (ragwort or ragweed, which is a vertical plant with a yellow flower) and amaranthus (pigweed) which is extremely high in nitrates, toxic Horse Tail, etc. High nitrate crops and pastures will make high nitrate silage, so avoid or mix them thoroughly with low nitrate species.

Wheat also requires a shorter growing period and has the added benefit of not being frost tender, so can be sown earlier, but lacks many minerals, so, if fed on its own, minerals should be fed. When grazed it can taint milk, but I don't know about when ensiled.

Peas or a similar legume can be sown with millets or similar at low levels, and improve the feed value and make some nitrogen.

Maize silage

Maize is a popular silage crop with top yields of 33,000 kg DM per ha (30,000 lb per acre) like this one grown by the late Bill Chynoweth to my specifications. See Forage Crops > Maize for how it was grown.

The average NZ yield is about 24,000 kg DM per ha in half a year, which is about double what poor pastures yield in a year. However, pasture silage produces a lot more milk than maize silage, partly because maize has 30% less protein, which is important for animal growth and milk and meat production. Maize has more energy, but it is a lot lower in mineral levels, so needs pasture or pasture silage to be fed with it.

Maize silage is not a good supplier of energy, averaging around 67% TDN (Total Digestible Nutrient) whereas corn (maize grain) contains up to 97%.

Maize is an expensive crop to grow, but sowing and harvesting early can make it profitable, such as when renewing pasture.

The final decision whether to grow maize or not depends on -

- The ability to grow a good maize crop. A yield below 24,000 kg per ha will mean a loss. See Forage Crops > Maize and the spreadsheet Pasture Silage Hay Crop and N Costs
- Whether there is a paddock needing cultivating and resowing, and if maize is the best crop to grow.
- Whether a large amount of silage is required to feed with pasture.
- The income from the animal products produced.
- The profitability of fully feeding pedigree animals balanced feed (maize and pasture) for high production, where some of the profit comes from selling the high producing animals.
- A shortage of land area, so, to make a farm profitable, maximum amounts of feed per hectare have to be grown.
- Whether short sappy pasture needs the benefits of the carbohydrates in maize silage to be fed with it, for example in early spring and after autumn rains.
- Aiming to reduce some metabolic illnesses when grazing fast growing pasture.
- Having all the equipment to sow, harvest and feed it, but having the equipment isn't a good

enough reason on its own to grow a crop. You must need it, and the one you choose must be the best for the purpose.

Analyses of Pasture and Maize Tissue (not silage)

	Crude Protein	P	K	S	Ca	Na
Pasture Silage*	29%	0.4%	2.8%	0.4%	0.8%	0.2%
Maize Silage**	20%	0.3%	2.2%	0.2%	0.4%	0.02%

* Pasture with 70% perennial ryegrass and 30% white clover.
** 50% silking. Minor elements are much the same in maize as in pasture.

Feeding

Even if all the above good points are carried out and fine-cut silage is fed to hungry cattle with an empty rumen, such as after milking, it will be gorged and go to the bottom of the rumen and start moving through the empty digestive system without being regurgitated.

Saliva, the first digestive juice, will not be added and the maize and kernels will not be chewed to pulp by the average five regurgitations, so will not be fully digested. In this case, even if the maize is cut so short that all kernels are cut in half, many will go through the digestive system and come out the other end.

Solutions are -

- Insist on the contractor harvesting sooner and cutting it longer.
- Don’t let the cows get so hungry which may mean reducing cow numbers. Most NZ dairy farms are losing money as a result of being over-stocked. Use the GrazingInfo software spreadsheet called Dairy Cow Numbers for Maximum Profit, to determine how many cows your farm should milk. $7,000 per hundred cows can be made.
- Feed some pasture before milking.
- Feed short-cut silage one to two hours after going on to pasture.
- This can be done by feeding it in another paddock so that it just means opening a gate.

Tower Silos

These don’t deserve any space, except to confirm what the Swiss have found, and that users must be careful to not enter a tower silo without first running the blower for at least 10-15 minutes for at least the first two to three weeks after filling.

While nitrate-nitrogen may harm livestock at 4,000 parts per million (ppm), nitrogen dioxide levels as low as 25 ppm can be toxic to humans. Nitrogen dioxide comes from nitrate-nitrogen during fermentation. Most gases are produced 3-4 days after filling the silo, but the production of gases begins within 2 hours. Concentrations of 25 ppm are invisible and can't be smelled. When concentrations of nitrogen tetroxide reach 100 ppm, the gas appears yellowish brown and smells like laundry bleach. It will leave a yellow stain on most material it contacts. If inhaled, nitric acid forms in the lungs where it can quickly corrode the tissues.

Excess nitrates in silage crops leads to increased development of silo gas (nitrogen dioxide) from the crop when stored in a silo. The more nitrates the more gas. Plants wilted by drought or ensiled after drought-breaking rain are likely to have more nitrates.

North American farmers fell for the ego of tall silos that were pushed by machinery companies making big money (from gullible farmers) and promoted by researchers who wanted them because they also wanted toys.

Flying over Wisconsin (and other parts of USA) is an eye opener as one sees hundreds of tower silos standing empty as monuments to man’s stupidity. I’ve been told that many are now not used. They were expensive to buy, use, and maintain. They made dreadful silage, which had to be chopped fine to blow to the top and needed additives. This was because it couldn’t be compressed, and caused

digestive problems when, if fed on its own, was too short to be regurgitated enough to incorporate enough saliva. Mixing in hay to make total mixed rations (TMR) which enabled more regurgitating saved the day, but not in New Zealand where some fine-chop silage is fed on its own.

I got my first US clients in 1981 to sell their silos that made bad and costly silage. Now they can't be sold, so many stand empty as monuments to man's stupidity the ignorance of universities and greed of machinery companies.

My favourite cartoon is the silo salesman asking the farmer standing next to a tower silo, "When are you going to pay us for the silo?"

"You told me that it would pay for itself," the farmer replied.

Silage in New Zealand

Thousands of long, low stacks of silage covered with plastic and tyres are made every year.

Benefits of concrete bunkers

- Making silage in a bunker is better, easier, safer and faster.
- Compaction is better and easier, especially with short cut silage that can collapse at the sides.
- They usually have a concrete or gravel floor and apron, although there is no reason why open stacks can't also be made on a gravel or concrete floor.
- Covering bunkers is easier.
- Applying vacuum is easier.

