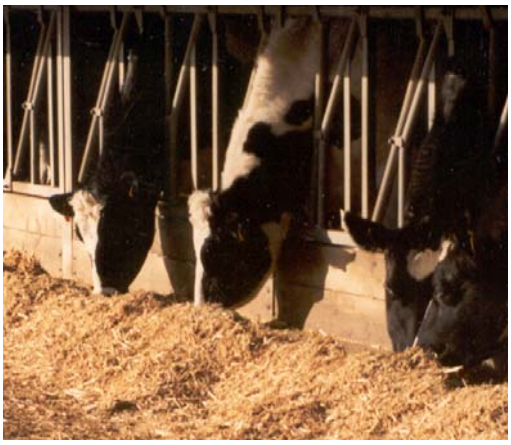
Cereal Options

A Technical Guide from ECOSYL Products Ltd



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Introduction

Cereals have always offered a highly flexible and reliable source of home grown feed, providing producers with the simple option of taking either the forage route by harvesting the whole crop, or the concentrate route by harvesting the grain on its own.

Recent developments in machinery, additives and conservation techniques have introduced a much wider choice of harvesting, storage and feeding options, greatly increasing the flexibility of the crop, but also causing some confusion on the costs, nutritive value and merits of the various systems.

One of the attractions of home-grown cereals used to be the arable aid payment which made even relatively low yielding crops a potentially worthwhile proposition. This advantage has now gone, most costings making wholecrop silage and maize similar and not much less than grass silage.

As with all crops, the yield achieved makes a big difference to the bottom line. If you have a track record of high DM yields it will almost certainly be worthwhile continuing to grow wholecrop cereals, especially if their inclusion has led to a significant increase in DM intake. If yields are only moderate you may need to reconsider. If growing spring cereals, undersowing will increase the total DM yield but remember, the wholecrop fraction will have reduced DM and grain yields.

This technical note aims to help producers find their way through the maze of options to determine the most suitable and cost-effective system to fit their individual circumstances and herd nutritional requirements. It includes a straightforward description of each system, covering equipment, labour and additive requirements, harvest timing and the key advantages and disadvantages, together with simple tables comparing production costs and nutritive value. Finally, a decision guide identifies the key factors to consider in determining the right system for you and your cows.

We have identified four wholecrop options and six grain options, each offering a range of harvest timings according to the desired crop dry matter as detailed in the Cereals Harvest Guide (Table 1). It is not possible to give dates as the stage of growth will vary with the season and location, but a guide to crop colour and grain texture is included to help you assess the crop DM in the field.

It is important to recognise that cereals are extremely prone to aerobic spoilage and that for all wholecrop and grain options, except when stored as dry grain, an additive is required. Failure to treat not only increases losses, with reduced palatability, intake and performance, there is also a significant risk of mycotoxins being produced by moulds with severe implications for herd health and fertility. There is also the danger that some mycotoxins can pass through the cow and contaminate the milk.

Forage or grain?

One tremendous benefit of growing cereals is that the final decision of when and how to harvest does not need to be made until after the first cut, even second cut, of grass silage has been taken. The cereal crop is grown the same way regardless of the conservation method that will eventually be used, allowing you to wait until you have a good idea of how your grass silage is going to turn out and can therefore more accurately predict your alternative forage needs in terms of yield and quality.

At its most simple, if grass yields are low such as in a dry or cold season, then bulk becomes high priority and cereals should be harvested as forage, taking the wholecrop route. If quantity is not an issue, then there is more opportunity to focus on increasing the overall quality of the home-grown ration by taking the grain route. Between these two extremes, the various options available within each route enable a finer adjustment between quantity and quality, and also allow you to consider additional factors such as harvest timing, processing requirements and cost.

Wholecrop Options - forage

- **Fermented**
- **Acid**
- **Urea**
- **Alkalage**

Grain Options - concentrate

- **Fermented**
- **Acid**
- **Urea**
- **Crimped**
- **Caustic**
- **Dry rolled**

Wholecrop Options

Wholecrop cereals can provide a strategic boost to forage stocks following a disappointing first-cut grass silage, but also have an important role to play in the use of mixed forage diets to increase dry matter intakes, either as a replacement for or alongside maize silage.

