The Wholecrop Guide

Fermented Wholecrop – Changing the forage mindset

Welcome to the Fermented Wholecrop Management Guide

The key to developing a sustainable business is to challenge all costs and formulate a robust cost base. This means understanding the return on every pound spent while focussing on those areas giving the best return. On dairy farms, forage remains the best starting point.

Cows are designed to eat forage and convert it into milk. It is the cheapest feed available so the more you can produce from forage, the more sustainable your business will be, and the better placed it will be to withstand lower milk prices.

Whichever costing service you look at, farmers who are more proficient producing milk from forage have better margins, typically 1.5-2.0ppl extra margin being generated by driving forage utilisation.

To maximise contribution from forage, the objective must be to ensure there is sufficient, high quality forage available throughout the year. However, most years, weather and other factors will conspire to mean farms fail to produce enough forage of adequate quality.

So the fundamental question becomes, how can dairy farm businesses revise their forage management systems to reduce risk and increase the likelihood that they will produce the forage they need to maximise margins?

The first challenge must be to plan to produce enough. Do you start off knowing how many hectares of specific crops you need to grow, which based on your average yields, will give you the amount of forage you need, expressed as kgDM/day for all stock to be fed silage? And will it be adequate quality?

If you have a target it is easier to assess progress during the season and to react more quickly to what the season brings, identifying ways to make good any shortfall.

The second challenge is to manage risk, and I will be the first to admit forage making is a risky business, especially for systems based on grass and maize. Will we have a good window for first cuts? Will aftermaths allow a decent second cut or will we get a drought? Will maize be planted on time and get the hours of sunlight required? And what will conditions be like at harvest?

The truth is, in the last five years one or other of maize and grass has failed to live up to expectations, reducing forage availability and consequently production from forage.

So how do we manage risk? It is widely accepted that to reduce and spread risk you need to increase flexibility in what you do, so in effect you have your eggs in more baskets. In forage production terms this would mean having more crops available, or having a crop that can be used in several ways.

One way to reduce risk is to grow a third, flexible crop where production can be tailored in response to the season, and as a recent trial shows, fermented wholecrop offers huge potential. By allowing a range of harvest dates, it can be cut strategically to react to the season as it unfolds. This flexibility can help farmers to more consistently achieve the yields of quality forage required for their livestock.

This guide is based on the results of a major independent trial into exploiting the value of wholecrop and is designed to help you get the most from this flexible feed and in so doing produce more from forage and develop a most robust cost-base for your business. Lee Gresham, Country manager, Lallemand Animal Nutrition.

Section 1

The case for growing Fermented Wholecrop

Fermented wholecrop is currently grown by around 2000 dairy farmers in the UK, producing around one million tonnes freshweight of forage annually. It has the potential to play a much bigger role in boosting milk from forage and margins.

Dairy costing data show that producing more from forage leads to lower costs and higher margins (table 1).

To capitalise on the financial benefits of producing more from forage, you need quality forage and plenty of it. It is essential farms produce more quality forage consistently, year on year to fully meet the demands of the livestock on the farm. Every kilo of concentrate fed which could have been replaced by forage is a lost opportunity to increase margins.

Table 1 Influence of milk from forage on dairy margins (Holstein/Friesian herds)

	Ranked by milk from forage (March 2019)	
	Top 25% Producer	**Average Producer**
Cows in herd	183	205
Milk Production		
Yield/cow (L)	8258	8352
Yield from forage/cow (L)	3750	2486
% of total milk from forage	45.4%	29.8%
Feed		
Concentrate use per cow (kg)	2148	2638
Concentrate use per litre (kg)	0.26	0.32
Total purchased feed cost/litre (p)	6.76	8.48
Margins		
MOPF/cow (£)	1847	1713
MOPF/litre (p)	22.37	20.51

