BETTERRETURNS

AHDB

The cereals directory

BEEF & LAMB

Contents

The information in this booklet has been compiled by AHDB Beef & Lamb Livestock Scientist Dr Mary Vickers and ADAS, with guidance from a number of other industry experts.

AHDB is grateful to all those who have commented and contributed to this publication.

Photography: JGO Norman, Limagrain, FiveF Agri LLP, Kelvin Cave, DLF Trifolium, AHDB Cereals & Oilseeds, Harper Adams University, Mark Bassett and Richard Webster Nutrition Ltd.

Key to abbreviations used in this guide

ADF	Acid detergent fibre
Ca	Calcium
Co	Cobalt
Cu	Copper
CP	Crude protein
DM	Dry matter
DMI	Dry matter intake
K	Potassium/potash
ME	Metabolisable energy
MC	Moisture content
Mg	Magnesium
MJ/kg DM	Megajoules/kg dry matter
Mn	Manganese
N	Nitrogen
Na	Sodium
NDF	Neutral detergent fibre
P	Phosphorus
Se	Selenium
Zn	Zinc

Introduction

Cereals can provide ruminants with a rich source of energy in the form of starch that can, when fed with care, have a positive effect on animal performance.

Cereals provide livestock farmers with a variety of feeding options that can be adapted to meet the needs of the rotation, the livestock and production system. They can also exploit soil fertility, following a grass ley and other forage 'break crops', and fit well into a mixed farm system.

This directory considers a range of methods for harvesting, processing and storing cereal crops destined to be fed to beef cattle and sheep.

Average nutrient composition is provided. However, there is much variation in nutrient composition, so it is always recommended to analyse individual crops.

On farms where growing cereals is viable, it can be useful to grow crops for home consumption. It will also provide some straw, and cushion the business from external influences that affect feed and bedding prices from year to year. However, there will be a number of factors to consider before growing cereals on livestock farms. These include the minimum viable yields required, how good is crop agronomy, coping with difficult harvesting conditions, equipment and availability of local contractors, and the need to consider greening requirements for Basic Payment Scheme calculations.

Dr Mary Vickers
AHDB Beef & Lamb
Livestock Scientist

Tips for feeding cereal grains

In general, cereal grains have high energy and starch content, modest protein and low fibre levels.

They are deficient in certain minerals, especially calcium (Ca), and vitamins A, D and E. Maize is also very low in all trace elements.

Do not feed cereal grains alone. Always provide a source of long structural fibre as well. Consider the other ration components carefully, the feed requirements of the type of livestock, and the overall nutrient balance and physical structure of the ration.

Processing

In most cases, cereal grains need to be processed or rolled to crack the seed coat before being fed to cattle. The exception is oats, which can be fed whole to calves up to eight months of age before processing is recommended. The extent to which dry grains are processed should be limited to that needed to achieve an acceptable level of digestion. They should not be ground too finely as this can cause rapid fermentation in the rumen.

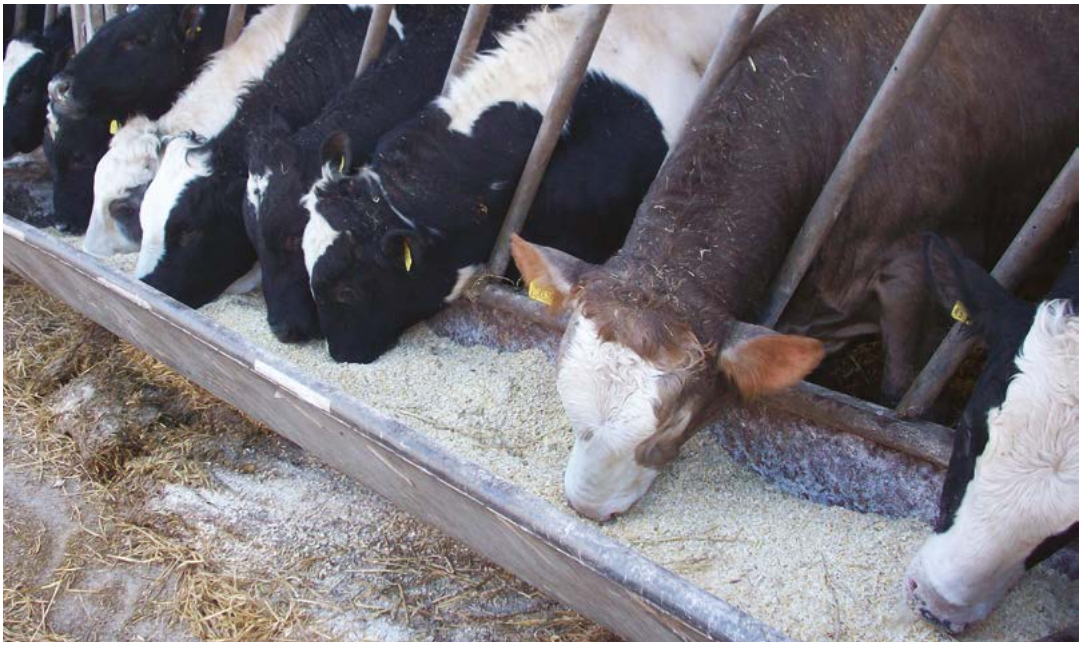
Whole grains (other than maize) can be fed to sheep over two months of age, as the slow rate of passage of feed through the gut means they can be fully utilised.