There are four methods to choose from; traditional fermented silage, acid treated and urea treated with either feed grade urea or a urea based additive. The fermented and urea options are limited by crop maturity. You cannot use a urea additive on immature or undersown crops as there will be some fermentation of sugars to acids in the green material, counteracting the alkaline effect of the urea. Conversely, the fermented option is only available for crops up to 50-55% DM as above this both water and sugars required for microbial fermentation may be limiting. Acid treatment is probably the most versatile option since, in theory, you could use it right across the DM range, although below 55% DM fermentation is always the most sensible option due to lower additive costs.

Fermented wholecrop

Many prefer the fermented option; it slots neatly into the majority of livestock systems with harvest often timed to follow directly after second-cut grass. The same equipment can be used and the wholecrop can be put on top of the grass clamp. By getting it off early there is the potential for an early re-seed or a catch crop or, if undersown, some useful extra grazing and/or some extra autumn silage.

Traditionally, fermented wholecrop is made at 35% DM at which point there is plenty of sugar but very little starch present. New additive developments, combined with good clamp management to control aerobic spoilage, have encouraged the production of fermented wholecrop at much higher DM, increasing both yield and nutritional quality.

Harvesting wheat just three to four weeks before combining, when the grain is at the soft cheddar stage and the crop just starting to turn yellow, will deliver a crop DM of around 45-50% (barley about 5% less). At this stage winter wheat can yield up to 15t DM/ha with a starch content as high as 35%, although 25-30% is more likely, without the risk of grains being too hard and passing through the rumen undigested.

The crop is best harvested direct using a self-propelled forage harvester with a combine reel or Kemper header, but it can be mown conventionally (ideally with a swather mower) and either picked up with a forage harvester or baled. But field losses will be higher using this method, especially if there is a delay in picking up.

Chop to about 2cm in length to ensure there is plenty of effective fibre without making it difficult to consolidate in the clamp. At this higher DM, cereals are prone to aerobic spoilage, so all the usual precautions must be taken to minimise the risk, eg fill in narrow layers (max 30cm), roll well and seal quickly and effectively with a weighted double sheet and treated with an additive specifically designed to control aerobic spoilage. At lower DM, fermentation is not usually an issue but at higher DM sugars may be in short supply and must be used efficiently so an additive that addresses this too would be best. Additives cost from around £1.40 per tonne of fresh crop, most offering either fermentation benefits or improved aerobic stability. DoubleAction Ecocorn provides both in a single pack, a chemical preservative (potassium sorbate) to reduce aerobic spoilage and MTD/1 inoculant to ensure the best use of the available sugars. In trials MTD/1 has been shown to give an extra 2.2 litres/cow/day with wholecrop wheat.

Wholecrop silage has a low buffering capacity so acidosis is not usually an issue, even when the pH is low. Also, the grains in fermented wholecrop are slowly digested and the fibre remains long so it can make up 100% of the forage ration.

Acid treated wholecrop

Although acid treatment is an option across the full DM range from 35% to 80%, with additives costing from around £4.50 per tonne treated, it is relatively expensive compared to inoculants and the new DoubleAction Ecocorn hybrid additive, precluding its use on crops harvested below 55% DM. Above 55%, however, it is a very flexible option, allowing you to harvest for quantity or quality.

Harvest is with a self-propelled forage harvester fitted with a combine or Kemper header and a grain processor, with the additive applied in liquid form at the forager, directly into the accelerator. Suitable additives usually contain propionic acid and/or its salts as one of the main ingredients as propionic acid is one of the most effective inhibitors of yeasts and moulds and some, such as Ecocrimp, have been treated to reduce fuming and corrosion, making them much

easier and safer to handle. The crop is clamped as for fermented wholecrop.

The main advantage over fermented wholecrop is that the later harvest allows you to benefit from higher yields of both DM and energy from the more mature crop. There is also the potential for increased DM intakes due to the higher DM of the final forage, particularly when fed in a TMR. Until recently, there was a problem with more mature the crop leading to a greater the likelihood of grains passing right through the cow, undigested. The development of forage harvesters with integral grain processors has solved this. They dent the grain rather than crushing, allowing easier access to the starch within.

