Sprouted wheat, barley and triticale grains as feed for ruminant animals.

Pre-harvest sprouting (PHS) occurs when wheat, barley or triticale grain germinates prematurely before grain can be harvested. Prolonged wet and/or high humidity conditions that delay the harvest of grain are the predominant risk factors for PHS. Sprouted grain remains potentially very suitable as feed for ruminant animals. This document covers five key discussion topics relating to PHS grain. First, the reasons why PHS occurs are covered. Second, the reasons why PHS affects the quality of grain grown for human food and beverage, yet grains typically remain suitable as feed for ruminants are explored. Third, changes in grain quality that occur with sprouting are discussed. Fourth, the risk of fungal growth and mycotoxin accumulation is explained. Finally, ideas for harvesting or conserving sprouted grain for ruminant feeds are discussed.

What is pre-harvest sprouted (PHS) grain?

Pre-harvest sprouted grain is defined by many other terms including sprouted grain, shot or sprung grain, field sprouted grain or prematurely germinated grain. All terms relate to the same challenge – that cereal (wheat, barley, triticale) grains have started to germinate while still in the head of the plant. Sprouting typically occurs during or following wet and/or humid weather before or at the time of harvest.

Why might sprouted malting barley or milling wheat be diverted from the human food industry to feed barley or feed wheat for ruminants?

Sprouting can reduce the usefulness and value of grains grown for human consumption. For malting, PHS barley is less useful as grains may germinate less vigorously or some grains don't germinate at all. For flour milling, PHS wheat contains starch that is less suitable for flour-based food products. Sprouted grain is characterised by a lower than ideal falling number (meaning that enzyme activity associated with grain germination is underway. Enzymes are starting to break down the starch in the grain making it less suitable for milling).

Even though sprouted grains might not be ideal for human food and beverage manufacture, they'll still potentially be very useful as feed for ruminant species. Feed quality of sprouted grain is often the same or even slightly better than non-sprouted grain.

What changes to grain feed quality are associated with sprouting?

All aspects of grain feed quality, as relates to suitability of grain as a ruminant feed, may (potentially) change with sprouting. The extent (if any) of changes in digestibility, megajoules of metabolisable energy (MJME), starch and neutral detergent fibre (NDF) content depend very much on the extent of sprouting. Minor sprout damage won't necessarily change the feed quality of the grain from that of non-sprouted grain. If the root radicle of the grain is just visible as a white tip (so perhaps day one or two of germination), chances are the feed quality of the grain is just as good, if not slightly better than non-sprouted grain.

Major sprout damage will reduce grain feed quality. If both the root and shoot are visible and both are well extended from the grain, germination has been underway for some time – for several days at least. These more extensively sprouted grains will potentially contain less energy and are less digestible than grain with just the root radicle showing. Fibre content of extensively sprouted grain is higher than non-sprouted grain.

After day 7 of germination, when both root and shoot are emerged, useful nutrients including starch and amino acids are being converted into water soluble carbohydrates and fibrous cell walls. Adult ruminants can digest and utilise the higher levels of fibre present in sprouted grains. Rumen microbes break down and digest the fibre associated with root and leaf material to yield volatile fatty acids. In contrast, compared with ruminants, poultry are less well able to digest a higher content of fibre in sprouted grains, and poultry performance is more negatively impacted by less starch and more fibre contained in PHS grains. The animal performance consequences of the slightly reduced quality of sprouted grain are therefore less for ruminant species than for poultry.

The protein content of PHS grain isn't usually that different from non-sprouted grain. The profile of individual amino acids may change as the extent of sprouting advances. For ruminants, changed amino acid profile of PHS grain isn't of major concern, but might become more of an issue if PHS grains are included in pig and poultry rations. Fat (or lipid) content of PHS grain is slightly higher for PHS than non-sprouted grain, mostly to do with the increase in structural lipids linked with plant growth.

The percentage of PHS grain vs. non-PHS grain within a silo also influences the feed quality of the overall line of grain. The occasional sprouted grain is of minor consequence compared to a line of grain that contains 50% PHS grain.

Does the moisture content of sprouted grain differ from the moisture content of non-sprouted grain?