Disadvantages of normal (two walled) bunkers over stacks

- Extra cost.
- Their position is fixed.
- Self feeding is limited to its site.
- If they have two walls and are long, and to have a small face, which reduces deterioration after opening, self feeding will not be practical. A one walled bunker overcomes this.

One walled bunkers

These have the advantages of two walled bunkers and allow -

- Easier and faster loading when feeding.
- Easier self feeding on a wide face if necessary.
- Cheaper to build.
- Vacuum can still be applied.
- Easy low-cost construction.
- Easy storing of silage.
- Easy covering.
- Easy loading when feeding out.
- Easy self feeding.
- Easy cleaning with a tractor and blade or scraper. This must be done each year to prevent old silage decomposing the new.
- Easy extension if ever required.

Other uses include -

- Stand-off area in between grazing when soils are wet. Don't make one mainly for this reason, because foot deep peelings, bark, chips, shavings or sawdust (in that order) base are far better and cheaper. .
- Storage of fertiliser and/or lime.
- Skate boarding and Roller blading!
- Sound shell!

Some farmers in New Zealand, after the removal of all subsidies overnight in the mid 80s, high fuel prices (three times the price of that in USA), and a general down-turn, started all sorts of money

making projects to make ends meet, such as farm stays, farm tours, open air music festivals if they have a good sound shell, Harley Davidson and vintage car rallies, etc.

A wealthy uncle once told me that it is easy to make money by catering for young people before they are married, while they don't have family costs to meet. They don't require the comforts of older people and enjoy squatting down on a blanket in a paddock listening to music in a country atmosphere. Farmers can provide this and many city folk have the money. Seize the opportunity.

Imagine the "Silage Bunker Music Festival" to celebrate the start of silage making. Use a good and proven marketer to promote it and run a pasture ensilage (silage before ensiling) judging competition. Farmers could bring samples of their ensilage for a learning and tax deductible event.

Siting the bunker, pit or stack

In much of Europe stacks in paddocks are not allowed. Silage has to be in bunkers on concrete with ditches leading effluent to tanks, from where it is fed or used as fertiliser.

Site it on centrally situated dry well drained slightly sloping ground, in a sheltered area. Sloping ground can allow climbing onto it from the top side when filling and provide better drainage for feeding, whether self or with machinery.

Avoid windy, exposed ridges where keeping the plastic secure is difficult and where freezing winds increase freezing of the silage face.

Bunker construction suggestions

Choose a central, slightly elevated, sheltered position, in view from your home if possible (but well away and down wind), not for the scenery, but to monitor the self feeding.

Plan to have the wall on the cold windward side.

Shape the site to allow a very slight fall away from the wall for easy cleaning, Allow for a narrow concrete ditch around the bunker to guide any seepage into a sump for feeding or spreading over paddocks. If the concrete is to be used for a stand-off area when soils are wet, then a wider depression should be installed to take the effluent to a sump or irrigator.

The bunker has to be a strong, everlasting structure, so use the services of a structural engineer, who should allow for the soil type, the height and thickness of the wall and decide the strength of the concrete.

The engineer may not know about the acid effects of silage. To cope with this, the concrete should be a stronger brew than normal concrete, but not as strong as bridge concrete. Here it is called 20 mpa strength.

After the bunker is finished and the concrete is well cured, it should be coated with a two pack epoxy protection against acid. It must be animal food approved because it is holding animal feed which will ultimately be producing food for humans.

The wall can be poured on the ground in sections and stood up with a crane, and supported with soil or buttresses. There is a lot of weight in rolled silage, so make sure the walls are strong. Slope the wall outwards at a 5° slope, to keep the silage tight against the wall as it settles. Pour the concrete on plastic for a smooth finish. Place half inch steel reinforcing rods every 8" in the centre of the concrete and have some protruding to lock into the floor when it is poured after the wall has been erected. The wall should have a large foot to go about 30" deep and under the floor. Vibrate the concrete with a portable pencil vibrator as it is poured.

Concrete blocks can also be used for the wall, and like the poured concrete, must be at a 5° angle outwards and smooth.

If timber or porous walls are used, cover them with strong plastic, but don't do this with concrete because it is an unnecessary cost and can get damaged when making the silage, so become useless.

The wall is best about 1.6 m (5' 6") high for feeding without face waste and self feeding, and to save them having to be stronger. A silage bunker covering a larger area rather than going higher, provides more surface area for self feeding and use as a wet weather pad. In some countries these have to have an effluent pond and spreading ability, so think twice. If silage self feeding is to be

done, choose an elevated free draining area. If muck and mud occur, spread it on poor areas. Know your effluent regulations.

Lay plastic sheeting to prevent soil getting onto the reinforcing steel, slow the concrete drying to make it harder, and provide a clean surface on which to work. Don't smooth the surface or stock will hate its slipperiness.

Keep animals away and allow it to dry slowly. If the weather is hot, water it for a day to ensure slow drying which will give harder concrete without cracks.

Making bunker, pit and stack silage

Silage must be made quickly. Crown the top to prevent water gathering. Roll for an hour or two with weighted tractors and cover it immediately so that acids form to kill all the bugs and preserve the silage. Weight the plastic cover with soil, sand and/or tyres rim to rim. When a perfect airtight seal is achieved, gas will build up under the plastic. This should be sucked out daily or let out after the second or third day. After resealing the plastic, it should fit in tightly around the silage. This gas can be poisonous so don't breath it in. Warn others of its risk.

Sides of soil, wood or anything porous need plastic sheeting to keep air and water out. Fill the sides higher than the centre until the end when the centre should be the highest to prevent water pooling which can freeze.

The ideal design is long, low and narrow. While loading from the back of this shaped bunker takes longer, the travel over it consolidates it.

Consider a bunker with just one wall to speed loading and to give a larger area to gain access to the silage, instead of just from the ends which can get muddy unless gravelled or concreted to the farm lane.

Tractors and wagons can drive over them down hill. Spreading in a pit is fast and safe.

All parts, including edges, must be well rolled. It must be covered. See Covering. It can be vacuumised.

Filling pits & bunkers

Pits and bunkers must be cleaned out thoroughly months before making silage and allowed to dry, to avoid bacteria affecting the new silage, and to stop any old rotten silage causing the new silage to decompose.

The bottom should be concrete or a hard base, not loose sand which can be picked up with silage when feeding out. Sand in silage is bad for animals and can stop them eating it.