As well as saving the processing cost, feeding whole grain to livestock means the starch is released relatively slowly so the risk of acidosis is much reduced. A proportion of whole grains may come through the gut undigested if forage quality is high.

Feeding options

Cereals can be fed as a supplement to forage to provide mainly energy and starch, or as the basis of an 'intensive' ad-lib system, alongside a source of long fibre such as cereal straw.

If fed separately, care should be taken not to overfeed cereals at any one time, to avoid digestive upsets, which can reduce intake and animal performance.



Where large amounts of cereals are fed, they should be offered as multiple feeds spread throughout the day. No more than the following amounts should be fed at one feed:

- 2.5 kg/head for cattle over 400 kg liveweight
- 2 kg/head for cattle over 250 kg liveweight
- 1.5 kg/head for cattle up to 250 kg liveweight
- 0.5 kg/head for sheep

It is also important that feeds are nutritionally balanced with the right level and quality of protein and minerals, dependent on age, type, breed and required performance of the livestock. If in doubt, consult a ruminant nutritionist.

Where cereals are fed separately in restricted amounts to the base forage or main ration, there must be enough trough space for all cattle to access it together, easily and without stress.

When feeding ad-lib cereals or a high cereal total mixed ration (TMR) diet, ensure that fresh feed is always available to appetite. Be aware that sheep are able to sort out whole grains in a TMR.

Milling wheat or malting barley rejected for human food can be fed to livestock, as long as it is free from disease and moulds, but check rations are balanced appropriately. Grain harvested moist and sprouting can be preserved using propionic acid or urea, and safely fed to livestock.

Avoid mouldy grain

Whatever storage system is used for cereals, it is important to avoid feeding mouldy grains.

Grain affected by fusarium or ergot must not be fed, as the mycotoxins produced can seriously affect animals, e.g. poor production, abortion, kidney failure and even death.

It is important to control disease in growing crops to avoid these problems.

Consider testing for mycotoxins if there is a likely incidence of fusarium in the crop, or visible signs of chalky white, shrivelled or pink grains. When taking samples for testing, make sure a fully representative sample of the whole heap or bulk load is taken, as distribution of mycotoxins is not necessarily uniform.

Useful information on mycotoxins is available in the BRP+ document ***Mycotoxin contamination in animal feed*** and forages, available at **ahdb.org.uk**

Barley

Barley is a palatable feed with high levels of energy and starch. It is low in fibre and has modest protein levels. Levels of Ca and vitamins A, D and E are low.

Growing

Soil

Grows well on light soil and good loam. Sensitive to low pH – needs 6.2 minimum.

Yield

Typical yield for winter barley is 9.4 t/ha, spring barley is 7.4 t/ha.

Varieties

Specialist varieties available according to sowing season. See **ahdb.org.uk** for recommended varieties.

Sowing time

Optimum sowing dates range from September to October, and late January to end March. Spring crops can be susceptible to frost damage.

Fertiliser

Carry out routine soil testing every three to four years to check pH, P and K. More information in the ***Nutrient management guide (RB209)*** or consult a FACTS qualified adviser.

Weed control

Pre-emergence and post-emergence options available. Consult a BASIS qualified agronomist for specific recommendations.

Pest control

Pests predominantly influenced by previous cropping and soil type, e.g. wireworm and leatherjackets may be a problem after a grass ley. See AHDB ***Encyclopaedia of pests and natural enemies in field crops***.

Disease

Plan to avoid or control aphid-transmitted viruses and foliar fungal diseases. See AHDB ***Controlling aphids and virus diseases in cereals and oilseed rape***.

Feeding

Barley grain is usually fed as a supplement to forage. However, where the target is for very rapid daily liveweight gain, e.g. in cereal beef systems, barley can be fed to appetite. Introduce gradually over a minimum of 10 days by increments of 0.5 kg/head, every other day.

If it is truly fed ad lib, the troughs/hoppers should always be topped up with fresh feed, and the ration balanced for protein, minerals and vitamins.

When barley is fed to appetite, a source of fibre should be provided in the form of long clean cereal straw, aiming for an intake of around 13% of DM intake (up to 2 kg/head/day), depending on animal liveweight. Do not rely on cattle consuming enough bedding; have straw available in feeders.

When cereals are fed moist, supplementation with vitamin E and selenium is essential, as both are reduced in wet grain, due to the fermentation and oxidation process.