In theory you could harvest wholecrop at up to 80% DM using such processors, but 70% DM is a more sensible target since above this level there is no significant increase in nutritive value and a greater risk of field losses due to grain shedding and chaff being blown away; chaff has a digestibility of 70-80%. Trials at Harper Adams have shown DM losses in excess of 1 tonne DM per hectare between 70 and 80% DM.

It is also possible to further increase the energy density of the resultant forage by raising the cutting height to increase the proportion of grain to straw. Although this reduces overall yield, the end product will have higher energy, protein and starch contents and at the extreme, just taking the cereal heads, it becomes more a concentrate than a forage, similar to crimped grain but with a lot less hassle. The straw can then be harvested separately for feeding or bedding.

The relatively low buffering capacity of wholecrop cereals makes them less likely to cause acidosis, even when they have a low pH. The amount of acid added to a high DM, acid-treated wholecrop will make no difference; it contributes less than 1% to the acids produced every day by rumen fermentation. But be aware that the processed grain in high DM wholecrops will ferment faster in the rumen so care is required if large amounts are being fed, particularly if the crop has been cut high to reduce straw content. Harvesting wholecrop at high DM can also result in straw shatter, reducing the amount of effective structural fibre in the diet and may mean straw needs to be added to compensate.

Urea treated wholecrop

Urea should not be used with low DM or under-sown crops because any green material included will ferment, producing acids that counteract the effect of the alkali preservative. Urea-treated high DM wholecrop is harvested in the same way as for acid treatment. Urea can be liquid or dry applied but application rates are high so it is usually applied at the clamp, requiring extra labour and machinery.

Most commonly, feed grade urea prills are applied with a fertiliser spinner at the clamp. It is very important that the pellets are incorporated evenly or preservation may be patchy. There is also a danger of toxicity problems in cattle ingesting pellets that have not completely broken down, this risk increasing with higher DM as the urea requires crop moisture to enable it to break down to ammonia.

$$\underset{\textbf{urea}}{CO(NH)_2} + \underset{\text{water}}{H_2O} \xrightarrow{\text{urease}} \underset{\text{carbon dioxide}}{CO_2} + \underset{\textbf{ammonia}}{2NH_3}$$

The breakdown of feed grade urea to ammonia is assisted by naturally occurring urease enzymes on the cereal plant. It is this gas that inhibits the yeasts and moulds that cause aerobic spoilage and also improves fibre digestibility to some extent. Minimal compaction should be applied at the clamp to allow the gas to distribute quickly throughout the crop. The clamp must be sealed quickly and tightly to prevent the ammonia gas escaping. Ammonia is heavier than air so will get out unless there are good side sheets, tucked under at the bottom. Leave for at least four, ideally six, weeks before opening.

Feed grade urea should be added at a rate of 2% on a DM basis and is a relatively cost effective treatment but assumptions that this will add 5% to the final crude protein content are incorrect as there are significant ammonia losses during the process. If you want to add non-protein nitrogen to the diet, it is much better to include it in the ration at feeding where you have more control and ammonia-N losses are minimal.

When successfully treated, urea wholecrop has a pH above 8 and is very stable once opened. The high pH is particularly useful where the crop has been cut high to maximise the proportion of grain as it helps to counteract the faster fermentation of the processed grain in the rumen, reducing the risk of acidosis.

Alkalage

An alternative is to follow the branded Alkalage process using a commercial pelleted additive that also applies urea at 2% but with additional urease

enzyme; apart from that the process is identical and follows the same pathway. This approach is the highest cost method of preserving wholecrop cereals, significantly more than feed grade urea. Ammonia losses at the clamp are similar to using urea and once again it should be noted that all of the additional N is non-protein N or ERDP.

There have been claims that alkalage can be made at DMs up to 90% but all urea treatments require water for the urea to be converted into ammonia. The addition of extra enzyme should make things happen faster in Alkalage but if insufficient water is present the reaction cannot occur and having extra enzyme present will not make any difference. At DMs above 75% this is a real risk since crops do not ripen evenly and, while the average DM may be 75%, there may be patches in the clamp well above this where the urea prills may not get broken down. Trials at Harper Adams have also shown that at DMs above 80% intakes increased while milk yield decreased. They suggest the ideal DM for urea treatment is around 70%.

