

Hay shed fires

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What causes hay shed fires?

There are two basic causes of hay shed fire. The first is due to accident and poor preparation. In hot weather dry hay is easily set alight by sparks from machinery, hot exhausts, cigarettes, etc. Hay is also very vulnerable to bush or grass fires unless care is taken to prepare a firebreak before hot weather.

The second cause and focus of this Primefact is spontaneous combustion, where moist hay naturally generates enough heat to burn.



Source: NSW Rural Fire Service

What is spontaneous combustion?

Spontaneous combustion occurs when moist hay heats up due to a combination of natural microbial and chemical reactions. If enough air (oxygen) is present the moist hay may get hot enough to ignite, with fire then spreading through the stack or shed.

Factors which affect heating in hay include moisture, air temperature, humidity, bale size, density and stack arrangement and crop type, which influences water-soluble carbohydrate (simple sugar) levels.

As a general guide, hay which has more than 16–18% moisture is at risk of heating or going mouldy, which will affect nutritional quality of the feed. Over 20% moisture (80% dry matter) the risk of heating increases, and if hay is baled in the range 25–35% moisture (75–65% dry matter), then spontaneous combustion is likely.

Risk of heating is also affected by bale size, density and how hay is stored. Smaller bales have a relatively large surface area, so can dissipate heat. Under dry conditions hay in small bales and lower density round bales will continue to lose some moisture after baling. Once stacked in a shed the effective size increases and the comparative advantage of smaller bales to dissipate heat is lost.

Large rectangular or round bales retain more of the heat generated and are more likely to show heat damage as brown or charred hay in the middle of the bale. For this reason it is necessary to **reduce moisture down to 14–16% if making large bales**. (Check the recommended moisture content for your baler with your machinery supplier.) This gives a very narrow range of moisture levels suitable for making large bale hay.

If the forage is too wet the hay will heat but as it dries leaf shatter and field losses during baling are an increasing problem and can exceed 25% if the hay is less than 12% moisture.

Bale configuration will also affect heat build-up. Tightly stacked square (rectangular) bales will not allow air movement and heat will build up. Some arrangements of round bales may allow heat to dissipate out of the stack, however damage is still possible in the middle of the bale.

Crop type will also affect risk of spontaneous combustion. Uneven crops with varying yield and maturity, crops with a mixture of leaf and stem or crops with heavy weed infestations are all prone to uneven drying. Using a conditioner to crush to stems and a tedder to spread higher yield sections in a paddock will promote more even drying.



Source: NSW Rural Fire Service

Crops with high water-soluble carbohydrate (sugar) levels will support increased microbial growth and are at greatest risk of heating.

Look for signs of heating and monitor temperature

If the hay moisture level is known to be high due to poor wilting conditions, or rain or heavy dew after baling, the shed should be monitored. Signs of possible heating include steam or condensation under the roof. Check for a caramel or burnt tobacco smell. Smoke indicates the problem is serious!

Heating may be noticed within days of baling wet hay but can occur over 2 to 10 weeks. There have been reports of hay sheds heating 6 months after stacking but this is likely to be associated with a leaking shed.

A guide to temperatures using a metal rod

Temperature	How does the rod feel?	What does it mean?
50°C	Warm to touch but doesn't burn	Feed quality is being damaged
60°C	Uncomfortable to hold	Hotter than normal caramelising reaction, needs monitoring
70°C	Touch only, too hot to hold	Monitor regularly (several times a day), consider safety precautions. Move hay. Most microbes killed by extreme temperature
80°C	Too hot to touch. Dangerous	Get help! Water supply on hand before moving bales. Bales could ignite if moved and exposed to oxygen.
100°C		Critical. Hay is likely to ignite.
240°–280°C		Ignition point, depending on hay type and oxygen availability

If in doubt, monitor the temperature of a hay stack by driving a metal rod into the stack, leaving it several hours and then checking for warming (see the table below for more details). The metal rod can be left in place for ongoing monitoring or reinserted in other parts of the stack.

Note: One hot spot can start a fire and heat development is likely to be uneven across a stack, so the metal rod method can only be used as an indicator.

Some people have used a thermometer inserted down a pipe to measure temperature within the stack. This can be effective but risks introducing oxygen into a hot spot, which could then cause ignition. Specialist thermometers with a long probe can be custom-made or thermocouple wire placed in the stack as it is built.

Due to the many variables involved in spontaneous combustion it is not possible to be definitive about the temperature at which a haystack is definitely going to burn and therefore should be pulled apart to prevent a fire.

Measuring moisture (or dry matter) percentage

There are several ways of estimating the moisture content of forage before baling. In all cases the estimate will only be as representative as the sample being assessed, so it is always necessary to take samples from different parts of the windrow and different areas in the paddock.