Table 1. Average nutrient composition of dry barley grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
86	13.2	12.1	21.1	3.0

Starch	Sugars	Ca	P	Mg
59.0	3.0	0.1	0.40	0.12

Wheat

Wheat is a high-yielding, palatable cereal grain, with high levels of energy and starch. It is low in digestible fibre but its protein level, although modest, is higher than other cereals. Levels of Ca and vitamins A, D and E are also low.

Growing

Soil

Grows best on fertile, well-drained clay and loam.

Yield

Typical winter wheat yield is 10.4 t/ha, spring wheat is 7.5 t/ha.

Varieties

Specialist varieties available, according to target market and sowing season. Group 4 varieties are the feed types. See **ahdb.org.uk** for recommended varieties.

Sowing time

Optimum sowing dates generally range from September to November, and late autumn through to April.

Fertiliser

Carry out routine soil tests every three to four years to check pH, P and K. More information in the ***Nutrient management guide (RB209)*** or consult a FACTS qualified adviser.

Weed control

Pre-emergence and post-emergence options available. Consult a BASIS qualified agronomist for specific recommendations.

Pest control

Pests predominantly influenced by previous cropping and soil type, e.g. wireworm and leatherjackets may be a problem after a grass ley. See AHDB ***Encyclopaedia of pests and natural enemies in field crops***.

Disease

Plan to avoid or control aphid-transmitted viruses and foliar, root and stem fungal diseases. See AHDB ***Controlling aphids and virus diseases in cereals and oilseed rape***.

Feeding

The high starch level and low fibre content of wheat grain means it is very rapidly broken down in the rumen, so digestive upsets and acidosis can occur if too much is fed, and/or too little long fibre is offered. However, the high energy content means that good growth rates can be achieved and it is excellent for finishing stock, when fed correctly.

When fed moist, supplementation with vitamin E and selenium is essential, as both are reduced in wet grain, due to fermentation and the oxidation process.

The inclusion of wheat grain in a supplementary feed should generally be limited to 50% of the total DM of the supplement. However, this depends on method of processing. For example, crimped grain can usually be fed at higher rates.

Wheat can be included in rations fed to appetite (ad-lib or in a total mixed ration) to rapidly growing animals. However, its inclusion should be limited to 50% of daily DM intake with rolled barley, or 60% where it is fed alongside a high digestible fibre feed such as rolled oats, sugar beet pulp or soya hulls.

Processing into fine particles should be avoided and light rolling is preferable to grinding. Provide long fibre in the form of cereal straw, aiming for an intake of up to 2 kg/head/day depending on liveweight. Do not rely on cattle consuming enough bedding; have straw available in feeders.

It is always advisable to seek the advice of a ruminant nutritionist when formulating rations.

Table 2. Average nutrient composition of dry wheat grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
86	13.8	12.8	14.0	2.0

Starch	Sugars	Ca	P	Mg
69.0	3.5	0.04	0.35	0.11

Oats

Oats contain more fibre than other cereals, but are lower in energy and protein. They are low in Ca and vitamins A, D and E.

Growing

Soil

Better nutrient scavenging ability than wheat or barley so may be suited to poorer soils. Less sensitive to soil acidity and will grow well at pH 5.5.

Yield

Typical yield for winter oats is 8.4 t/ha, spring oats is 8.2 t/ha.

Varieties

Specialist varieties available, according to sowing season. See **ahdb.org.uk** for recommended varieties.

Sowing time

Optimum sowing dates range from mid-September to mid-October, and February to April. Autumn-sown crops can be susceptible to winter kill so spring crops are more popular in the north.

Fertiliser

Carry out routine soil tests every three to four years to check pH, P and K. More information in the ***Nutrient management guide (RB209)*** or consult a FACTS qualified advisor.

Weed control

Avoid growing in fields with grass weed problems. Pre-emergence and post-emergence options available. Consult a BASIS qualified agronomist for specific recommendations.

Pest control

Pests predominantly influenced by previous cropping and soil type, e.g. wireworm and leatherjackets may be a problem after a grass ley. See AHDB ***Encyclopaedia of pests and natural enemies in field crops***.

Disease

Crown rust, powdery mildew, barley yellow dwarf virus and ergot can be a particular problem. For identification, see AHDB/BASF ***The encyclopedia of cereal diseases***.

Feeding

Oat grains can be fed whole to calves up to eight months of age (and sheep of all ages), due to their high fibre content and high percentage of husk, which take a long time to be broken down by rumen microbes.

Whole oats can be fed to older cattle but some grains are likely to remain undigested. If whole grains appear in the animals' dung, it is likely that rolling will improve their digestibility.

The relatively balanced composition of oats means they are less likely to cause digestive upsets and can therefore be fed in larger amounts than other cereal grains.

An upper daily inclusion rate of 50% of the total daily dry matter intake (DMI) is recommended, depending on level of performance required. This is due to their high oil level and lower metabolised energy content compared with other cereals.

Oats are an excellent feed for youngstock and breeding animals, but are less suitable for finishing rations, in which rapid growth rates are required. However, adding 10–15% of oats to high starch rations (above 36% starch) may be useful to improve rumen health.