Whether taking the feed grade or branded approach, urea-treated forages should only be ensiled in outside clamps as ammonia will be released both before the clamp is sealed and again at opening. Ammonia is a potentially toxic chemical and care should be taken not to breathe in excess amounts. Also, as both treatments add significant amounts of non-protein N to the forage, check the urea content of other ration ingredients and ensure the total diet is balanced with sufficient energy to enable the extra nitrogen to be properly utilised in the rumen and minimise the risk of urea poisoning. This is particularly important with high yielding, fresh calved cows that may be in energy deficit.

Grain Options

All grain options require a combine and have a lower total DM yield than the forage approach, but harvesting the grain alone maximises feed quality and offers more flexibility in terms of feeding the grain and straw fractions separately.

The traditional method for conserving grain is to combine it mature and dry down to less than 15% MC to prevent moulding during storage. The grain is usually stored whole, as it takes less space, and rolled or ground in batches as required, a very time-consuming task. Such mature crops suffer high DM losses due to shedding in the field as well as from dust produced during drying; there are also health implications from handling such dusty materials. The biggest problem, however, results from the starch being highly degradable, its rapid fermentation causing acidosis with negative impacts on microbial protein production and fibre digestion. Feeding little and often in a TMR helps, allowing 6kg of dry, rolled grain to be fed rather than the 2kg maximum advised for a single meal.

An alternative is to combine the grain three to four weeks early at 60-70% DM (30-40% MC) and process it using one of several methods available, all of which are designed to increase starch digestibility while reducing its rate of fermentation in the rumen. Once the DM reaches about 60-65% there is little change in grain nutritional value so an earlier harvest can result in a DM yield as much as 20% higher with a similar nutritional value and improved palatability; the greener straw will also have a higher yield and nutritional value. It can be wilted and baled for bedding or picked up directly behind the combine using a forage harvester or baler and ensiled, providing a valuable feed for dry stock or sucklers.

Most important of all, harvest is more flexible with less chance of poor weather interfering; you can even harvest in the rain and there is no need to wait until the morning dew dries. An earlier harvest also gives you the opportunity for earlier establishment of the following crop, or even a catch crop, and if it is under-sown you will benefit from extra grazing. It should be noted, however, that wetter crops are slower to combine by about 20-30% on a DM basis, an additive will be required to prevent aerobic spoilage and vitamin E levels will fall significantly in stored moist grains so supplementation will be required.

Once again there are several methods available for conservation of moist grains, most of which involve some kind of processing designed to enable more cereals to be fed safely. Whole grains can be ensiled and fermented using an inoculant, treated with propionic acid or made alkaline by treating with either caustic soda or urea, or the grains can be crimped then ensiled after treatment with an inoculant or acid-based additive. Grains should always be clamped within 24 hours of harvest and note that yield can be up to 50%

higher than for conventional harvest so more storage capacity will be required.

Fermented grain
The grain is harvested any time from around 40% MC and mixed with an inoculant in a mixer wagon, up to 550 litres of water per tonne being added to bring the moisture content up to 45%. Each load takes about 20 minutes to mix and clamp. The physical action of mixing loosens the grain coat, improving digestibility, but the grain remains whole and starch degrades slowly in the rumen.

The treated product is clamped as usual, rolling and sealing well. The final pH will be around 4.5 and it can be used after about 30 days. An ordinary silage inoculant is not suitable for fermenting whole grain since it is very prone to aerobic spoilage so an inoculant specifically designed for this purpose should be used.

Acid-treated grain
The grain can be taken any time from about 40% MC up to maturity; propionic acid is sprayed on as the grains are augered into the store, the amount of acid added decreasing from 20.5 to 5.5 litres per tonne with increasing MC. One advantage of this method is that a proper clamp is not required, just a covered, clean area. Propionic acid also has a nutritional value in its own right, with an ME 1.5 times that of barley, and treated grains are easier to roll.

Caustic-treated grain
Often referred to as Sodagrain, the grains are harvested from 40% MC to maturity and mixed with caustic soda (sodium hydroxide) and water in a mixer wagon. Caustic disrupts the seed coat allowing a relatively slow release of starch. This, together with the buffering effect of the high pH (8-9) on the rumen mean higher quantities can be fed. Caustic-treated grains are unpalatable to birds and vermin and are ready for use within four days, but should usually be used up within about three weeks. If less water is added during processing they can be kept for six months, but water must then be added at feeding to bring the moisture content up to 30%.