Aim to keep the exposed surface small as you work by filling from the back to as high as practical for rolling. Don't spread over the whole pit or bunker area. Doing it this way also ensures that you fill to the required height, rather than have the whole pit filled to a lower height. Keep bunker edges higher than centres until the top then place a gentle crown on it.

If you can't drive up and over, vehicles can usually reverse up, provided it is kept well compacted.

If you make silage in two or more stages, cover it thoroughly each time, and when adding more don't disturb the already made silage, just spread the new material over the old.

Covering

Black with a white top plastic sheeting is usually the best to prevent silage heating. White plastic on top reduces heat transfer down to the silage which can cook the top silage and lower the protein and soluble carbohydrates (sugars) which provide energy. Covering should be done immediately, and not left until there is a dry layer of silage on top, which will then go mouldy and cause deterioration. While hot air is rising off the stack, cold air is being drawn in, so deterioration is occurring. For this reason it is advisable to cover the stack each night.

Stacks and bunkers should have plastic sheeting placed under the edges, up the sides and over the top to meet, and be taped to each other or well overlapped and weighted.

If making silage in stages in bunkers, roll and cover it each night, and when starting again, a day

or a fortnight later, put the fresh material straight on to the existing material, without disturbing it to prevent air from penetrating and decomposing the silage. In stacks add to the end.

Silage that is not well covered dries out and decomposes on the top and sides. Mould forms between the decomposed and the next layer of silage. If it is fed to animals problems occur. See Mould.

The top portion of silage in stacks and bunkers is not as well compacted (unless vacuumised) as the bottom, so is of poorer quality unless 15 cm (6") of sand or soil, or two layers of tyres cover the plastic. Removing the soil or sand is harder. If short of tyres, they or weights can be hung on the sides and connected over the stack with strong twine every 60 cm (2'). If lime is used over the plastic, it is imperative that absolutely none enters the silage, because it will raise the pH and start decomposition. With 100% air and water exclusion, well preserved and covered stack or bunker silage can last for decades.

Thorough covering and weighting of stacks and bunkers is essential, to reduce waste and the silage decomposing. The cost is more than repaid in reduced silage and feed value loss. Covering also prevents flies breeding in the silage.

Tyres should touch each other to prevent the cover from billowing and so pumping air in and out. Some like to get the tyres cut in half around the circumference to prevent water, rodents and birds staying in them. If there is wire in the tyres be careful that it doesn't tear the cover. Place cut tyres with the cut upwards.

Thin plastic sheeting is not always as good as one might hope, in that it can develop small holes when sitting on top of silage in hot sun. The minute holes then allow air and moisture entrance to the detriment of the silage. Holding used sheeting to the sun can reveal the pinholes. Spreading a layer of direct cut lacerated young pasture before covering with two layers of plastic sheeting will reduce pin holing. Walking on the tyres, not the plastic, will also reduce damage, but do so carefully to avoid sprained ankles.

After the silage has been fed, store the tyres on top of each other and cover them with the plastic to keep them clean and dry to make the next handling nicer. Tyres are usually moved from the site of the previous year's stack. If this is done at the time of covering the new stack the tyres can be thrown onto the stack from the truck or trailer which is easier than from ground level.

Plastic sheet manufacturers should make a degradable sheeting that decomposes after two years to overcome the disposal problem.

Baled silage

Baled silage and haylage became popular because of machinery sales people and contractor promotion of benefits without mentioning the problems. I think popularity will decrease once farmers realise that the cost is a lot higher than stack silage and the quality of all except good rectangular bales, is poorer, and mould in round bales is a real problem.

Some bale wrapping plastic is so thin that even when well wrapped, silage can be smelt through it. This can attract rodents and large birds such as Pukeko (wild fowl) to break the plastic and eat the silage, damaging the plastic and increasing mould. Over-mature ensilage can be so tough that its stems pierce the plastic wrapping, layer after layer, resulting in a mouldy mess. The same material can be ensiled in a pit or stack and covered with soft or lacerated ensilage before covering with plastic and/or using a heavier grade if necessary.

If using contractors and getting quotes for wrapping, ensure that you are getting quotes for enough layers of plastic.

Rules if you have to use bales for convenience -

• Use a good rectangular baler or a contractor who has one. These bales are more tightly packed and the plastic hugs the silage more closely so there is less air and mould. Good stacked silage is better still and costs less, while vacuum silage is the best of all. Square (actually rectangular) bales are much better because they are packed tighter and usually wrapped more. There is no round end to grow mould as happens in most round bales. Bales create a plastic disposal problem. Plastics are not very strong, and puncture very easily, letting air and moisture in and smell out which attracts rats and birds to rip it open and eat the silage. Lacerated material packs into bales better, and does less

damage to the plastic.

• Ensure that the moisture content is optimum, because if too wet the moisture can't get out and if too dry mould will occur. Recommendations for baled pasture silage moisture is about 55% (45% dry matter), which is when no moisture can be squeezed out by twisting tightly by hand. Obviously over-dry ensilage will not exude moisture, but if too dry it will go mouldy. This will cause a drop in feed value and possibly botulism in animals eating it. With pit and stack silage, exactness is not so important. With vacuum stack silage both wet and dry silage can be turned into a good product.

• Wrap bales adequately, giving more wraps if using thin plastic. Competition in the marketing of plastic sheeting has resulted in thinner plastics in some countries.

• Fence them well against animals such as cats, dogs and raccoons walking over them, and lay rodent poison.

• If you have trees that don't drop branches which could pierce the plastic, store bales under them to discourage hawks and similar large birds from landing on them and making holes in the plastic.

Benefits of baled & wrapped silage -

• Small amounts can be made at a time.
• Small amounts can be fed at a time.
• Can be moved easily.
• Can be stored around the farm.
• Can be sold.

Benefits of square bales over round -

• They pack tighter so the quality is better with much less mould.

• Can be stacked more tightly, which means more can be transported on a vehicle to move or sell.

• Are ideal for small farms because the silage can be fed out by hand by one person with a small tractor and tray.

Disadvantages of baled & wrapped silage include -

• Costs can be double that of stacked silage.
• More equipment and labour are needed to to make, store and feed.
• Bales are harder to load into mixer and feed out wagons.

• Quality of some is lower than bunker or stacked silage because of mould on edges and the requirement to be lighter, so drier, for handling with loaders.

• Plastic damages easily allowing air and moisture in.
• Must be protected against animals of all sizes.
• Doesn't keep for more than a year unless tightly baled and well wrapped.
• The masses of plastic can't be used again so disposal is difficult and polluting.