Huskless (naked) oats with higher oil and lower lignin levels have been developed. Recent work, as part of a Defra-funded project, showed no benefits of huskless oats, in terms of methane reduction or improved animal performance. The focus for breeders will be low lignin husked oats.

Table 3. Average nutrient composition of dry oat grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
86.0	12.2	11.0	35.6	5.0

Starch	Sugars	Ca	P	Mg
42.0	1.0	0.08	0.34	0.10

Triticale

Triticale is a cross between wheat and rye. It is a good alternative to wheat, with higher protein levels and lower input costs. Generally, it has a higher nutritional value than barley but is lower in fibre.

Growing

Soil

Suited to marginal land and lighter soils. Needs pH >5.5.

Yield

Typical yield is 9.3 t/ha.

Varieties

See **ahdb.org.uk** for recommended varieties.

Sowing time

Optimum sowing dates range from September to early October for winter types, and from February to April for spring crops.

Fertiliser

Carry out routine soil tests every three to four years to check pH, P and K. More information in the ***Nutrient management guide (RB209)*** or consult a FACTS qualified adviser.

Weed control

Options can be limited as there are fewer herbicides approved for use on triticale than wheat.

Pest control

Wireworms, leatherjackets, aphids and slugs are common pests. See AHDB ***Encyclopaedia of pests and natural enemies in field crops***.

Disease

Powdery mildew, yellow rust, brown rust and ergot can be a particular problem. For identification, see AHDB/BASF ***The encyclopedia of cereal diseases***.

Feeding

A reasonably high-yielding crop, this palatable grain has high energy and starch levels but is low in fibre and protein. Levels of Ca and vitamins A, D and E are also low.

The recommended inclusion rate of triticale grain in a supplementary feed is similar to that of wheat and should be generally limited to 50% of the total DM of the supplement, due to its similarly low digestible fibre content. However, this depends on method of processing. For example, crimped grain can usually be fed at higher rates.

Triticale can be included in rations fed to appetite (ad-lib or in a total mixed ration) to rapidly growing animals. However, its inclusion should be limited to 50% of daily DM intake with rolled barley, or 60% when it is fed alongside a feed high in digestible fibre feed such as rolled oats, sugar beet pulp, soya hulls, oat feed or dried citrus pulp.

Processing into fine particles should be avoided, and light rolling is preferable to grinding. Provide long fibre in the form of cereal straw, aiming for an intake of up to 2 kg/head/day, depending on liveweight. Do not rely on cattle consuming enough bedding; have straw available in feeders.

Table 4. Average nutrient composition of dry triticale grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
86.0	13.4	12.0	13.2	1.9

Starch	Sugars	Ca	P	Mg
66.5	4.0	0.04	0.34	0.10

Winter rye

Winter rye is suitable for grain or as an early forage crop. Rye sown in the autumn is drought tolerant and very hardy. It can withstand low temperatures, and starts growing early in the spring.

Growing

Soil

Largely grown on light, low fertility, sandy or stony soils not suited to other cereals.

Yield

Typical yield is 9.4 t/ha.

Varieties

See **ahdb.org.uk** for recommended varieties.

Sowing time

Mid-September to end November.

Fertiliser

Carry out routine soil tests every three to four years to check pH, P and K. More information in the ***Nutrient management guide (RB209)*** or consult a FACTS qualified adviser.

Weed control

Options can be limited as there are fewer herbicides approved for use on rye than wheat.

Pest control

Wireworms, leatherjackets, aphids and slugs are common pests. See AHDB ***Encyclopaedia of pests and natural enemies in field crops***.

Disease

Powdery mildew, brown rust and ergot. For identification, see AHDB/BASF ***The encyclopedia of cereal diseases***.

Feeding

Rye grain has similar feeding value to barley. It is high in energy and starch and has modest protein content. However, it has high fibre content. Levels of Ca and vitamins A, D and E are low. Rye is very prone to shattering when processed and can be less palatable than other cereals.

Rye is susceptible to ergot. Toxicity problems, sometimes resulting in death, can occur if the ration contains more than 0.1% ergot bodies by weight.

Winter forage rye can be used for early grazing of cattle and sheep but matures quickly and becomes indigestible and unpalatable if not grazed effectively.

Strip graze from late February onwards or when the crop is 15 cm high, moving the electric fence daily where practical. As a general rule, 1 ha of forage rye will provide two weeks grazing for 25 suckler cows and calves or 50 to 60 ewes and lambs.

After the first grazing, the field can either be left and the regrowth grazed, or cultivated and drilled with a late spring sowing of forage maize or spring cereals. It can also be ‘zero grazed’, or cut and baled as late season forage.

Table 5. Average nutrient composition of dry rye grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
86.0	13.5	11.6	38.0	2.7

Starch	Sugars	Ca	P	Mg
45.0	3.0	0.06	0.5	0.1

Maize

In the UK, maize is generally harvested as the whole plant, chopped and made into silage. However, in the southern counties of England, increasingly it is being grown for grain.