The main drawback is the hassle and time it takes to process; each load takes about 24 hours to complete as a lot of heat is produced during processing and the grains must cool before being stored. A large clean area of concrete is required on which the treated grain can be spread with a loader-bucket to cool. Caustic soda is also very corrosive to machinery and hazardous to work with so protective clothing is essential. Treatment costs are difficult to define as caustic soda prill prices vary greatly depending on industrial requirements so it is important to fix a price with your supplier.

Urea-treated grain
The mode of action is the same as for wholecrop, conversion of urea to ammonia on contact with water. Wheat is treated using 3% (DM basis) and barley 4% due to its tougher seed coat. The grain and urea are mixed together for about 5 minutes in a mixer wagon (or on the ground with a bucket, or by spraying on a solution at the auger), water being added if required to bring the MC up to 30-35%. The mixture is clamped with minimal consolidation to allow ammonia to circulate freely, and well sealed. An outside clamp is advised as there is a strong ammonia smell when it is opened initially, a potential health hazard. As with caustic grains, urea-treated grains have a high pH (7.5-8.5) which helps buffer the rumen, and because the urea doesn't break open the seed coat, just softens it, higher inclusion rates are possible. It can be fed after six weeks and will remain stable all winter. The added urea increases the CP to 18-20% but the extra CP is all non-protein nitrogen so must be balanced with a suitable supply of readily available energy, such as molassed sugar beet or lactose, if it is not to be wasted. Ammonia makes the treated grains unacceptable to both birds and rats and will also prevent rats from burrowing into the heap.

Crimped grain
Grains are combined at 25-45% MC and lightly rolled to break the seed coat but not fully expose the endosperm so starch release is much slower than for rolled dry grain, allowing more to be fed. An acid additive, such as Ecocrimp, is added at the crimper to inhibit mould growth in the clamp. Processing rate depends on the crimper capacity and is often slower than the harvest rate from the field, although larger contractor crimpers are now available that can process 40 tonnes/hour. The treated grain should be clamped, taking care to roll and seal well. It is important not to ensile the grain too dry or it will be difficult to compact, increasing the risk of aerobic spoilage. Water can be added during crimping if necessary.

Making A Choice

There are several key factors to consider in determining the best option for your farm system and decisions may well vary from year to year depending on the season, future cropping plans, nutrient aspirations, availability of machinery, labour and/or contractors, storage and feeding systems, capital, quota position and milk price. The first step is to determine whether to take the forage or grain route.

Fermented wholecrop silage fits most easily into the majority of livestock farming systems since it can be harvested, stored and fed using the same machinery, storage and feeding systems as grass silage, with minimal additional labour or skill requirements. Many growers store the crop in the same clamp as their grass. This is a simple, cost-effective route to take when high quality forage is the key requirement, either to balance a poor first-cut grass yield or, particularly if maize is not grown, to tap into the intake and performance benefits of mixed forage diets.

It has a relatively short harvest window, around three weeks across the full DM range from 35-55% but only one week if you plan to home in on the higher DM end to maximise yield and quality. It has the considerable advantage of an early harvest which reduces the pressure on the main cereal harvest and enables you to make further use of the land in the same season with either a catch crop, summer grazing of undersown grass and/or some autumn silage. It is this factor alone that makes fermented wholecrop such a favourite on heavily stocked dairy farms, particularly as the ground is released at a time when grass can be in short supply and milk prices are at their highest.

As well as a minimal capital requirement, many farms can produce fermented wholecrop with no additional spend on buildings or machinery, it also has one of the lowest production costs per tonne DM (see Table 2).

The production (growing) costs used in Table 2 are for wheat and are the same regardless of method of harvesting and conservation. The rest of the costs are only a guide to show the relative costs of the different methods. When it comes to making final cost comparisons between systems, it is better to do your own calculations using your own figures. Regional variations in contractor charges and the spreading of existing machinery or labour costs across an extra operation will obviously change the picture, but most importantly, try and make an accurate assessment of the expected DM yield as this has the most significant impact on the final cost of the crop. Don't forget to allow for crop losses and any additional charges. Some, but not all, contractors charge a little extra for harvesting high DM wholecrop with a grain processor attached, to account for the extra cost of the machine and processor wear and tear, but combining charges appear to be the same for both dry and moist grains despite the slower harvest with the latter.