Making Baled & Wrapped Silage

Soft pasture should be used, rather than over-mature grass or sorghums with thick strong stems which can puncture the plastic. This occurs especially when the ensilage is too dry. This is a tendency with baled silage in order to reduce the weight. Best of all is to mow the material with a lacerator which crimps and softens the stems. Wrap bales immediately. Leaving them unwrapped allows the outside to over-dry which will encourage mould.

Baled silage needs to be drier for baling and ease of handling and also because there is nowhere for moisture to get out. Frequently baled silage is over-dried and it is difficult to avoid damage to the plastic, so if the bales are kept for more than a year the silage quality decreases rapidly. Remember it costs nearly twice as much as stack or bunker silage.

Bales must be handled carefully to avoid even pin prick holes which allow air and water penetration - the enemies of silage. Store the bales in a safe place and fence them to prevent

everything from large animals down to rats, dogs, cats and possums from damaging the plastic. Poison should be used for rodent control. Wrapped bales should not be stored against each other, because they can stick together, aggravated by the plastic's static electricity, so removing one bale can damage an adjacent one. If several are fed each day this doesn't matter as much. Don't store them under trees which drop branches and can puncture the plastic.

Store them on their ends because -

- The extra plastic there makes it thicker.
- The top will then also be thicker reducing damage from standing on them and from cats or dogs jumping up on top of them.
- They can't roll so are safer.
- They don't become oval so are easier to handle.

After they have been stored don't move them until feeding. If you must, use gentle equipment and seal any holes immediately. Avoid dropping bales on stubble after wrapping. It can cause plastic damage and spoilage of entire bales. Don't wrap in the rain because the plastic doesn't seal as well.

Small farmers can make small quantities of silage by placing it in plastic sheet and folding the edges in to one point then vacuumising it with a vacuum cleaner. Place the vacuum cleaner pipe in the folded edges and once all air is out, fold the edges over and tape them securely so air can't enter. If air does enter over night, go through the procedure again. The silage will be hard, and if securely tied, it will last for years. If even smaller amounts are to be made, use a strong plastic bag. Bags can be opened carefully and used again. Always use a strong tape for joining plastic sheet, not ordinary office tape.

Feeding silage

Don't feed silage until it has been made for at least ten days.

It is imperative that the change from any other feed, including pasture, to feeding even pasture silage, is done gradually over at least a week, preferably over ten days, to allow the ruminants' micro-flora to adapt and multiply.

The statement that milking cows or beef won't produce well on silage fed in summer to animals grazing insufficient pasture, so it should not be fed then, could be because of the sudden change to feeding silage after the pasture has finished, and after milk and meat production has already dropped, rather than starting sooner. All changes must be gradual to allow the digestive system to adapt over about three weeks.

Another reason can be because so much silage is chopped too short so can't be regurgitated to chew the cud. The northern hemisphere total mixed rations (TMR) of longer cut hay mixed in helps avoid this. Two inch or shorter chopped silage eaten by hungry animals results in fast guzzling which will mean that insufficient saliva is mixed with the silage and cud regurgitating of short feed can be impossible. The result is indigestion and reduced digestibility as the silage goes through the system without saliva, the first and most important digestive aid. A ruminant depends on incorporating saliva into its food during eating and cudding.

A time when feeding of supplements is most important is from the day of the first autumn rain until the pasture is long enough for the animals to eat without scouring or suffering nitrate toxicity, and/or facial eczema because of high spore numbers in the base of new short pasture. See Animal Health > Facial eczema. The reason for starting it after rain falls is because, while the cows may have been getting enough sustenance from dryish pasture, they will not get the same value from it once it starts to rot and grow mould after rain falls on it. Also the short lush pasture shoots after autumn rains are not well digested until the cows' rumen bacteria have changed and multiplied again. These are reasons for production and animal condition (weight) drops after autumn rains.

A problem with most very fast growing pastures and crops is an excess of protein and nitrates, (which is indigestible protein). High nitrates in pastures, crops, silage or hay make animals scour and can even kill animals if too much is eaten, without balancing the diet with a high carbohydrate/energy feed. Digesting protein and nitrates needs energy (sugars), so aim for adequate levels. If energy is too

low, animals use their body fat to help digest nitrates, which is counterproductive.

When pasture is limited, stock can still do well on a mix of limited (rationed) pasture and good quality silage.

When feeding silage, the plastic cover should be folded back only just far enough, and preferably left with an overhang over the face to prevent water running into or over it.

Tractor mounted forks pulling silage from the face loosen the silage to about half a metre. Shear grabs, which guillotine the silage from the stack onto the fork, reduce this deterioration caused by drying out, mould and the start of decomposition.

When possible, feed supplements before animals enter the paddock to reduce walking and pugging. Feed out along fences, in troughs, or in heaps.

If it is not vacuum silage, avoid feeding the edges, which can be mouldy.

On some soils in some climates the difficulty of feeding it in paddocks in wet weather must be considered. Feeding silage in troughs on concrete is a triple cost because of building, cleaning the concrete and spreading the effluent. Feeding supplements along fence lines on pasture, before animals enter the paddock reduces pugging and gives the best consumption.

Waste occurs if too much is fed

In winter when there is snow lying on the ground, silage can be fed to non-milking animals without water, but watch for any stress symptoms of some animals that won't eat snow.

Silage starts deteriorating as from when it is opened and loosened, so aim to have it eaten soon thereafter.

Feed it in summer before milk production or meat gains decrease. Once production has dropped it is harder to increase it. The old idea some still have of keeping all supplements for late autumn and early winter can be very costly when cows go dry through lack of pasture in late summer or early autumn. Then good autumn rains and an autumn flush, using the built up N, P and K in the soil, provide a surplus of pasture for the now dry cows. When short of summer pasture, sell the culls, dry off the very thin ones, and feed the others silage to keep them milking well - and hope for a good autumn.

Silage stacks or bunkers higher than about five feet will make the silage so compacted that it will be hard to pull out, which can reduce the amount animals (especially young stock) can eat in a day, causing slow growth. Mature dry cows are not so badly affected by this. Don't have mixed age animals feeding from the same face. Check all animals daily. Look at each one to ensure that all are getting their fill. They may need training to self feed by supplementing with loose silage or hay, or by pulling some silage out for them. If an electrified wire is being used, keep in mind that some animals are so scared of high power that they may not go anywhere near it. In all cases a power reducer such as a Gallagher Flood Gate Controller should be used.