Source: Kingshay Dairy Costings Focus 2019

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A risky business

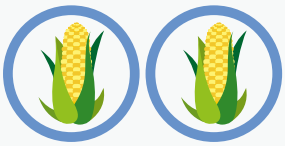
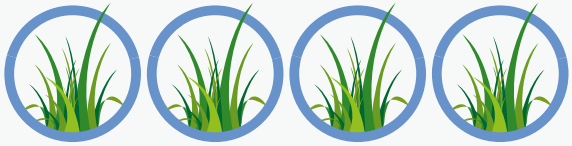
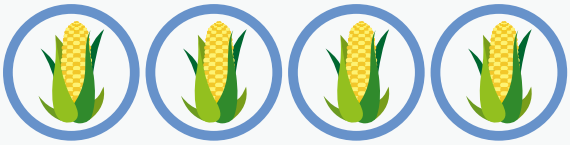
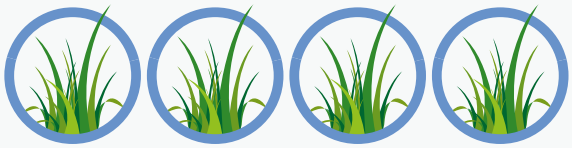
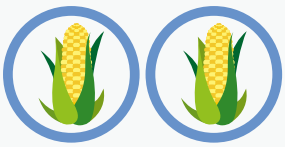
The key to improving consistency of forage production is to plan and to manage risk.

Risk management is a common practice in business. Forage production is a risky business as in systems based on grass silage, or maize and grass, the weather can significantly influence quality, quantity or both leaving farms with less forage than required (table 2). When is the last time that maize and grass were not affected by the weather on your farm?

To reduce and spread risk you need to increase flexibility in what you do, in effect putting your eggs in more baskets. In forage production terms this would mean having more crops available, or having a crop that can be used in several ways.

One way to reduce risk is to grow a third, flexible crop where production can be tailored in response to the season, and our trial shows fermented wholecrop offers huge potential.
By allowing a range of harvest dates, it can be cut strategically to react to the season as it unfolds, helping you to more consistently achieve the yields of quality forage required

Table 2 Recent forage qualities

	Grass	Maize
2012		
2013		
2014		
2015		

(based on averages throughout the UK but the variation in forage quality every year is huge)

Seven reasons

why more dairy farms should grow fermented wholecrop

Fermented wholecrop has the potential to change the forage mindset, allowing an increased degree of management control across the entire growing season. By giving greater flexibility over crop selection and harvesting date, it provides a unique way to react during the season. In so doing it will reduce the risk inherent in forage production.

In addition to reducing risk, there are seven reasons why fermented wholecrop should be incorporated in more dairy farming systems.

By more reliably achieving the target forage production, farmers will be able to increase milk from forage.

Each extra kg of forage dry matter produced will save approximately1kg of concentrate freshweight. If your current system is failing to deliver the forage quantities you need, adding an additional, proven and reliable forage will help drive production from forage and margins.

More production from forage will help reduce overall costs of production

Milk from forage is cheaper than milk from any other source and the more successful businesses in the future will have systems which drive milk from forage

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A third crop with flexible harvest dates will build greater resilience into dairy systems

In each of the past five years, either maize or grass has struggled to perform due to the season. A third crop increases the options and reduces the impact of a difficult season for one of the other forage crops.

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By being harvested in July, wholecrop can improve crop rotations and management.

Crop rotations and manure management will becoming increasingly important with ever tightening environmental legislation. With wholecrop taken in July, farms will have an ideal window for the application of slurry and manure at an optimum time for nutrient use, with waste incorporated before a successor crop.

Successor crops will also be established in better conditions leading to improved establishment with less land left fallow over the winter.

Feeding wholecrop can improve rumen health

Fermented wholecrop can be a high dry matter, high starch forage, or a lower dry matter, high fibre forage depending on cutting date. This allows it to be used to balance other forages in the diet. The inclusion of fermented wholecrop in diets can improve the presentation of the diet and stimulate higher dry matter intakes.

Most dairy farmers can grow good quality cereals meaning fermented wholecrop can be a viable option on the majority of dairy farms.