Growing

Location

Suited to fertile soils in lowland areas. Can be sown under plastic on sites where reaching crop maturity may be difficult.

Soil

Will not tolerate compacted soils. Medium-textured soils are best.

Yield

Grain yield can be 7.5 t/ha. DM yield of wholecrop can be 17 t/ha.

Varieties

Variety choice is a compromise between DM content, yield, feed quality and resistance to lodging. See the descriptive lists for favourable and less favourable sites at **herbagevarietiesguide.co.uk**.

Sowing time

Maize is a tropical plant and, therefore, vulnerable to frost damage. Sow after 15 April, when soil temperatures reach 8°C for five consecutive days (or 6°C under plastic).

Fertiliser

Carry out routine soil tests every three to four years to check pH, P and K. More information in the **Nutrient management guide (RB209)** or consult a FACTS qualified adviser.

Weed control

Maize is not competitive when young. Weed control during the first six weeks post-drilling is critical.

Pest control

Wireworms, leatherjackets, fruit fly, slugs and birds are the main potential problems.

Disease

Look out for maize eyespot and *Fusarium* mould.

Feeding

Maize is high in energy and starch. Fibre and protein levels are low, and it is deficient in minerals.

Maize grain

Maize grain contains relatively high levels of by-pass starch (rumen undegradable), which is digested further down the digestive tract than other cereals. This means it works well in a mixed cereal diet.

Table 6a. Average nutrient composition of maize grain (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
65–86	13.8–14.5	8–10	12.1	4.3

Starch	Sugars	Ca	P
65–74	2.0	0.01	0.30

Maize silage

Maize silage is a high energy forage, with good levels of starch. It has good intake characteristics, high in digestible fibre, and increases overall forage intake when mixed with other forages such as grass silage.

Table 6b. Average nutrient composition of maize silage (% in DM or MJ/kg DM for ME)

DM	ME	CP	NDF	Oil
25–35	10.8–11.7	8–9	40–55	2.9

Starch	Sugars	Ca	P
25–35	0.5	0.4	0.20

Wholecrop silage

Wholecrop cereal silage is made by harvesting the whole plant and storing it anaerobically. It can be made from a wide range of cereals, clamped, baled and wrapped or conserved in a plastic tube. However, baled wholecrop, especially wheat, can attract vermin, so take steps to protect it. Ideally store on a hardstanding or concrete pad. If baling use six layers of wrap on bales at least, as wholecrop is drier and more susceptible to yeasts and moulds than grass silage. Chopping improves compaction, using an additive will help ensure a good fermentation and aid the keeping quality of the crop once exposed to air.

	Maize silage	Fermented wholecrop	Drier milled wholecrop	Dry alkaline wholecrop
Which species can be used?	Maize	Barley, wheat, oats, triticale	Barley, wheat, oats, triticale	Barley, wheat, oats, triticale
Harvest timing	25–35% DM The grains are hard on the outside but still milky on the inside. Grains nearest the stem are dimpled and feel waxy	30–45% DM Crop is just starting to turn yellow with grain at the 'soft cheddar' stage (about 4–6 weeks before conventional harvest)	45–75% DM Two to three weeks before conventional harvest. There is still some green in the crop	70–85% DM At the conventional combinable stage
Harvest equipment needed	Direct cut forage harvester with maize header	Direct cut forage harvester Disc mower and forager within an hour of each other	Direct cut forage harvester fitted with a grain mill	Direct cut forage harvester fitted with a grain mill
Field losses	Minimal in unlodged crops	Height of stubble can be controlled in direct cut systems Losses will be moderately low in well-timed mower and forager operations	Height of stubble can be controlled in direct cut systems Separate mower and forage harvester not recommended, due to high field losses	Height of stubble can be controlled in direct cut systems. Separate mower and forage harvester not recommended, due to high field losses
Additive options	Sulphite and potassium salts, buffered acid blends, inoculants and enzymes	Buffered acid blends, acid salts, sulphite and potassium salts, inoculants and enzymes	Sulphite and potassium salts, buffered acid blends, inoculants. Urea can be added to make urea-treated wholecrop	Alkaline ammonia release system, e.g. urea and enzymes
Storage	Clamp or plastic tube, sealed to exclude air	Clamp or plastic tube, sealed to exclude air	Clamp or plastic tube, sealed to exclude air	Clamp or plastic tube, sealed to exclude air

Table 7. Average nutritional composition of wholecrop (%in DM or MJ/kg DM or ME)

	DM	ME	CP	NDF	Starch	Oil	Ca	P	Mg
Maize silage	25–35	10.8–11.7	8–9	45	25–35	2.9	0.4	0.20	0.25
Fermented wholecrop	30–45	10–11	10	50	18–22	3	0.2	0.25	0.1
Drier milled wholecrop	45–75	10.3–11.3	9*	50	20–28	3	0.2	0.25	0.1
Dry alkaline wholecrop	70–85	10.3–11.5	14–16	55	28–32	2	0.2	0.25	0.1

*Protein levels will be higher if urea is added at ensiling

Maize silage

Forage maize is a very palatable feed. It has high energy and starch content but, if fed alone, its protein content is too low for cattle and sheep, so supplementation is required. Like all cereal wholecrops, it is low in minerals, vitamins and trace elements. When ordering mineral and vitamin supplements, tell the supplier they are to be fed with maize silage.