Wastage when feeding out

Fine chopped silage (under 5 cm) is wasteful in energy chopping it, wasteful feeding on pasture (it kills pasture and not all can be eaten) and wasteful because of poor digestion. Cows will be able to eat more of the silage they are given if it is fed out on dry paddocks or feed-out areas, on dry sacrifice paddocks for next year's cropping, or in troughs. Where you don't have troughs you can improve pick-up by the cows and minimise waste by feeding -

- Close to the opposite side of a hot wire.
- Close to a conventional fence.
- On long grass, such as the new break. It will not then kill pasture as can happen with short cut acid silage fed on short or grazed pasture.
- Hay only when the weather is very wet.

Self Feeding

Stacks and bunkers of silage can be self fed by using an electrified wire or rolling rails. Advantages are the extremely low cost. Disadvantages are the mud, concentration of dung, some

animals going hungry, and waste if the setup is poor. A concrete or gravel pad can be worthwhile if the same site is to be used regularly. Ensure that it slopes to a soak hole, effluent pond or similar, to use the effluent and animal manure as fertiliser.

Place the stack on raised, sloping dry ground, and, if in a cold area, on the leeward side of a hill or trees. Also make the stack low, narrow and long. A high stack can have the top undermined by stock eating in to their maximum height and creating an overhang which can then fall on the electrified wire and short it. If a high stack, bunker or pit has been made it may require labour to fork the top down, or the use of non-eletrified barrier. These can be made to be pushed forward by the stock. A double rail steel frame on sets of wheels (front and back) is best, because animal consumption and growth are better.

Galvanised steel wire is best because it stands more knocking and doesn't stretch as easily, but if using an electrified polywire use a top quality non-stretch one. Push the insulated or fibreglass supports exactly horizontally into the stack so they can be knocked in once or twice a day and are not knocked over.

If using a high powered energizer lower the shock with an energy reducer such as a Flood Gate Controller, otherwise timid animals can starve through fear of the high power. Watch for animals not eating. They may have to be moved somewhere else and fed separately.

High stacks increase the time animals are standing in one place, increase mud and limit the feeding face distance. Stacks should not exceed 1.5 m (5') height if to be self fed.

Wastage can be kept to a minimum by moving the wire in twice daily and tidying up the face and floor at least daily. If the quality is good and the silage is well covered, self feeding will be more efficient than when there are patches of bad or mouldy silage which the animals eat around or under until it falls down to bury and waste good silage.

When to wilt

Aerobic bacteria are on all plants. The longer that plants are left after cutting to wilt, or left un-compacted (with air around them), the more these bacteria multiply and use the plants' carbohydrates. The more carbohydrates used, the less left available for turning into lactic acid and the lower the feed value of the silage.

To reduce aerobic bacteria we need to eliminate the air quickly. If you do, the bacteria will use up the remaining air in a few hours and start producing lactic acid.

Also, too much moisture dilutes the sugars and makes them less effective.

For these reasons; cut in dry weather in the afternoon, preferably after a few days of sunshine (seldom possible in some springs) when the pasture is dry and carbohydrates are at their highest, and, if wilting, leave the pasture spread out (not in windrows) for fast wilting, then after a few hours, ensile it and suck the air out immediately. In the long days of late spring this should all be possible in most springs, even if it means making smaller stacks and working into the night.

Irish research re-discovered that quickly wilted pasture produces much more milk than the same pasture wilted slowly over two days, before ensiling.

Maize silage usually has about 30% DM, 10% protein, 10 megajoules of ME per kg DM and 65% digestibility.

The feed value of maize silage decreases considerably if dry matter is below 30% or above 40%.

Saved pasture in winter usually has about 17% DM, 20% crude protein and 10 megajoules of ME per kg DM and 75% digestibility.

Spring leafy pasture usually has 14% DM, 24% crude protein and 12 megajoules of ME per kg DM and 85% digestibility.

Sampling & Analysing

Very few NZ farmers get their silage analysed, because knowing what went in, how it went in, how well it was compressed or vacuumised, how it looks, feels and smells, tells them a lot. How much the animals like it is not always a good guide, because they quite often like cooked silage which is dark and smells like tobacco, but has lost a lot of protein in the heating. Silage should not

heat.

The percentage dry matter is most important so as to determine how much to feed. An animal needs 50% more 30% DM by weight than 45% DM. Moisture can be felt or measured by weighing, drying and weighing again once it stops losing weight. Dividing the dry weight into the original weight will give the DM%.

The presence of mould indicates over-dry silage and air. The drier it is the more rolling (compaction) is needed to exclude the air. Vacuumising is best.

Maize silage may need a mould inhibitor, especially if too dry and if feeding only a little each day from a wide face which can grow mould.

The mineral content of the silage should be known from pasture analyses.

pH is the second most important factor(assuming one knows what went in and how it went in). $20 garden soil pH meters do a reasonable job, they are instant, last forever and don't even need batteries. Push it in to firm silage or squeeze it around the end of the rod. Close contact is essential. pH papers are also available.

If you are buying silage and decide to get an analysis first, check with the lab to see how much they need, how they like it packed (some like it frozen if sent any distance), etc. Usually they require you take half a dozen samples from across the face as far in as possible (half a metre minimum), so that it is fresh from a compact site which has not been exposed to air and is typical of the stack. Fill a two litre ice cream carton tightly to exclude air and tape the lid all round to keep it air tight. Drill a 6 mm hole (1/4") in the bottom and suck any remaining air out with a milking machine or vacuum cleaner, then tape it quickly. Alternatively use strong double plastic bags and again suck the air out and tape them.

If the stack was made in stages and a true analysis is required, each batch in the stack should be analysed.

Vacuum silage

If possible make vacuum silage. Vacuum removes all air and uses atmospheric pressure to pack the silage down better than any other way. Air and moisture are sucked out of the stack and springy dry material is compressed by vacuum.

Vacuuming is better than most inoculants at improving quality, but low sugar ensilage such as lucerne (alfalfa) will need molasses or a suitable inoculant, and over-dry material may need a mould inhibitor; however, good vacuum silage seldom gets mouldy, but, like all silage, it must not be polluted with soil or animal manure.

Jack Green of Papakura, New Zealand, developed the vacuum concept in the 1950s. It eliminates rolling and makes the best silage possible.

One person with one tractor, forager and silage wagon can harvest and make vacuum silage on its own. If it rains, there is no pasture being ruined in the paddock. When the rain stops, harvesting can continue without worrying about the next three-day forecast.