Cereals are suited to being grown successfully in most parts of the country, meaning they are applicable for most situations. Their flexibility is enhanced by both winter and spring sown crops being ideal for the crop. All field work can be carried out by most contractors and agronomists are available to advise on variety choice and management so all farmers have access to skilled support.

It is a cost effective crop

Fermented wholecrop compares well with grass and maize in terms of cost per tonne of dry matter. Importantly, it is a very consistent yielding crop meaning costs per tonne dry matter will be predictable year on year.

Section 2

Incorporating wholecrop into your system

In this section we consider key areas that will help ensure you make a success of fermented wholecrop, including:

- How much you need to produce
- Relative benefits of spring and winter sown options
- The importance of variety choice.

How much wholecrop do I need?

The trial looked at the performance of 11 different cropping options, a mix of spring and autumn sown crops. They were cut at five different intervals to explore the impact of harvest date on dry matter yield and feed value. Table 1 shows the range in dry matter yields and growing costs for the different crops.

Table 1 Dry matter yields and cost/tDM for different crops

Crop	DM yield (t/ha)	Range in cost/tDM (£)*
Winter wheat	11.1-20.5	£51 - 94
Winter barley	14.1-18.7	£57-71
Winter triticale	14.1-22.2	£48 - 76
Winter oats	8.0-15.2	£69 - £98
Winter rye	14.5-20.8	£50 - 72
Spring wheat	8.4-13.6-	£61 - 99
Spring barley	12.1-14.4	£55- 66
Spring triticale	12.3-14.8	£57 - 69
Spring oats	11.3-13.2	£57 - 67
Spring barley and peas	11.2-12.9	£60 - 69
Spring barley undersown with grass	11.5-13.6	£50 - 58

*Growing costs calculated over the 5 harvest weeks (2015 costs)

The trial shows that all the crops grown are capable of a high dry matter yield and contributing to forage production targets. While cost per tonne of dry matter varies by crop and by cutting week (DM yield), costs are comparable with maize at £113/tDM and a three cut grass system at £124/tDM. (source: Kingshay)

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Typically wholecrop will be fed at 4-6kg DM per cow per day but can be fed successfully at higher rates, up to 50% of the diet forage dry matter.

Table 2 shows the tonnage requirement and crop area grown for 100 cows for a 200 day winter at different inclusion rates.

Table 2 Wholecrop tonnage requirements

Inclusion rate kgDM/cow/day	Winter requirement assuming 100 cows for 200 days (kgDM)	Area of winter wheat needed to supply requirement (ha assuming 16tDM/ha)	Area of spring triticale needed to supply requirement (ha assuming 13.5t/ha)
4	80,000	5	6
6	120,000	7.5	9

Wholecrop can be grown strategically to help increase production from forage in several ways, each of which will help spread forage risk and increase the probability that total target forage yields will be achieved:

As a second forage in areas where maize cannot be reliably or successfully grown, wholecrop can be used to add a second forage to complement grass. (See case study 2 and 4).

As a third forage where grass and maize are grown, adding wholecrop as a third forage will maximise risk prevention while ensuring a starch based forage is available earlier in the season.

As a third forage to boost total output the flexibility of wholecrop lends it to double cropping and undersowing systems, so helping produce more quality forage per hectare. (See case study 1 and 3).

The actual area that needs to be grown will depend on:

- The target daily DMI per cow
- The strategy adopted for wholecrop and its importance in the overall system
- The crop and variety grown and the suitability of the farm to growing cereals.

Which crop to grow?

The trial shows that a wide range of crops is suitable for use as fermented wholecrop, increasing the flexibility and suitability of the crop. No longer is it that fermented wholecrop is seen as a way to preserve winter wheat as a maize starch substitute.