Concentrated forage is a term that could be applied to the high DM options of acid and alkali treated wholecrop. This is the route to take if you still need a good forage yield, but are prepared to harvest later and potentially pay a bit extra for a crop of higher nutritional value (Table 3). This approach allows you to fine tune the balance between yield and quality simply by adjusting the cutting height and if you just take the cereal heads, you end up with a crop very similar in nutritional value to the grain options, with a lot less hassle.

The key issues to consider before taking this route are: availability of machinery and labour or contractors, storage and feeding facilities, health and safety, and feeding management. High DM wholecrop, whether acid or alkali treated, must be harvested with a forager fitted with an integral mill or processor to minimise the amount of grain passing through the cow undigested. For acid treated, there are no other special considerations as the additive is applied at the forager, it can be clamped separately or with grass, inside or out, and there are no feeding risks other than the usual acidosis considerations when feeding high levels of rapidly digestible grain. The higher additive costs are offset if a higher DM yield is achieved.

The alkali approach requires the crop to be handled completely separately from grass and/or maize, and an outdoor clamp to minimise health and safety risks from ammonia gas. Additional labour and machinery is required at harvest, to apply the additive at the clamp with a fertiliser spinner, and at feeding as separate storage means a mixer wagon will be required. Where TMR feeding is already being used, there is no onerous change but, if not, significant adjustments will be required to accommodate this crop.

Ammonia is a dangerous gas and should be given due respect both at clamping and at opening. Care should also be taken to ensure urea prills are evenly applied and fully broken down and, as always when feeding non-protein nitrogen, good dietary management is required both to maximise the potential nutritional benefits and minimise health risks.

The most noticeable difference in alkaline wholecrop production costs is the significantly higher cost of doing Alkalage, due entirely to the high cost of the additive. To some extent this is offset by the value of the extra CP added but this would apply equally to feed grade urea. It must be remembered that it is all non-protein N (ERDP) and must be properly balanced if it is not to be wasted. Also, not all the added CP will be recovered as there will be significant ammonia losses, both at the ensiling and feeding stages. At the end of the day there are better and cheaper ways to add N to the diet.

Home-grown concentrates, where the aim is to increase nutrient value of rations rather than provide forage, will require a combine to harvest the grain. The traditional approach of dried/rolled grain is the most expensive and, bearing in mind the feeding limitations, this alone makes moist grain an attractive proposition. Add the lower dependence on good weather and reduced field losses from grain shedding and you can see why this approach has gained popularity. The energy and protein values of moist grains and dry grain (Table 3) are similar but in moist grains the starch has a higher digestibility, is more slowly degraded in the rumen and the protein should be more rumen degradable. The vitamin E content of moist grains will be significantly lower and need supplementation.

Production and harvesting costs are identical for all options, the only difference being the processing and additive costs. When comparing costs make sure you are using up-to-date figures as some additives, particularly caustic soda, can vary greatly.

Some processes require a (watertight) mixer wagon, but this will be needed anyway as moist grains fit best with a TMR feeding system. Crimped grains will require a crimper and the labour to run it. If you are crimping a significant acreage, make sure you have a high volume machine or crimping will become a bottle-neck in the harvesting system. Some processes will also require a ready source of water for mixing and a clean area for dumping the grain prior to processing or spreading it out to cool after, and don't forget that moist grains can take up to 50% more storage space than dry grains. You may also need to purchase an applicator, eg for applying propionic acid at the auger.

Although harvest is later, keep a close watch on the crop as once beyond 50%, DM increases by about 1% a day, 2% in very hot weather. You can add water at the yard if the grain goes too dry but shedding losses will rise and there is no gain in feed value.

The choice is yours. All of the options have their place and can deliver excellent results if managed correctly. Fermented wholecrop is the simplest and cheapest, moist grains offer better nutritive value and acid-treated, wholecropped cereal heads deliver concentrated forage without the labour, machinery and hassle of crimping. Determine your aims, assess your resources and take the lowest cost option that meets your feeding requirements and fits your system. And if you have any questions, give us a call.