There is no rolling of the stack to compact it.

The same silage wagon can be used to feed out on pasture. All cattle, even the most timid, get their silage without the mud and competition around a feeder. The silage is so good the cows lick the ground to get it all. Feed it on clean pasture to avoid getting listeriosis from the soil.

Vacuum silage in New Zealand has always been a small percentage of what is made because -

- It takes more planning.
- There is no money in promoting it so most don't even know about it.
- It can't be done from a tractor seat.
- Not much silage in NZ is used for milking cows, and if it is the cows will be also be getting some pasture, which in New Zealand is very high in protein. Most is fed when cows are going dry, or dry in winter, so quality is not essential to produce milk and to save buying grain. These are reasons why there was a swing to round bale silage, the quality of which is very poor.
- NZ farms have always been short of labour and low on income (both compared with Northern Hemisphere farms), so anything that appears to make more work on NZ farms is unpopular. I say

“appears” because once organised, vacuum silage can be faster to make because there is no time consuming rolling.

• A high percentage of silage in New Zealand is made by contractors who don't like vacuum silage because they like sitting on tractors, charging out tractor hours, not labourers’ time.

Sir Bruce Levy in his Grasslands of New Zealand (1970) book quoted wastage of hay to be 30 to 50%, silage well covered with plastic or similar 15 to 20% and vacuum silage below 10%. The quality losses on average are about the same.

If you would like to see the quality of vacuum silage, put a few handfuls in a strong plastic bag, or plastic sheet folded to form a bag. Then use a household vacuum cleaner to suck out the air through a hole which can be quickly taped over. Open it after two weeks.

Procedure

Lay 10 cm diameter Novaflo or a similar perforated drainage pipe on the ground for the length of the stack or bunker. If not available use PVC pipe and drill 1 cm diameter holes every 15 cm in it for the entire length.

Cap the far end and connect a 5 cm plastic water pipe to the other end and connect it to a 200 litre (50 US gallon) drum or similar container to catch the liquid. Where the pipe comes out through the cover use duct tape to seal it.

Suck the vacuum out of the top of the drum with a large vacuum pump. An old one not good enough for a new milking machine might do it. It needs to do about 60 cubic feet per minute requiring a 8 kW motor.

Vacuum will need to be applied each day for a few days.

Don't make precision-cut ensilage because it has more effluent unless pre-wilted.

Don't roll it too much because it damages the leaves and releases moisture.

Seal the plastic cover joins with tape and the edges around the stack with ample soil to create a seal. A plough or grader blade may cover the plastic edges mechanically.

If on soil there will be less moisture than if on concrete because some will soak into the soil. If on soil use a new site each year.

Vacuum silage can be made in bunkers by laying a stainless steel channel in the concrete walls. Alternatively, tubing can be set in concrete with a cheap plastic strip around it and then pulled out to leave a channel. Use milking machine air tubing to hold the plastic in place to make it air-tight.

Silage has to be airtight and sucking all air out under vacuum makes it even better.

To get airtight seals around the bunker, grooves should be formed to press rubber tubing in to hold and seal the plastic cover. The best seal is a stainless channel set in the top of the wall and around the edge of the silage. A groove in the concrete is cheaper, but needs to be well made and be sealed with epoxy to prevent acid damaging it. Once concrete edges break down it becomes useless. Vacuum silage can be made on level ground without concrete.

Making hay

It is difficult to produce milk or meat from feeding average hay on its own unless it is soaked in water-diluted molasses, or -

• The quality is exceptional as when containing mostly leaf with few stems and at least 30% legumes.

• It is made from perennial ryegrass or endophyte-free tall fescue and clover no more than 3,000 kg dry matter per ha or lb per acre which is about 25 cm (10 inches) high, and cut with a lacerator with a hay chute and haybar* after at least four hours of sunshine, then turned each time the top is drier than the bottom. The last turnings should put it into windrows. This halves drying time, which improves the feed value and palatability compared with cutterbar or disc-mown hay. Cows relish a

certain amount of lacerated hay, but always need some greens.

*A haybar of 5 cm inside diameter pipe is bolted to the bottom front of a heavy flail type lacerator forage harvester so it bends the pasture over to 5 cm from ground level; pasture then gets cut off at that height and is dragged around the haybar to lacerate it, but is not cut into shorter lengths. The lacerator leaves the hay spread out for fast drying. Turn it as soon as it is drier on top than below. A haybar reduces the power requirements so a mowing tractor can travel about 50% faster. This system makes full length hay that packs more tightly in bales. Baler pressure adjustments may have to be loosened. Animals like it so much that they turn up their noses at other hay. If you have both, feed the other hay until it is all finished. If you feed poor quality hay then good quality hay each day, in two days animals will learn to wait for the good.

Don’t cut for more than four hours and then start tedding immediately, unless there is a second tractor and driver. Ted again each time the hay is drier on top than underneath. This may mean tedding four times a day. Doing so achieves faster drying and more evenly dried hay.

If it is left for too long before tedding and the top becomes over dry, the quality will be lower and clover leaves will be lost. Bale as soon as there is no obvious moisture in the hay. If too moist it will heat, ferment and/or go mouldy, which must be avoided.

The dryness of lacerated hay can be deceptive, because it can feel drier than it is. Baling at moisture levels above the optimum will cause heating and spoilage of the hay. Conversely, baling at moisture levels below the optimum causes excessive leaf loss which translates into lower quality hay. The optimum moisture for baling is not a constant and depends on the bale size being used.

Moisture for small rectangular bales should be no higher than 20%, unless a preservative is used to reduce mould. The upper moisture limit in large bales, both round and rectangular, is about 16% to avoid excessive heating during storage. In dry climates if large round bales are stored outside and uncovered, moisture content at baling can be up to 20%.

Determining moisture content can be done with a microwave oven or Koster moisture tester before baling, or an electronic moisture meter at baling. When using an electronic moisture meter, probe from the end of rectangular bales and through the rounded diameter of round bales. At least five probes of each bale should be taken and the readings should be averaged. If readings vary more than three percentage points, more probes should be taken and the average calculated.

Many factors can affect a meter's accuracy such as bale density. Tightly packed bales will give the most accurate readings. The use of chemical preservatives is another factor that may affect the accuracy of electronic moisture meters. Some chemicals such as propionic acid can increase readings as much as four percentage points. If preservatives are used and the instruction manual for the moisture meter does not provide information about effects of chemicals on meter performance, contact the manufacturer for additional information.