Different crops can be chosen to provide a range of feeds to complement other feeds in the diet. For example:

- Wheat – generally seen as a higher starch feed.
- Triticale – known for the higher straw and fibre content.
- Barley/pea mixtures – a higher protein feed

The individual crop sheets in section 2 contain details of yield, dry matter yield and analysis which can help when choosing the most suitable crop. Factors to consider when selecting which crop to grow should include:

- The type of feed you want to produce. Some crops will tend to be higher starch which others will be a more fibrous feed. Undersowing and bicropping can improve protein content which can be important to reduce feed costs.
- Whether the farm is better suited to spring or winter crops? It might be that the crop will vary depending on the part of the farm being used for wholecrop in a particular year (see case study 4).
- Soil type, altitude and attitude will all affect the suitablility of the farm to specific crops. Choose a crop that is suited to the farm. Harvest management can then be used to influence the yield and type of feed produced.
- Rotation. Select a crop that suits and fits the farm rotation to simplify overall management and to ensure the performance of other crops is not compromised. Where wholecrop is to be followed by grass a spring crop undersown with grass can be a strong option.

The diagram gives an overview of crop selection.

Table 3 Crop suitability selector

	Energy & Starch Levels	Effective Fibre Levels	Level of required Management	Soil requirements	Average Yield
Wheat	✚✚✚	✚✚✚	↗	↗	10-14 tonnes / acre FW
Barley	✚✚	✚✚	↗	↘	8-12 tonnes / acre FW
Oats	✚	✚✚✚	↘	↘	10-15 tonnes / acre FW
Triticale	✚✚	✚✚✚	↘	↘	10-15 tonnes / acre FW

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Importance of variety choice

Once you have selected the best crop for your circumstances, pay close attention to variety selection. In addition to looking at yield and quality parameters, pay close attention to disease resistance. Choosing a variety with good resistance to diseases know to be prevalent can help improve yield and save on spray applications, both of which will help reduce cost/tonne of dry matter produced.

Zero waste harvesting

Growing a quality crop and harvesting at the optimum time for your circumstances, only gets you to the starting line. The finishing line is maximising the proportion of nutrients in the field that are effectively utilised by the animal. This comes down to harvesting and clamp management to reduce any losses.

Preparation

- The most important thing is to talk to your contractor so he knows your plans, especially if you intend to be flexible on cutting date.
  A delay in harvesting could significantly change the characteristics of the feed produced.
- Ensure the storage area is clean, powerwashing if necessary. You want to ensure there are no sources of contamination when the crop is clamped. Line the sides of the clamp with a plastic sheet and a true oxygen barrier.
- Order inoculant in advance so it is delivered on time. As wholecrop is a starchy feed, inoculant will help reduce the risk of nutrient loss due to aerobic spoilage, especially in drier crops. In an earlier harvested, lower dry matter crop it will also help accelerate the rate of initial fermentation. Only use an inoculant specifically formulated for use on wholecrop to ensure the most effective fermentation. Recommendfed inoculants are:
  - o Wholecrop harvested below 45% dry matter Magniva Platinum Wholecrop
  - o Wholecrop harvested above 45% dry matter Magniva Platinum Wholecrop & Platinum Maize
- Make sure your contractor knows you will be using an inoculant.

Harvesting

- Ensure the forager is set to a 2.5cm (1 inch) chop length to improve effective fibre when fed and to achieve good consolidation in the clamp.
- If harvesting material over 45% dry matter , ensure the forager is fitted with a processor to dent the grain.
- Set forager to leave a stubble to suit the forage and ground conditions. It is better to leave a bit of extra stubble in the field rather than bring soil and contaminants into the clamp.
- Mix inoculant using clean water and apply at the appropriate concentration. Make sure you mix enough to treat the entire crop. Pockets of untreated material can spoil the fermentation of surrounding material.
- Make sure the rate of trailers arrive at the clamp matches the ability of the buck rake operator to fill the clamp.