Fermented wholecrop

The ensiling of wet wholecrop cereals such as barley, wheat, oats and triticale will produce a feed of moderate energy content with low protein levels.

This can be a good option if, for instance, first cut grass silage yields were low or there is an obvious shortfall in forage for the winter. The combination of wholecrop with other forages fed together significantly increases daily DMI and helps maximise rumen function.

Cereal and legume bi-crops can make useful wholecrop silages, lifting protein content above that of the cereal alone.

Drier milled wholecrop

Drier milled wholecrop made from barley, wheat, oats or triticale has moderate energy and protein levels. Its starch content is usually higher than fermented wholecrop because it is harvested later.

It can be used in place of silage for growing animals performing at moderate levels and for pregnant livestock. However, take care to ensure it is properly balanced for protein, minerals and vitamins. Being relatively dry, an additive is advisable to control yeasts and moulds.

Adding urea to this type of wholecrop can increase protein content and inhibit spoilage and fermentation losses through increasing the pH. This typically raises protein content to between 14–16% CP in DM.

Dry alkaline options for wholecrop

The use of an ammonia-releasing product increases the crude protein level to around 16%. The ammonia stabilises the crop material and makes it alkaline. The feeding value is similar to that of good-quality grass or maize silage, which it can be used to replace a proportion of in the overall diet. Care should be taken to provide adequate levels of rapidly fermentable energy in the ration, to use the ammonia in the rumen effectively. This is a useful product to feed alongside acidic silage.

With all wholecrops, it is possible to increase the energy density of the crop by raising the cutting height so the proportion of ear to stem is increased.

Moist grain

High moisture grains can be preserved whole or crimped. Regardless of method, all grain harvested at above 14.5% moisture content should be treated with an appropriate preservative as quickly as possible after harvest, to reduce spoilage and nutrient loss.

Storage of moist grains reduces vitamin E and Se levels, due to fermentation and the oxidation process. Where ammonia treatments have been used, supplementation with sulphur is recommended, to enable the rumen microbes to use the nitrogen sufficiently, and an increase in trace elements is important. Discuss appropriate mineral and vitamin supplementation with your nutrition adviser/supplier.

Grain harvested at a moisture level over 30% contains soluble carbohydrates (sugar) and supplies digestible fibre from its unlignified seed coat. Effective preservation will retain these nutrients.

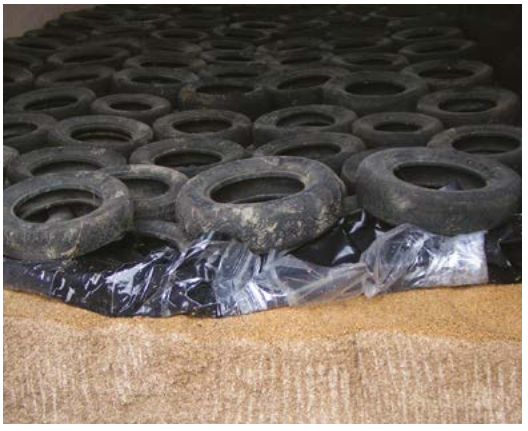
At a moisture content of 25–40%, grain can be crimped, treated with either acids or inoculants and ensiled within 24 hours of harvest; or it can be treated with urea and stored under a sealed sheet to contain the ammonia gas.

Grain harvested at moisture contents of 15–25% can be treated with propionic acid, after which it will keep for up to 12 months, depending on the quantity added. Alternatively, as long as the seed coat is not green, it can be treated with an alkaline ammonia release product, which, as well as preserving it, will increase crude protein content.

	Crimped	Urea treated	Caustic treated	Alkaline ammonia treated	Propionic acid
Which species can be used?	Maize, barley, wheat, oats, triticale	Maize, barley, wheat, oats, triticale	Barley, wheat, oats, triticale	Maize, barley, wheat, oats, triticale	Maize, barley, wheat, oats, triticale
Harvest timing	30–45% moisture content	30–40% moisture content	20–25% moisture content (harvested dry or rehydrated)	Less than 25% moisture content – ideally, at conventional combining stage	15–22% moisture content
Additives	Innoculant, acid or acid salt	Urea	Caustic soda	Alkaline ammonia release product – e.g. urea and enzymes	Acid, acid salt (non-corrosive)
Storage requirements	Crimp and then clamp or store in a plastic tube, e.g. sealed to exclude air	Loose, but sealed to keep gas in	Loose under cover	Initially clamped but can be uncovered, once stable. Needs to be rolled or cracked either at treatment or afterwards	Loose under cover

Crimped grain

The grain is mechanically flattened, causing the seed coat to break open. The addition of an effective preservative is required to restrict fermentation and improve aerobic stability, stopping the growth of yeasts and reducing heating during ensiling and feed-out. It requires a structurally safe, airtight clamp for storage. Vermin control is required.