In practise there can be areas of a paddock where the hay is not as dry as it should be. These can be sheltered areas, the corners or in the shade of hedges or trees. The wet bales should be left spread out in the barn or kept out of the stack and spread out to dry. If rain is likely cover them as best you can. If there are a lot, stack and cover them, then unstack them to dry after the rain stops.

If for any reason the hay is baled before it is fully dry (and this should be avoided if possible), then stack small bales loosely to allow air to move around them, and don't go any higher than necessary to get them under cover. They can be stacked higher and closer later, when dry, which will turn them at the same time. With large bales stacking loosely is not practical or helpful because there is so much in the bale which can heat and go mouldy. If you have to bale moist hay, then loosen the adjustments to make the bales less compact.

If hay is stacked when damp containing a level of 85% dry matter (DM) it can heat, and at about 75% there is a risk of spontaneous combustion making it catch fire, and, if not, mould will develop which will lower its feed value and the dust can cause severe human and animal health problems.

When the temperature of hay rises above 55 degrees C flammable gas is produced that can ignite. This generally does not occur after six weeks.

There are mould inhibitors which can be added at baling. Use only ones that don’t corrode the baler, but they or salt won’t save the hay from burning if the DM is under 70%.

Heating hay will smell and steam may rise from it, so open it up, turn the bales, spread them around, immediately, but be careful of combustion. If fire is imminent phone the fire brigade and never walk on the hay. It could be ready to ignite, which needs air. Not much can burn without air. Disturbing smouldering hay can let air in and flames can occur in a flash, so be careful. In addition, heating hay can give off highly toxic fumes.

All the above gives the message that planning is essential. Don't mow if rain is likely. Mow with a lacerator and turn frequently to halve the drying time. If rain occurs unexpectedly you'll get some warning, so make vacuum silage or baleage before rain falls. Material which is too dry for silage and gets wet will still make reasonable vacuum silage.

It is not only moist hay which can combust; dry silage, damp leaves, oily rags, coal and even bodies can burn without a match.

More facts and figures on heating, fire and temperatures are on -
http://www.montana.edu/wwwpb/ag/hayfire.html

Benefits of lacerator hay include -

- The hay can be cut earlier in the season which gets all paddocks growing again well before the dry weather sets in.
- Drying time is halved, frequently meaning that hay can be brought in before rain, which may come after two days. Getting a two or three-day drying period is easier than getting a four-day one.
- Quality is far superior. Try feeding conventional hay after having fed forager hay and the stock will frequently walk all over it looking for the quality hay to which they have become accustomed.

Quality

25 cm (10 inch) high grass and clover hay lacerated pre-flowering and baled within 36 hours has a feed value almost as good as grain and has more minerals. Good quality hay can reduce the requirement for grain or concentrates and give healthier animals than those fed too much grain or too much very short (< 15 cm) immature pasture, even with over-mature hay. Good hay is also valuable for rearing calves and building their rumen.

As pasture grows in height above 25 cm (10 inches) it decreases in feed value. Taking longer to dry makes it lose feed value, and the net animal production per hectare or acre cut doesn't increase. In fact it can decrease if they eat less of a poorer quality feed.

When I was invited to Cornell University in 1982 to discuss growing pasture and grazing, they were making hay from 90 cm (three feet) high mainly orchard grass with no clover at that height, so I pointed out to them that it was 'bedding' and this was a reason they had to feed so much grain to get good animal production. The crude protein of lacerated 25 cm tall good grass and clover hay can be double that of 90 cm clover-less hay, which costs twice as much per kg of protein.

If you have both, feed the other hay until it is finished. If you feed poor quality hay then good quality hay each day, in two days animals will learn to wait for the good.

The best quality hay comes from pasture that -

- Is not too long and definitely not seeding.
- Is dense and leafy rather than tall, stemmy and spindly.
- Has a reasonable percentage of clover or other legume.
- Was not boosted with artificial N which increases the moisture content of pasture so lengthens the drying time. It also lowers the mineral content (magnesium, calcium, sodium, copper and boron) and decreases the clover content.
- Is cut at midday after at least one day of sunshine.

Hay has an advantage over silage in that it is relatively easy to store, easy to transport and easy to break down into small ration quantities without deteriorating in the first year. This might be an important consideration for those who are grazing stock off the property, by having a few bales

around to feed a sick animal.

Hay can quieten stock like no other feed supplement will. This can be very useful when using on/off grazing practices over the winter wet periods. After receiving their daily grass break, confining cows to a small sacrifice area with even a small amount of hay will quickly see them eat it and lie down and start chewing their cud.

All calves should have access to good pasture hay from a few days old and every day thereafter until well after weaning. This will significantly help in rumen development. Calves fed ample milk, too much grain, and pasture, tend to develop pot bellies - not large rumens. Ruminants must be encouraged to eat plenty, thus encouraging the development of a large rumen in calves. Hay helps to achieve this.

Reasons for making hay include -

- Good quality hay with lush pasture is invaluable for high animal production and for growing good young stock.
- To feed during pasture shortages.
- To feed after the crop is finished and after autumn rains fall when the number of facial eczema spores are still high. It is most important to feed from the day of the first autumn rain until the pasture is long enough for the animals to eat it without scouring and suffering nitrate poisoning.

The reason for starting it when rain falls is because, while animals may have been getting enough sustenance from dryish pasture, they will not get the same value from pasture which starts to rot and grow mould after rain falls on it. The fresh lush pasture after autumn rains is not well digested until the cows' rumen bacteria adjust.

To harvest the surplus grass which grows in spring. If not needed it can be sold.

- Top quality hay is beneficial for calves from the first week of their lives to help develop their rumen, and it is a help to improve digestion when pastures are sappy as in early spring and autumn after warm growing rains produce lush low dry matter pasture.

Large amounts of hay can bind ruminants, and, if of poor quality, can even kill them if one is not careful.

Storing hay

In areas which have wet autumns and winters, it is important to store hay in a barn or under a cover to avoid waste. Covers must be held down with ample twine and weights such as tyres, or with netting. In dry winter areas it may not be necessary to put hay under cover, or even to bale it. In low rainfall and low wind areas the hay can be raked into large windrows and strip grazed in winter. Bales can be left and fed as the paddock is strip grazed.

Haylage or baleage

Haylage is in between silage and hay in moisture content with a DM of about 75%. Haylage is seldom stacked because it is too difficult to exclude all the air. It is usually baled and is sometimes called baleage. Some moulds/bacteria (bugs as far as animals are concerned, especially young stock) prefer silages above 70% DM.