Clamping

- Make sure the entrance of the clamp and unloading areas are kept clean as organisms such as Clostridia and E. coli in soil and slurry will compromise fermentation quality.
- Spread the crop evenly in layers of no more than 22-30cm (9-12 inches) to ensure effective consolidation.
- Fill the clamp as fast as possible.
- Treat the shoulders and joins in the clamp with extra inoculant.
- Seal the clamp with a true oxygen barrier and a plastic sheet. Ensuring at least a one metre overlap at any joins.
- Cover the clamp with appropriate material to ensure an effective seal.

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Feedout

- When opening the clamp, ensure the top sheet is always in contact with the top of the clamp and avoid peeling too much back.
- Use a block cutter to keep the face compact and tight.
- Keep the area around the face clean to reduce contamination risk.
- Move across the face quickly, taking shallower blocks on a wider face or consider only revealing half of the face at a time to reduce spoilage.
- In the event on any spoilage, remove and discard any contaminated material.

Section 3

Managing wholecrop

In this section we look at the management of the growing crop, the options for harvesting and ensiling.

Think quality

To make the best of wholecrop it is crucial to manage it as a high quality crop, not one where you can save on inputs. A productive cereal crop needs to be well fed and protected from pests and diseases. A failure to do so will reduce yield and quality.

The attitude has to be that you are growing a crop that could be harvested and sold as a commercial grain crop, because this is actually one of the options. Once a field of cereals is planted, initially destined for wholecrop, there are actually five options for the crop:

- It can be taken as fermented wholecrop, with harvest date adjusted to affect the specific feed requirements
- If a high dry matter feed is required it can be taken as fermented milled wholecrop where the grain is processed
- It can be taken as crimp cereals if forage stocks are adequate and you want a source of more rumen-friendly home grown cereals
- It can be harvested and incorporated in the diet as dried grain
- It can be harvested and sold as a cash crop.

To maintain this outstanding flexibility you will need to treat it as a commercial crop.

Key considerations:

Seed bed preparation the actual activities required to prepare the appropriate seed bed to ensure good establishment will depend on factors including soil type, previous cropping etc.

Plant nutrition cereals for wholecrop can provide an ideal outlet for organic manures as a source of nitrogen, phosphate and potash. Regular soil sampling can help ensure crop receive sufficient potash and phosphate. Nitrogen requirement will vary by crop but ensure requirements are met.

Pest and disease control it is important to implement a comprehensive weed, pest and disease control programme suited to the crop, the variety and the conditions/season. A failure to do so will lead to a reduction in yield, quality or both.

Straw shortener the use of straw shorteners is a matter of personal choice and individual circumstances. If the crop is prone to lodging, then a straw shortener may help improve the quality of the harvested crop. They can also reduce the proportion of straw to grain which can be an advantage where a higher starch feed is required.

In all circumstances, we would recommend working with an independent agronomist to ensure a healthy crop is produced.

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The table shows the relative costs of growing the main crops used for fermented wholecrop. These are the actual costs recorded in the trial carried out at Harper Adams and include all cultivations, all inputs and an allowance for rent and interest.

Table 1 Relative growing costs for different crops

Crop	Growing costs (£/ha)	Range in cost/tDM (£)*
Winter wheat	1053	£51 - 94
Winter barley	1015	£57-71
Winter triticale	1063	£48 - 76
Winter oats	1045	£69 - £98
Winter rye	1047	£50 - 72
Spring wheat	833	£61 - 99
Spring barley	799	£55- 66
Spring triticale	849	£57 - 69
Spring oats	757	£57 - 67
Spring barley and peas	774	£60 - 69
Spring barley undersown with grass	680	£50 - 58

*Growing costs calculated over the 5 harvest weeks (2015 costs)

Harvesting decision making

Conventionally the guidelines for the harvesting of fermented wholecrop has been to harvest at 35-45% dry matter, with the grain at the 'cheddar cheese' stage. Crops harvested later, certainly over 55% dry matter, have an increased requirement for physical processing of the grain to increase utilisation by the animal.