Urea-treated grain

Feed grade urea prills are added to moist whole grains immediately after harvest (within 12 hours) to preserve the crop. They make the seed coat more digestible and increase the crude protein content to around 18%. Thorough mixing of the urea into the grains is required, to avoid nutritional problems. Fertiliser grade urea should be avoided as it may contain heavy metals. The urea treatment deters vermin.

Caustic soda treatment

Caustic soda (sodium hydroxide) works by breaking the seed coat of the grain, so it can be fed to animals without further processing.

There is a large moisture range for this type of treatment, the harvest window is wider. An additional benefit is that it is relatively alkaline and can help reduce the risk of acidosis, especially if treating wheat.

Grain can be treated dry by adding the appropriate amount of water at the time of mixing with the caustic soda. It is important to obtain the correct application rate from the caustic soda supplier. It is a hazardous chemical and should be handled with care, adhering to safety instructions.

Alkaline ammonia-treated grain

The grain can be harvested with a conventional combine and then rolled or harvested with a forage harvester, fitted with a grain mill. Ammonia releasing pellets need to be applied promptly after harvest and then the grain sealed in a clamp.

Grain can be harvested between 15–25% moisture and can be combined in slightly damp conditions, as a small amount of surface water can help processing. However, make sure the crop is fully mature, because immature and green grain have a higher level of sugar, which will affect preservation.

The alkaline pH produced can act as a buffer, which can improve rumen function. Crude protein content is also increased by 3–4 percentage units of DM, depending on pellet application rate.

Propionic acid

Non-corrosive forms of propionic acid are available that can be applied to either whole or processed grains under 25% moisture content. Grain should be treated straight off the combine to avoid drying costs. Treated grain does not need to be clamped but stored in a clean, dry, covered area or bunker. This option avoids the need to dry grain that is nearly at the conventional harvest stage. It also keeps the grain cool and discourages mites and weevils.

Feeding moist grain

Crimped grain

Crimped grain provides a high energy, moist feed, which could replace dry combined grain.

The starch is fermented more slowly than ground/rolled cereals, so the cereal inclusion rate can be increased without heightening the risk of acidosis, if fed in a correctly balanced ration.

Crimped grain, while not higher in protein than the original grain, does have a higher protein availability than later harvested crops. Also, the ability to harvest grain two to three weeks earlier than conventional harvesting reduces losses from grain shedding and provides an opportunity for establishing a forage crop in the rotation. The feed value of straw is also increased by the earlier harvesting, although it may require drying in the field before baling.

Urea-treated grain

Urea-treated grain can be fed whole but should be soaked before feeding if grains are seen coming through in the dung. While high in protein, it is mainly in the form of non-protein nitrogen, so feeding other sources of less rapidly degradable protein may be worthwhile for some classes of livestock. It also requires high sulphur minerals to be fed but feeding high levels of urea-treated grain can make copper more readily available, so avoid using high copper minerals. Storage of moist grains will reduce vitamin E and selenium content, due to fermentation and the oxidation process.

Caustic soda treatment

While further processing is not required before feeding, it needs to be thoroughly mixed in a diet feeder with the other components. High in sodium, this feed needs a low salt mineral and should not be fed ad lib. Increased urine output may occur, which will increase bedding requirement.

Alkaline ammonia treated grain

The grain should be left in a sealed clamp for at least two to three weeks. Alkaline ammonia-treated grain needs to be rolled before feeding. Can be fed to all categories of stock over three months of age. Its alkalinity has a beneficial effect on rumen stability. Sulphur and iodine supplementation is recommended with ammonia-treated grain, along with vitamin E and selenium.

Propionic acid treatment

The treated grain is highly digestible and should be rolled as coarsely as possible, maintaining large particle size to reduce the risk of acidosis. As with other moist grain treatments, vitamin E and selenium supplementation is required.

If unfamiliar with feeding moist grains, seek professional nutritional advice, as they are nutritionally different from dry grains.

When feeding moist grain, the amount fed should be adjusted to give the required dry matter intake. For example:

	Moisture content	Dry matter	Fresh weight of 1 kg DM (kg)
Dry grain	14	86	1.16
Moist grain	20 30 40	80 70 40	1.25 1.43 1.67

As with crimped grain, the earlier harvest can give reduced losses/higher DM yields and higher-quality straw.

Dry grain

Which species can be used?

Maize, barley, wheat, oats, triticale.

Harvest timing

<14% moisture content.

Additives

None.

Storage requirements

Loose under cover.