Reasons for making haylage are -

- Bales are lighter than baled silage so more easily handled with an ordinary front end loader.
- Baleage is easier than baled silage to feed out with most types of feedout equipment.
- It is not as risky as hay to get in without getting wet.
- Not as leached as hay, so, if well made, has a slightly higher feed value than hay, but not as high as good silage.

Many farmers change from making baleage to making silage or hay because of the mould problem.

Mould & Poisons

Don't bale moist hay. Ideally hay should be at 86% dry matter (DM).

To measure the dry matter content take a large handful of the wettest hay and weigh it by drying it in an oven or microwave (using several small heatings) until it just about stops losing weight. Then weigh it and divide the dried weight by the original weight (say 90 divided by 120 = 75% DM).

Dampness and heat cause mould and a loss of nutritional value and can burn barns or stacks. I was told of a US farmer who always bought hay or haylage and had hardly any live calves born for two years, because of mould affecting the cows.

Using mouldy hay for bedding can cause mould allergies, and be toxic to animals and affect their health and decrease production without your realising it. Working with even slightly mouldy hay can affect health, causing coughs, respiratory problems and even severe lung damage (farmer's lung).

Stacking damp hay on pallets allows air to enter and rise through the hay, especially if small bales are stacked with gaps and with the cut sides up.

Good material well conserved doesn't need a preservative; however, mould inhibitors help make better quality hay when conditions are not perfect, and can be a good investment, rather than having done all the work, and ending up with poor quality hay which can be a liability, rather than an asset.

In New Zealand the handling of hay is seldom a toxic risk because almost all feeding is on pastures not in barns.

"Nine out of 90 cattle on a dairy farm in Finland died after being fed silage contaminated by animal carcasses [one would wonder how]. Clostridium botulinum type C was identified in liver samples. The importance of the acidification process in silage production to inhibit C. botulinum toxin production in silage and thus to prevent further botulism outbreaks was emphasised. Nevertheless, preformed toxin in the carcass is not destroyed by acid."

Carcasses of all types from rodents up should be got rid of correctly by disposal companies or burying at least a metre below the surface in a dry elevated area, not where moisture can leach from them.

One blue rodent poison has killed dogs, and poisoned rodents have killed owls. There are safe rodent poisons.

Feeding

The reason for starting feeding hay as soon as rain falls is because, while animals may have been getting enough sustenance from dryish pasture, they will not get the same value from pasture which starts to rot and grow mould once rain falls on it. Then the fresh lush pasture after autumn rains is not well digested until the cows' rumen bacteria have changed.

Using hay or silage troughs, rings or feeders (welded pipe hay & silage holders) on pasture is asking for mud and pasture damage. One person wrote on graze-l, "We have been feeding on the ground, as it got to be too deep with mud around the feeders."

Spread the hay out well on sloping, dry, clean, poor areas and there will be less damage, better fertility spread on the poor areas and the seed will do some good. There can also be less wastage of hay when fed directly on to pasture.

I don't like feeders on pastures, but if using one, an old big satellite dish can be used to protect the hay from rain.

Hay barn & stack positioning

The positioning of hay barns is important because they can be used for other purposes before and after the hay, such as a calf shelter, implement and fertiliser storage, sick cow bay, etc.

One barn near the farm dairy has many advantages, but if a second is half way down the farm it can be used to rear calves in cleaner worm free surroundings than exist around the dairy.

Even if calves are reared near the farm dairy, after weaning they can use a barn half way down the farm as shelter in bad weather.

Round barns are generally the best all round for security (they can have doors fitted), for keeping hay and fertiliser dry, keeping calves warm and they are less likely to be blown away in

storms. For these purposes, a second barn half way down the farm can save a lot of travelling.

They also cost less.

The farms I see with the healthiest stock are those that provide a little hay every day through the winter and early spring to all classes of stock.

The nutritional value of hay is most often summarised in terms of metabolisable energy (ME) as an indicator for potential cow performance. In these terms, hay is approximately 95% of the value of silage and only 88% of that is of good leafy pasture. However such analyses largely ignore the mineral content of hay.

Important minerals such as calcium, magnesium, sodium, copper and zinc increase in pastures during seed formation, some as much as five fold. These are harvested along with the hay and can play an important role in filling nutritional gaps over the winter and early spring period when these minerals are often lacking in pastures.

Having supplements in equal parts of hay and silage, or winter forage crops will be complementary in energy, protein and minerals.

When eating hay, stock produce copious amounts of saliva. Saliva is the important first step in the digestion process. Only small amounts of hay are required to produce this necessary saliva, and this helps considerably for the more efficient digestion of accompanying feed stuffs such as grass and silage.

Hay also provides a vital role in the chewing of the cud. Rapidly growing short spring pasture is high in moisture and low in fibre, with insufficient fibre to allow regurgitating and chewing of the cud. This process is very important for getting the most benefit out of feed that is eaten. Having even a little hay present will help initiate this process in stock grazed on soupy spring pastures.

The reasons for large stacks of loose or baled hay are to have the material compress itself and to save surface wastage. In wet areas cover the stacks.

The benefits of smaller hay and silage stacks around the farm are: less hauling, quicker storing and less feeding-face deterioration (oxidation and mould).

Tips

When making spring hay in temperate areas it is difficult to find many days of dry weather so cutting may have to be done after only one sunny day.

Don't store it under inflammable trees, and don't allow dead grass to grow up around the stack or barn. Have it in sight of your residence to see and discourage children from playing in it, and burning it.

Buying Hay

Before buying hay or haylage, check it for weeds, especially thistles some of which can prevent animals from eating hay, and (as best you can) for mites and other insects and of course the dry matter level. A US farmer itched for days each time he handled hay he bought.

Buying hay from good weed-free pastures provides seeds to grow on your poor areas.

Buying bad weeds in hay will cost you for decades.

Try to feed hay (and silage) on poor areas of paddocks to help improve soil fertility there.

Importing Hay

The first thing to check is freedom of diseases. Bedding straw from China brought Foot and Mouth Disease into Japan, costing them billions of dollars and losing thousands of their very valuable Wagyu cattle.

Imported PKE to New Zealand has had a sheep's leg and a whole monkey, and it comes from foot and mouth infected countries.

Vaughan Jones
Agricultural consultant & journalist
GrazingInfo Ltd