Yes. Sprouting grain is likely to have higher moisture content (so, a lower dry matter %) than dry, dormant grain. During sprouting, the grain undergoes cellular respiration. Respiration simply means that the grain, as a living thing, takes up moisture from rain or humidity and this initiates the germination process. Cells rehydrate and expand, and 'respiration' gets underway. During respiration, the starch within the grain is broken down to water soluble carbohydrates. Soluble carbohydrates in turn are used by the seed as a source of energy. Breakdown of carbohydrates during respiration releases energy, carbon dioxide and water. Water from respiring, sprouting grains increases moisture content of grain. The higher moisture content of sprouted grain increases risk of fungal growth in one of two settings. Firstly, increased moisture associated with sprouted grain when grain is in the paddock. These fungi are called field fungi because they literally grow on grain that's still in the head in the field. Secondly, when higher moisture, PHS grain is harvested and stored in a silo, risk of growth by storage fungi increases. It is essential to check and keep rechecking moisture content of all grain and the temperature of stored grain – but these checks are even more important for PHS grain. Higher moisture and higher temperatures increase risk of storage fungi growth and the potential accumulation of mycotoxins within grain in the silo.

Risk of fungal growth and mycotoxins in sprouted grain.

The higher than normal moisture content in PHS grain increases risk of fungal growth and mycotoxin accumulation. It is difficult to correctly predict risk of fungal growth, and the relationship between fungi and presence of mycotoxins within high moisture grain. Sometimes PHS grain appears discoloured with apparent fungi and moulds present yet mycotoxins aren't necessarily present. Conversely, the opposite may be true – that is, sometimes grain might appear bright and clean yet when tested, PHS grain may contain mycotoxins. The only way to truly define the presence of unwanted mycotoxins in grain is to collect samples and send to a reputable feed testing laboratory. Unfortunately, due to sampling error and sample collection technique, results are not always fully or correctly representative of the mycotoxin status of the entire silo of grain. A single sample may detect mycotoxins, yet that sample happened to be taken from one small area in the silo that contains mycotoxins. Conversely, a clear result on a grain sample (with no mycotoxins detected) may not correctly identify the presence of mycotoxins in other areas within the silo.

Fungi and mycotoxins are potentially undesirable for ruminant species for at least three reasons which are detailed below. The mycotoxins produced by fungi occasionally may make animals unwell and/or animals may grow or produce milk less efficiently. The presence of fungi and/or mycotoxins might increase risk of grain refusal by animals. Finally, (and this is a much less common risk), the growth of *Aspergillus* (a storage but not field fungi) in high moisture grain within a silo (but less likely pre-harvest while still in the paddock) could transfer mycotoxins, specifically aflatoxins, via lactating dairy cows into milk. Presence of aflatoxins is very low risk from feeding grains that have gone mouldy in the silo but do remain a hypothetical risk all the same.

Fungi, mycotoxins, and animal performance and wellbeing.

Mouldy grains don't necessarily contain mycotoxins. If in doubt, presume some toxins might be present. Depending on the types of fungi in grain, there are a wide range of mycotoxins that may negatively influence the ruminant animal. Sometimes the toxins change the rumen fermentation, including reducing the efficiency with which microbes can digest fibre. This may reduce dry matter intake. Other toxins can damage the liver and/or kidneys or other tissues within the animals. One mycotoxin, zearalenone, is potentially oestrogenic – potentially influencing reproductive performance in ewes and cows and causing enlargement of parts of the reproductive tract noticeable e.g. as swelling of the vulva of dairy cows.

Animals may refuse to eat PHS, fungal damaged cereal grains. Compared with clean, non-PHS grains, PHS grains that are discoloured with obvious fungi and moulds present may be less well accepted by sheep, cattle and deer. This isn't a given, and may not happen, depending on the extent of sprouting and presence or absence of fungi and mycotoxins. When blended with other feeds e.g. silages, less tasty grains won't be refused - which helps offset this problem. Dairy in-shed feeding systems that offer just grain and nothing else to hide the taste of grain might see more problems of PHS grain refusal and inconsistent intake of PHS grain - with some individual cows continuing to eat normally and others flatly refusing to eat the grain. Adding more palatable feeds on top of PHS grain via in-shed dairy feed systems, e.g. feed grade molasses, may improve the consistency of intake by cows of PHS grain.