Feeding

Very dry grain can be difficult to roll without it breaking into fine particles. The starch is then very quickly fermented in the rumen and more likely to cause acidosis. If possible, feed a digestible fibre source with dry cereals, such as sugar beet pulp, oats or soya hulls. For example, include at a rate of 10% with barley and up to 35% with wheat, depending on processing method and cereal fed.

Alternatively, dampen the grain with water a few hours before processing to soften the seed coat, to help avoid grain shatter. However, be careful this does not cause the grain to heat and produce mould if stored too long or create blockages in hopper feeders due to 'bridging'.

Cereals are often deficient in protein for the class of stock being fed; digestible fibre content is low in wheat and triticale, and the grains can be deficient in Ca and vitamins A, D and E. Devise rations with the appropriate nutritional and mineral/vitamin balance.

Straw

Straw can be either harvested dry and baled, or baled and/or ensiled wetter as strawlage, for example after crimping. Strawlage can be expected to analyse with an ME up to 7 MJ/kg DM and CP 4.5–6% in the DM, compared with dry straw at 6 MJ/kg DM and 4% CP.

Moist straw (80–85% DM) can be treated with ammonia or ammonia-releasing urea-based pellets, such as the alkaline wholecrop and alkaline ammonia grain treatments. These will increase its protein content from 4% to 8–10% CP and improve its digestibility. Treated straw contains virtually no vitamins, minerals or trace elements and needs additional sulphur. Speak to the mineral supplier or a rumen nutritionist before feeding ammonia-treated straw.

This type of straw can be fed as a sole forage, along with the appropriate supplementary energy source and minerals. It can also be fed alongside other forages as a 'forage extender' or 'replacer', but care must be taken to balance the ration appropriately. Always seek nutritional advice before feeding.

Which option?

When deciding which cereal crop to grow to feed cattle or sheep, it is important to consider:

- Type of nutrition needed
- Soil type, fertility and climate
- Crop rotation plan
- Weed and pest burdens
- Experience of growing the crops
- Machinery/contractors required to harvest, treat and store
- Storage, handling and feeding-out facilities
- Cost-effectiveness of treatment options

Winter crops normally have higher yields than spring crops, but they tend to need more inputs – such as fertiliser and management time. Spring crops can provide areas for overwintered stubble or cover catch crops. The later spring crops also allow a chance for better control of perennial weeds and grass weeds.

Preservation

The options for preservation depend mainly on the DM content of the material being harvested, whether the grain and straw are being harvested separately, and the facilities for on-farm processing and storage.

Dry matter content will depend on date of harvest, maturity of grain and weather conditions. Harvesting the crop earlier than conventional combining can be beneficial, because it:

- Widens the harvest window
- Is less weather-dependent
- Allows earlier establishment of following crops
- Produces higher DM yields
- Reduces the need to dry the grain
- Offers the potential to feed higher levels
- Promotes better use of nutrients by ruminants, with less risk of acidosis

Types of storage available

Storage option	Clamps and plastic tubes	Barn stack	Wet grain storage on floor, possibly outdoors	Good grain storage
Suitable cereal feeds	Fermented wholecrop, urea-treated wholecrop, alkaline ammonia treated wholecrop, crimped grain, maize silage	Straw, strawlage	Urea-treated grain, alkaline ammonia treated grain, caustic soda treated grain, propionic acid treated grain	Dried grain, whole or rolled moist grain

Cereals harvest guide

Shaded boxes indicate stages of growth suitable for each conservation method.

Crop colour	Green	Green, going yellow		Yellow, hint green	Yellow, hint green on stem		Yellow/ brown green at nodes		Yellow/brown			Final % MC
Forage/ grain % DM at harvest	35	40	45	50	55	60	65	70	75	80	85	
Forage options												
Fermented	■	■	■									
Drier milled			■	■	■	■	■	■	■			
Dry alkaline								■	■	■	■	
Grain options												
Crimped					■	■	■	■				30–45
Urea						■	■	■				30–40
Caustic									■	■		20–25
Alkaline ammonia										■	■	<22
Propionic acid									■	■	■	15–25
Dry, rolled											■	<15
Grain % MC at harvest					45	40	35	30	25	20	15	
Grain texture	Milky	Soft cheddar		Hard cheddar			Very hard		Grains loose			

DM = Dry matter, MC = Moisture content

Beef and sheep BRP Manuals

Manual 1	Improving pasture for Better Returns
Manual 2	Assessing the business for Better Returns
Manual 3	Improving soils for Better Returns
Manual 4	Managing clover for Better Returns
Manual 5	Making grass silage for Better Returns
Manual 6	Using brassicas for Better Returns
Manual 7	Managing nutrients for Better Returns
Manual 8	Planning grazing strategies for Better Returns
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Produced for you by:

Better Returns Programme
AHDB Beef & Lamb
Stoneleigh Park
Kenilworth
Warwickshire
CV8 2TL

T 024 7647 8834
E brp@ahdb.org.uk
W ahdb.org.uk
@AHDB_BeefLamb

If you no longer wish to receive this information, please email us on **comms@ahdb.org.uk**

060004 0422

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