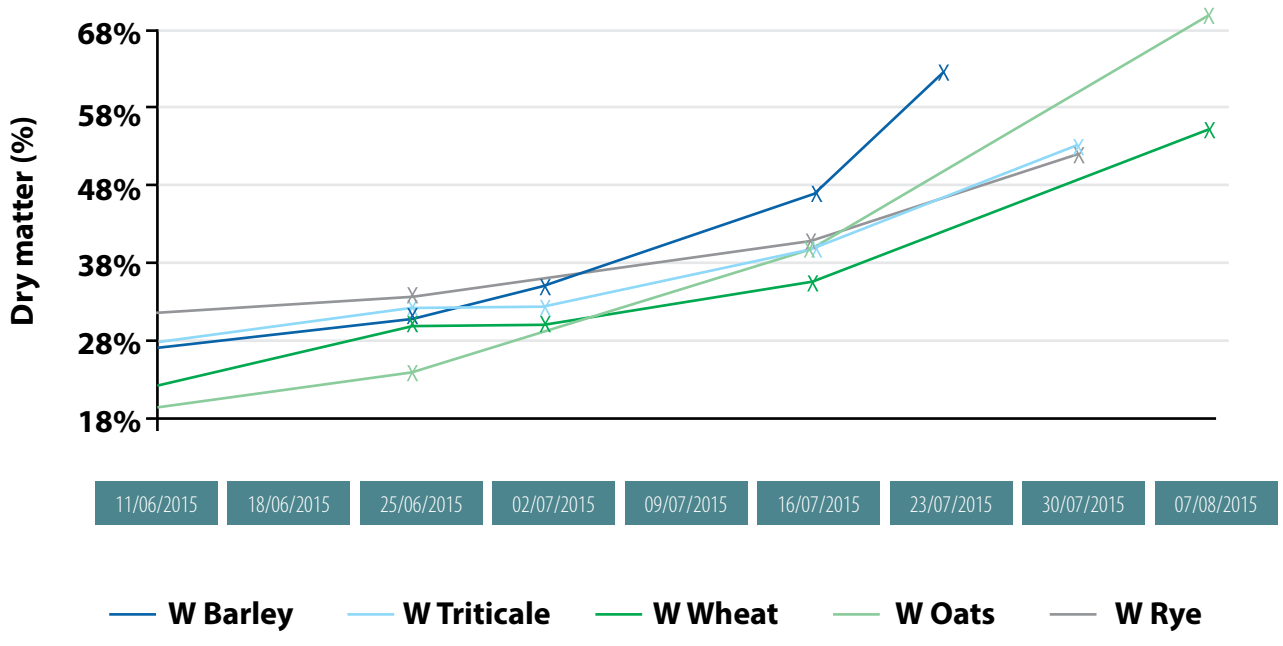
This advice, while appropriate, failed to recognise the unique development of wholecrop which can allow a range of products with different feed characteristics to be produced depending on the season.

The Lallemand trial at Harper Adams set out to explore the impact of harvesting date on crop development and yield. The crops grown were harvested at five, weekly intervals and the yield, dry matter content and resulting feed analysis were recorded.

Whilst individual crops developed at different rates, the trial showed some consistent trends. As the crop matures:

- Dry matter content increases as the plant matures (see graph 1)
- Dry matter yield increases
- NDF content declines as the plant lignifies and the straw dries out (see graph 2)
- Starch content increases as the grain matures (see graph 2)
- Overall digestibility remains largely unchanged with the increased starch digestibility counteracting the decline in fibre digestibility

