Hot silage is bad silage!

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Many farmers and contractors still think of silage in terms of being "cooked," referring to the amount of heat generated in the stack or bunker. The hotter the stack, the better the cooking. Wrong! The hotter the stack, the more you have stuffed the nutritive value of that stack! Silage actually undergoes a fermentation process and this activity does result in some heat being generated but should only be to the stage of being warm at most.

In a well compacted stack that is well sealed immediately, the average temperature of that stack should not rise more than about 5^0C to 12^0C above the ambient temperature at filling. However, temperatures can reach 43^0C to 54^0C in the upper layers of the stack during filling as a result of excessive air (oxygen) trapped in the surface layers of the forage. Temperatures at these levels favour unfavourable fermentation bacteria such as *Clostridi*a and *Enterobacteria* but storage temperatures at approximately 27^0C favour the desirable Lactic acid producing bacteria. Stack temperatures will decrease rapidly with further packing of new material or once the stack is sealed.

What causes this increase in temperature? The presence of air is the culprit. Air, actually the oxygen in the air, is the enemy of silage and becomes an issue from the moment the crop is mown.

Silage + air (oxygen) results in the production of Water + Carbon Dioxide + Heat.

Let's examine the ensiling process at each stage of harvest, why it heats and what can be done to minimise heating, thereby reducing substantial loss of quality and dry matter.

Mown crop. The mown forage continues to be metabolically active and plant enzymes systems continue to function, ie. the plants continue to "live", until the forage reaches a dry matter (DM) content of about 70% DM, well above stack and baled silage ideal DM contents for harvesting. However, this activity is greatly reduced once plants have wilted to about 50% DM as long as there is still food (substrate) available to the microorganisms. The longer the wilting period, greater are the losses.

Action: Increase the rate of wilting. Mow in fine weather. Use a tedder immediately after mowing and possibly ted twice early in the season. Mow with a mower-conditioner leaving wide windrows. Mow once the dew has lifted and avoid mowing late in the day.

Harvesting. Aim to harvest within 24 – 48 hours of mowing. Plant sugar losses due to plant respiration and aerobic microbial activity increase extremely rapidly after about two days after cutting. Proteolysis, the breakdown of protein to soluble non protein nitrogen (NPN) such as peptides, free amino acids and amides, although undesirable but unavoidable, is also reduced substantially if the forage is wilted to the correct DM content for stacks and bales within 24 hours ideally, or 48 hours at the longest period.

Action: Harvesting quickly. Ensure the contractor is on time. The forage harvester and baler must be of reasonable capacity for the size of the job and must be well maintained and routinely serviced. Any barriers to speed and efficiency of operation such as rough tracks, narrow gateways, long distances, etc. should be minimised. Chopping the material as short as possible will usually result in higher weights being carted to the stack or being baled per unit of time.

Compaction. Once the forage is in the stack or bale, oxygen is trapped amongst the ensiled forage and continues to allow respiratory activity of the plants and aerobic microorganisms.

Short chop length allows denser compaction and less air being trapped in the stack or bale. If sealed very soon after harvest, this trapped oxygen is “used” very quickly. In the right conditions, this then allows the anaerobic (no air) bacteria to increase in numbers and start to ferment the plants’ water soluble carbohydrates (WSC’s) to produce lactic acid. This does result in a slight drop in nutritive value from that of the original forage, but is unavoidable.

This fermentation leads to an increase in acidity of the forage which “pickles” the crop and maintains the nutritive value near the new level as long as air and water is prevented from entering the sealed storage.

If the forage is too long and/or too dry, compaction is difficult resulting in excess air being “trapped” in the storage resulting in extended respiration activity causing storage temperatures to increase.

If conditions are not suitable, a poor fermentation, or worse, eventual decomposition, will occur and the nutritive value drop off and loss of DM is much more severe. To add to the pain, the final silage will most likely be low in palatability, ie. animal intakes will be greatly reduced.