With experience a visual assessment of the look and feel of a sample can be used. Generally forage which is dry enough for hay looks, sounds and feels dry and crisp. It will be brittle and snap easily, and bark cannot be lifted from a stem. Crush stem nodes with a hammer and look for signs of moisture.

A range of electronic moisture meters are available. These can be used to measure moisture percentage in the windrow before baling or in the bale using different probes. Moisture probes can be convenient but they must be calibrated to ensure they are accurate and reliable.

A microwave oven and digital scales can be used to dry a sample and calculate moisture percentage. (This method is widely used when assessing dry matter % for silage or pastures).

Hay additives

Several additives can be applied to hay to reduce or prevent mould growth and reduce the risk of heating. This can improve feed quality and reduce the risk of fire when adequate wilting is not possible and it is necessary to bale hay with more than 16 to 20% moisture.

The main additives are organic acids, most commonly propionic acid, which act to inhibit microbial development. Higher rates are required if the hay has 25–30% moisture. Follow manufacturer's guidelines because product type and concentration does vary.

Some specialist bacterial inoculants can also be used and have a similar effect. These bacterial inoculants produce their own organic acids such as acetic or propionic acid, which inhibit mould growth. Bacterial inoculants are best used on high-sugar (water-soluble carbohydrates), high-value crops, especially where there is variation in the crop and uniform drying to desired moisture levels is difficult. Refer to the manufacturer's guidelines when applying these additives.

Additives may have a role under difficult drying conditions, but good hay making practice, including the use of conditioners and wide swaths or tedders to promote rapid drying, is the preferred option.

Safety first

Be very careful if you suspect heating in a hay stack. Walking on the stack could cause it to collapse, especially if the centre is hot and has a burnt-out cavity. If you must walk on the stack, for example to insert a metal probe to check temperature, lay a ladder or wooden boards across the hay to spread weight. Use a safety rope and have someone to help if you get into difficulty.



Source: NSW Rural Fire Service

If moving heating bales from the stack, be **very careful**, as any disturbance could expose hot spots to oxygen and the stack could ignite.

Do not store flammable liquids, pesticides or fertilisers in hay sheds. Some fertilisers can explode or give off dangerous gases when exposed to intense heat.

Are you adequately insured?

The value of hay has increased significantly in recent years and insurance contracts may need to be updated. The hayshed and its contents may be insured under separate policies. Check your policy and be aware of any conditions that may affect your insurance coverage. Also check your policy for coverage of machinery or anything other than hay that is stored in the shed.



Source: NSW Rural Fire Service

More hay shed fires during drought

The drought years of 2006 and 2007 saw an unusually high number of hay shed fires at a time when drying hay would not be expected to be a problem. Many reports were of apparently dry cereal hay which had not been conditioned. It appears that although leaves were dry, the stem around the joints or nodes and seed heads still

contained enough moisture to allow a heating reaction to develop.

It is also thought that higher than normal water-soluble carbohydrate (sugar) levels due to drought effects meant this hay was more prone to microbial activity and so more susceptible to fire risk.

These problems were not detected by normal visual assessment, moisture probe or microwave testing.

Take extra care with drought-affected crops to ensure hay is dry before baling, and monitor sheds or stacks for signs of heating.



Source: NSW Rural Fire Service

Does silage burn?

Hay is preserved by drying. Silage is a wetter product which undergoes an anaerobic (no oxygen) fermentation. Effectively sealed, 'true' silage will not burn because it is too wet and no oxygen is present to support fire.

If a bushfire occurs the plastic seal covering above-ground silage will be destroyed, exposing the ensiled material to air and causing it to spoil.

Dry silage made at higher than recommended dry matter levels, in the range of 60 to 70% dry matter (40 to 30% moisture), is sometimes called haylage. This is similar to 'wet hay'. If this dry silage is not sealed to eliminate oxygen it will heat up and could burn.

Air pockets in dry silage are likely to heat, char and even smoulder. Dry silage may ignite if it is disturbed and air penetrates. If a smouldering silage fire occurs it is best to seal up the whole structure (bury with dirt if possible) for several weeks and the burning should stop once all the oxygen is used.

Effect of heating on feed quality

Wet hay may lose feed quality, either through development of mould and/or heating.

Mouldy hay may be rejected by animals and could cause respiratory problems for animals or people handling the hay. In extreme cases more serious

animal health problems could be associated with mouldy hay.

Heating is also associated with a drop of digestibility and energy levels and affects availability of plant protein. Although mild heating (caramelising) can improve palatability of some forages, the feed value and resultant animal production potential are likely to have been affected.

Excessive heating will cause charring in the middle of a large bale or burning of a stack, which obviously has a significant cost and impacts on feed supply.

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