The full story about mouldy hay

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Mouldy hay is usually a result of baling forage too wet. Moulds live and multiply by consuming the energy and protein in the hay so the more mould, , the greater the loss of hay dry matter and nutritive value. Also if hay is too wet, heat and moisture (+ carbon dioxide) is produced compounding the problem that can lead to spontaneous combustion (a self-ignited haystack fire).

If heat exceeds about 38^0C in the hay, there is reaction a between the amino acids in the protein and the plant sugars (Maillard Reaction) that causes darkening and it becomes less degradable and/or less digestible. This is referred to as caramelized hay and recognized by brown to dark brown material in the centre of bales or stacks of bales.

This hay is very palatable to stock but the hay has lost much energy and digestible protein. If heating caused by various mechanisms (heat resistant bacteria and fungi, heat producing chemical reactions) continues and it cannot escape from the bale or stack, the next step is spontaneous combustion.

Mouldy hay starts in the standing crop. Plant leaves and stem surfaces are mainly covered with bacteria which helps protect the living plant from fungal infection and yeasts. Once mown the moisture content of the plants rapidly decreases.

The result is that the predominant bacteria and yeast on the standing crop are no longer competitive and becoming less so as the crop continues to cure.

Now conditions in the mown forage allow a new group of microbes (bacteria, some yeasts and a greater presence of fungi) to start multiplying. These feed off sugars and organic acids emitted from the plant during the curing process.

The more rapidly forage dries down in the windrow, the lower the dry matter losses occurring from the growth of fungi. Dustiness in hay without visible mould is usually a result of fungi growing in the windrow.

Once the forage is baled another new group of mainly fungi and yeasts start to multiply, especially when the moisture content is between 20 per cent and 30 per cent. These new fungi out-compete the windrow fungi because they grow at the lower moisture levels and higher temperatures that occur in baled hay.

Sorry for being scientific for couple of sentences, but in storage three of the main groups of fungi that start to grow are *Alternaria*, *Aspergillus*, *Cladosporum*, *Fusarium*, *Mucor*, *Penicillium*, and *Rhizopus* Some of the specific fungi that grow during bale storage such as *Aspergillis flavus*, are known to produce mycotoxins and may cause animal health problems.

However, the production of mycotoxins is minimal or non-existent in hay which has been cured to recommended levels (Table 1).

Remember temperatures within a bale almost always increase after baling due to natural plant reactions and increase in bacteria populations.

This is why moisture meter readings several days post-baling are higher than at baling.

However, the temperature never gets high enough to cause heat damage in well cured hay. Normally bale temperatures decline after about two weeks but in moist hay they can exceed 150^0C degrees in the following weeks, causing excessive heat damage, browning or even charring of hay, and at this stage potentially a high risk of fire.

The various types of fungi grow best in their own ideal temperature and moisture level, but interestingly, while mouldy hay and heat damaged hay go hand in hand, the fungi alone cause little heat damage.

Management-wise fungi do not grow well in hay at the recommended moisture levels for each bale form (Table 1).

Most hay made will have at least some mould growth. In hay, mould growth comprises mycelium and spores. Mycelium are the stringy growth structure of fungi and spores are the reproductive or seed like structures.

The main concern of mouldy hay fed to cattle is the total amount of mycelium and spores combined or the total fungal biomass but spores only can cause respiratory problems in humans and horse. In hay, the white mould is mycelium and the dustiness is from the tiny spores.

Mould and Hay Quality

Results from specific tests have shown even hay harvested under the best of conditions often contains 1 to 2 per cent total fungal biomass, but severely moulded hay may contain up to 10 per cent total fungal biomass. Cattle do not like eating mould and in the molding process, there is a substantial loss of other nutrients.

Standard chemical and NIR measurements of forage quality provide little indication of moldiness such that two lots of hay can have almost the same nutritive values with one be moldy and the other not. At this stage a visual appraisal extent of mould is the best we have in Australia.
The most common complaint about mouldy is the loss of palatability or refusal to eat it by stock but unknown whether this is due to taste, dustiness, or loss of feed quality, but all are likely factors. Very little research has been undertaken to look at the effect of mouldy hay on animal performance.

One feeding study conducted at the University of Manitoba with four month old Holsteins heifers were fed Lucerne hay at three different levels of total fungal biomass (1.7%, 3.2 % and 4.3%), remembering that hay made under ideal conditions can contain 1% - 2% total fungal biomass.

In this study, the young heifers could eat as little or as much as they wanted. Intake was 40 per cent lower for the heifers that were fed hay containing high levels of total fungal biomass.

To reduce mould growth there are several proactive management options that can be done.

How to Prevent Mould Development

Fungi are always present in the windrow and in the bale, so are always present. To minimise further mould growth is to do the obvious, bale hay at the recommended moisture contents (Table 1).

Yes, everybody knows that and it is much easier said than done. However equipment manufacturers have developed machines such as tedders and mower conditioners and are continually trying to find the perfect combination.

A not-so-common technique, well utilized by many in silage making, is to ted or spread the mown crop as soon as possible after mowing to increase the rate of water loss while the stomata are still open in the leaves.

This can reduce the curing period by at least one to three days, depending on such factors yield, curing conditions and soil moisture.

Mower conditioners with swath boards left as wide as possible can also save a day or so. Using tyned-

type tedders in pastures can leave a fluffier windrow compared to te roller types, although these are required for stemmy crops such as sorghum and lucerene,

For Lucerne crops only, hay desiccants such as potassium or sodium carbonate can reduce curing time by partially dissolving the waxy cuticle on the alfalfa stem allowing it to dry down faster, but climatic conditions can influence its effectiveness.
More commonly used currently is the use of a hay preservative. These limit microbial growth that contributes to heating and as well as restricting mould growth.

This allows hay to be baled slightly sooner, . slightly more moist than recommended, with reduced concern for heat or mould growth. The most effective preservatives are organic acids such as propionate and acetate which are very acidic or more commonly used now, are their derivatives such as sodium diacetate which are much less corrosive or dangerous to operators.

It is crucial to remember preservatives have to be added at recommended rates on a fresh weight basis but the potential for damage during storage will increase at higher moisture levels.

Some bacterial inoculants can be another method to potentially reduce mould growth. There are naturally occurring bacteria that can inhibit the growth of fungi in the windrow and after baling.

The aim of bacterial inoculants is to deliver sufficient numbers of these beneficial bacteria to inhibit the mould causing fungi and outcompete the bacteria that contribute most to heating.

Some cases bacterial inoculants have shown very good results in some conditions but sometimes they have not substantially reduced mould growth.

If using a TMR wagon for mixing mouldy hay with other feed ingredients, there are some products that can be added to the mix which can reduce the potential for mycotoxin toxicity

Bottom line: Cattle can tolerate slightly mouldy hay if introduced slowly or if diluted with other better quality feeds, however, avoid feeding mouldy hay to pregnant animals.

Table 1. Recommended moisture contents (%) for safe storage of hay in various bale types

Bale type	Moisture content range (%)
Small rectangular bales	16 - 18
Round bales (Soft centre)	14 - 16
Round bales (Hard centre)	13 - 15
Large rectangular bales	12 - 14
Export bales	Under 12