The growth of storage fungi in the silo in high moisture grain may result in the accumulation of aflatoxins in cereal grains. The transfer of aflatoxins from grain to milk, when dairy cattle eat grain, may cause issues with the milk company that a dairy farm supplies to. Note that alfatoxins are only produced by storage fungi (those that grow in the silo on high moisture grain) – all the more reason to make sure sprouted grain is ideally at 15% moisture or preferably less at the time it goes into the silo.

The best work-around with risk of mycotoxins in PHS grain would be to consider blending a reputable, efficacious mycotoxin binder to reduce risk of mycotoxins causing health or animal performance problems. With several products available, ask a rural merchant or veterinarian for good evidence from the product supplier that the product will help with cereal grain-associated mycotoxins**.**

What to do with a PHS cereal crop?

Harvest grain as usual?

This is likely the best outcome for PHS wheat, barley and triticale grain. Minor sprouting damage may not have a massive impact on feed quality for sheep, cattle and deer. The most important issue will be to manage moisture content (dry matter, DM, percentage) of PHS grain. PHS grain must be dry enough (and cool enough) to store safely in the silo without 'sweating', heating and ongoing fungal spoilage in the silo post-harvest.

Silage or baleage?

No, this is not necessarily a practical option for mature standing grain crops where the PHS grain is well past the dough stage. The moisture content will be too low (that is, the dry matter % is too high) to encourage an active ensiling process that will successfully stabilise the feed. Once whole plant, whole crop cereal dry matter % is higher than 50% there is insufficient moisture present to support any meaningful ensiling process. More likely there will be massive heating of the baled or stacked cereal forage and grains, with extensive associated loss of feed quality.

Hay

Cutting a PHS crop for cereal hay is very unlikely to be a practical option under our cooler New Zealand late summer/early autumn conditions. Even if hay was a practical option in some hotter, drier regions, care is required cutting barley crops for hay. Sharp barley awns in hay can cause problems when animals, cattle particularly, eat barley hay.

Bagged grain with additives to ensile grain

Contractors and companies may offer processes as alternatives to heading PHS cereal grain crops. PGG Wrightson Grain is not recommending or endorsing these treatments, rather the information below acknowledges that some processing options may, under some circumstances, be suitable as ways to preserve PHS grain. Below are two reported methods of preserving grains (so, stopping ongoing fermentation of moist grain and preventing ongoing fungal growth) including alkagrain or propionic acid. Note that these processes can be quite expensive on a cents per kgDM of grain treated. Consult with the appropriate experienced rural professionals to ensure that the PHS grain crop is suitable for preserving in one of these ways, and that a cost-effective outcome will be very likely before committing to these processes. Note that these processes will NOT neutralise or remove mycotoxins that may already be present as field fungi, pre-harvest.

Alkagrain. Cereal grains are harvested at a higher moisture content / lower DM% than a finished mature grain – usually between 15 and 25% moisture (so, between 75 and 85% DM). The grain is processed e.g. crimped then a specific commercial product that contains urea (enzymes, and other additives such as soybean meal) is carefully blended through the grain. The grain is either bagged up or tightly sealed under plastic (to hold in the ammonia gas produced from the breakdown of urea) and left for at least 2 weeks before feeding out. The grain is preserved by the urea being converted to ammonia which increases the pH of the grain upwards of pH 8 or more, stopping ongoing fungal and mould growth. Note - NEVER simply add straight fertiliser grade urea to the grain, always use a proprietary product designed specifically for this purpose.

Propionic acid-based preservatives. As for alkagrain, cereal grain is harvested at a high moisture (lower DM %) than mature grain, typically between 15 and 25% DM. Grain is processed e.g. crimped and blended with propionic acid at varying rates depending on the moisture content of the grain. Propionic acid preserves the grain by reducing grain pH (so it's working in an opposite manner to alkagrain). Low pH stops ongoing growth of fungi in the grain.

This information provided by PGG Wrightson Grain is of a very general nature and is not intended in anyway to be prescriptive for all situations. Work in with local rural professionals including your PGG Wrightson Arable Representative, local agronomist, farm consultant, and/or farm contractor. Each and every crop will be very different as to the extent of sprouting and therefore ideas about what to do with the grain. In many cases you may do nothing different from previous years if the extent of sprouting is very minor, but we do encourage you to talk to your local experts.

This information was originally posted in the Facebook ruminant nutrition group 'The Rumen Room' by veterinary nutritionist Dr Charlotte Westwood, PGG Wrightson Seeds