Action: Compact the stacks and bales densely. Drier the forage, shorter the chop length. Maintain sharp knives and chopping mechanisms to reduce needless fuel usage and more efficient cutting rather than “smashing” the forage. Spread forage thinly on the stack (no more than approx. 15 – 20 cm depth). Roll the stack slowly with heavy, wheeled equipment. Bale at a slightly slower speed than often used to produce denser bales. Net wrap bales rather than string to give a more even finish for wrapping. Ensile at the correct DM content for each silage form.

Sealing. Until the ensiled forage is sealed, the oxygen in the storage will be used by aerobic bacteria and respiration activity producing carbon dioxide, water and heat. The heated gas, or steam in extremely poor ensiling practices, escapes the storage but is immediately replaced by cooler air, setting up a convection cycle. This cycle is best stopped by immediately sealing the stack or bales as airtight as possible as soon as practical after harvesting is finished.

The rolling of the stack should have kept up with the harvesting so a final short roll at the end should be all that is required before final sealing. Rolling the next day really just pushes more air into the stack. If the stack sinks from the next day’s rolling, why is this? If rolling was well done during harvest, it should not be needed the next day. Obviously, if harvest is completed during the late hours of the night, practicality may dictate a quick morning roll and then sealing.

Unfortunately, many stacks are well covered but are very poorly sealed! Hence air slowly leaks into the edges and top of many stacks. Table 1 shows the DM losses of stacks left uncovered or that were poorly to well covered. The perimeter of the plastic should be sufficiently weighted or even buried to prevent any air from entering the stack. Adding weight such as tyres touching all over the stack or placing gravel-filled “sausages” every few metres and along all plastic joins greatly minimise air movement into or under the plastic sheets.

Bales should, ideally, be wrapped no later than a couple of hours after baling.

Action: Seal the storage airtight as soon as practical after harvesting is completed. Use ultra-violet light treated plastic film, placing the white side up. Consider using newer plastic films and sealing systems which incorporate an oxygen barrier which is 20 times more effective than existing plastic sheets currently available. Consider covering stacks temporally over night if harvesting over several days.

For baled silage, apply 4 – 6 layers of cling wrap film to bales ensuring no underlapping occurs and 55% stretch is achieved. Be aware that most new films now require 70% stretch, and possibly a change of gearing on the pre-stretcher or wrapper may be required.

Maintain the seal. Holes or deteriorating film will allow air entry resulting in aerobic microbial deterioration beginning anew resulting in temperature increases. Holes can be caused by many means and each should be prevented or avoided. The bigger the hole or longer the silage is exposed to air or drier the ensiled forage, the greater the amount of air entry, so greater the heat produced (cooking?) and substantially greater the losses in nutritive value and DM itself.

Action: Maintain an airtight seal. Regularly inspect storage for new holes and immediately repair them with plastic repair tape specific made for silage film. Lay vermin bait around bales, especially cereals harvested at the milk – soft dough stage. Avoid storage where tree twigs and branches may fall and control prickly weeds such as blackberries, thistles, etc. which start to grow amongst the bales.

Silage fermentation is highly complex and the above only scratches the surface albeit the most important aspects have been covered. Crop type, contamination with soil or effluent, heavy vs light crops, ambient temperature and effect of light to heavy rainfalls, ensiling too wet or too dry for each silage form, techniques for filling a stack, etc. can all have detrimental effects on the fermentation and influence the silage nutritive vale, DM losses, palatability of the silage and occasionally affect animal health.

Temperature is a result of air which allows plant, microbial, and chemical processes before, during ensiling and throughout storage. You have the control to ensure silage ferments and to prevent it "cooking."

Table 1. Dry Matter Losses (%) in Sealed and Unsealed Silage Stacks in Gippsland

Sample Depth (m)	Dry Matter Losses (%)			
	Unsealed		Sealed	
	Average	Range	Average	Range
0.3	40	13 - 66	15	1 to 31
1	25	11 to 40	8	0 to 17

Source: Hadera-Ertiro and Clarke, 1987

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