Cereal Cost Calculator

Yield:

Fresh weight (t/ha) _____ **A**

DM at harvest (%) _____ **B**

DM yield (t/ha) _____ (**A x B)/100 = C**

Establishment, growing & harvesting (per ha):

Seed _____

Fertiliser _____

Sprays _____

Sowing _____

Cultivations _____

Harvesting _____

Total (£/ha) _____ **D**

Total (£/tDM) _____ **D/C = E**

Misc (£/tDM):

Additive _____

Processing _____

Storage _____

Total (£/tDM) _____ **F**

Total Production Costs (£/tDM): _____ **E + F = G**

Table 1. Cereals Harvest Guide

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

Crop colour	Green	Green, going Yellow		Yellow, hint Gr.	Yellow, hint Green on stem			Yel./Brown, Gr. at nodes	Yellow/Brown			
Forage % DM at harvest	35	40	45	50	55	60	65	70	75	80	85	Final % MC
Forage Options:												
Fermented												
Acid												
Urea												
Alkalage												
Grain Options:												
Crimped												25-45
Urea												30-35
Fermented												45
Caustic												30
Acid												16-40
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			

Table 2. Comparative Costs for Conservation of Wheat

Costs do not take account of ensiling/storage losses.

	Wholecrop*				Moist Grains*					Dried/Rolled Grain
	Fermented	**Acid**	**Urea**	**Alkalage**	**Crimped**	**Fermented**	**Urea**	**Caustic**	**Propionic acid**	
% DM at harvest	35-55	55-80	60-65	60-80						
% MC at harvest					25-45	25-40	25-40	25-40	16-40	16-21
DM yield (tDM/ha)	12.5	14	14	14	8.5	8.5	8.5	8.5	8.5	7.5
Production (£/ha)**	515	515	515	515	515	515	515	515	515	515
Harvesting (£/ha)	140	140	140	140	75	75	75	75	75	75
£/tDM										
Production	41.20	36.79	36.79	36.79	60.59	60.59	60.59	60.59	60.59	68.67
Harvesting	11.20	10.00	10.00	10.00	9.76	9.76	9.76	9.76	9.76	11.07
Processing***	-	Incl.	-	Incl.	11.00					25.00
Additive****	3.22	7.11	12.65	29.75	6.86	12.85	17.67	24.64	17.92	-
TOTAL	55.62	53.90	59.44	76.54	88.21	83.20	88.02	94.99	88.27	104.73

* for calculations, assume wholecrops harvested at midpoint of DM range and all moist grains harvested at 30% MC
** MGA figures (11/07)
*** it is assumed that a TMR wagon is available where required
**** includes additional labour costs for application where appropriate

Additives:

Wholecrop: Fermented – DoubleAction Ecocorn - £1.45/t treated; Acid – Ecocrimp (3 l/t) – £4.80/t treated; Urea – Feed grade (£495/t applied at 20g/kg DM) - £9.90/tDM treated + extra labour at clamp to apply; Alkalage – Home 'n' Dry (£540/t applied at 35kg/t) - £18.90/t treated + extra labour at clamp to apply

Moist Grains: Crimped – Ecocrimp (3 l/t) – £4.80/t grain; Fermented – Biograin - £9/t grain; Urea – feed grade (£495/t applied at 25kg/t grain) - £12.37/t treated; Caustic – caustic soda prills (£575/t at 30kg/t grain) - £17.25/t treated; Propionic acid – (£190/197 litre drum at 13 litres/t grain) - £12.54/t treated

Table 3. Nutritive Value of Conserved Wheat

Wholecrop

	Fermented	Acid	Urea
DM (%)	35-50	70	65-80
ME (MJ/kgDM)	9.5-11.5	11-12	11-12
starch (%DM)	20-30	35-45	35-45
CP (%DM)	9-11	10-11	12-14
NDF (%DM)	40-50	40-50	40-50
pH	3.8-4.8	4-4.5	8-9

Grain

	Crimped	Fermented	Urea	Caustic	Propionic	Rolled
DM (%)	65	55	65	74	70	86
ME (MJ/kgDM)	13.1	13.5	13.1	13.5	13.3	13.7
starch (%DM)	60	60	60	60	60	67
CP (%DM)	13.0	12.8	19.4	12.3	13.0?	12.8
NDF (%DM)	11.4	12.4	12.4	11.4	11	12
pH	4	4.5	8.5	8.5	4	6.2