Why Does hay heat?

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Hay, on most occasions will undergo some degree of heating, but sometimes to the extreme when hay will catch fire on its own, referred to as spontaneous combustion. What causes this heating? Why does some hay heat more than others? What is the difference between bale types/

The only time hay will not heat once baled is when it has been baled at very low moisture contents (less than about 15% moisture). Unfortunately, baling hay this dry or drier, leads to dry matter (DM) and quality losses due to leaf shatter and leaf loss and these are the main contributors to high quality hay. This is overcome by baling the material when the evening dew comes in but then lifts moisture content somewhat above 15%.

Hay baled at slightly higher DM contents will reduce the above losses and will dry (cure) to a satisfactory level to allow safe storage in a shed. However, some losses will occur (4 - 5% of total DM) and are unavoidable. If hay is baled over 20% moisture content, the environment developed inside the bale will result in substantial heating and much greater loss of DM and nutritive value.

So what causes this heating?

Baling hay at safe moisture contents
The internal temperature of most well cured bales will increase slightly (warm to the touch) as a result of residual respiration by both plant cells and microbes associated with the plants in the paddock but will usually then cool down 4 – 5 days after baling.

Following this initial heating and cooling, a cycle of heating and cooling may occur several times for several weeks after baling due to the respiration by the micro-organisms that proliferated during the first heating phase. This evaporates off excess moisture until the hay reaches an equilibrium moisture content of about 15% moisture.

A rule-of-thumb to estimate yield loss of round bale hay is that 1% of original yield will be lost for each 1% moisture that is lost as stored hay reaches its equilibrium moisture content. For example, is hay is baled at 20% moisture and then dries to 14% moisture during storage, DM yield loss will be about 6 per cent.

This activity actually consumes or “burns” plant sugars, in the presence of air (oxygen), to produce energy for plant and microbial survival. This leads to the production of carbon dioxide + heat + water and is often referred to as “sweating” of the hay or “going through a heat”. This activity leads to the loss of DM (5% – 6 %) of the total DM) and energy, (1% – 5% digestibility units) of the hay due to respiration and microbial action is unavoidable.

Many farmers and contractors measure the moisture content of baled hay with portable capacitance moisture meters several days after baling and notice that hay was

baled wetter than they thought. It is simply extra moisture being released by the above activity.

Baling hay too wet (or becoming wet after baling)
However, excessive heating will occur in hay when the forage being baled is too wet (over 20% moisture in small conventional bales) or becomes wet (rain, flood, leaking roof, etc.) after baling.

This extra moisture results in sustained and excessive heat build up as a result of much increased plant respiration and microbial activity due to different populations (aerobic bacteria, yeasts and moulds). The environment inside the bales is now very warm-hot and moist and along with the supply of plant sugars, is now ideal for the exponential growth of heat resistant bacteria and moulds. Their existence results in substantial DM and quality losses, protein degradation, production of mould spores and potential for self-ignition (spontaneous combustion), i.e. haystack fire.

Both size and density of the large round and rectangular bales leads to even greater heating in haystacks compare to the conventional small bales. Density enhances spontaneous heating simply by packing more DM into each bale, but NOT by any change in the heat produced per unit weight of forage DM. Simply, the heat cannot dissipate into the atmosphere as quickly due to the size and density of these large d denser bales.

This problem is overcome by curing large rectangular bales more than large round bales which must be cured more than small conventional square bales. Table 1 shows the slightly changed recommended moisture contents for each bale type to allow for safe storage whilst minimising field losses.

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

Type of hay bale	Recommended moisture content* ranges for baling hay (%)
Small conventional bales	16 - 18
Large round bales (Soft Core)	14 - 16
Large round bales (Hard Core)	13 - 15
Large rectangular bales	12 - 14
Export hay bales	Under 12

* Hay stored at slightly above the maximum moisture content in each range will be reduced in quality and DM due to heating caused by yeasts, microbial respiration and possibly mould growth.

Two DEPI Information Notes, “What happens to hay when it heats” explains in detail the effect of heating on hay quality and “Haystack Fires (Spontaneous Combustion), explains the causes and processes leading to haystack fires.