Graph 1 Development in DM (%) for different crops



Source: Kingshay

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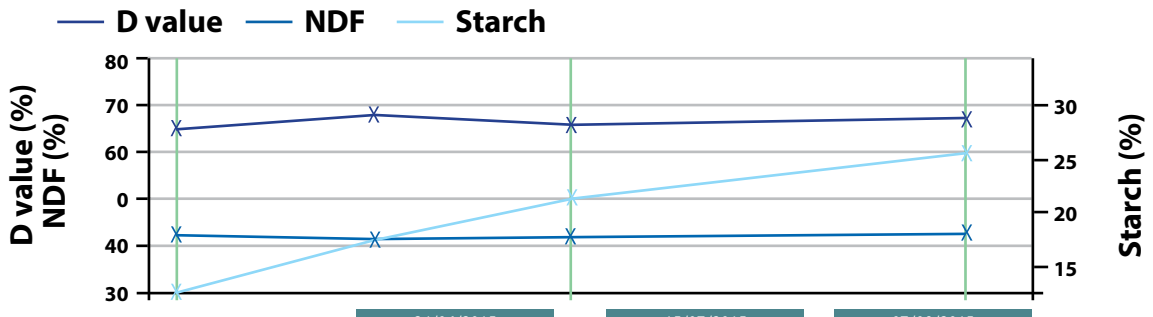
Graph 2 Trends in analysis over time for winter wheat



	24/06/2015	15/07/2015	07/08/2015
DM* (%)	29.65	35.34	55.29
DMYLD** (t/ha)	12.87	16.55	20.51
NDF** (%)	43.30	42.60	43.40
D value** (%)	64.60	66.10	66.50
Starch** (%)	10.00	22.00	25.20

* NIAB Date from trial

** NIR Date from trial

Graph 2 looks at the results for winter wheat harvested in the trial. The individual crop sheets in section 2 show this information for each of the 11 crops in the trial. They also contain a unique photo library showing the physical appearance of the crop, the ear and the grain at each of the harvesting stages to help you time harvest accurately.

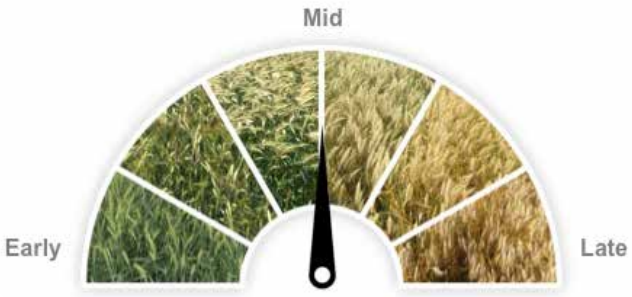
Putting these together, if you cut wholecrop earlier you will get a less dry, higher digestible fibre and lower starch feed while a later cut crop will have more starch but lower digestible fibre levels. At two cutting dates you can produce a feed that will work in different ways in the diet.

In practice, this can help to balance other forage. The figure looks at the most appropriate management strategy for fermented wholecrop to help balance two common forage season scenarios.

If you have poor grass and maize looks good then…

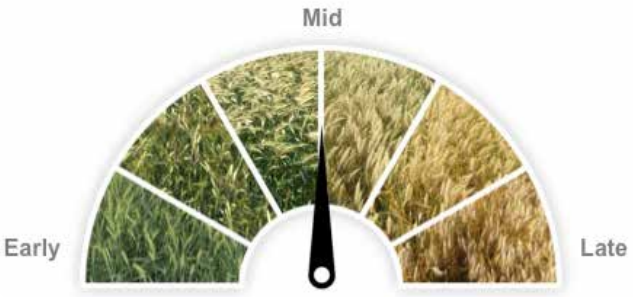
Cut early to mid season to get higher digestible fibre

If grass is wet then cut later to get a drier feed



If you have good grass and maize looks poor then…

Take later to increase starch in feed



Section 4

Feeding fermented wholecrop

This section explores the benefits of adding fermented wholecrop to diets and looks at how harvesting at different stages will impact on diet formulation.

Wholecrop can improve diets

Having grown fermented wholecrop it is important to make full use of it in diets. Fermented wholecrop is suitable for use in dairy cow and growing animal diets and can bring numerous benefits as all our case studies demonstrate.

A second or third forage feeding mixed forages has been proven to boost total dry matter intakes which can underpin higher production. In addition, by promoting higher forage dry matter intakes the inclusion of wholecrop can help reduce total feed costs.

Balancing forage quality because wholecrop can be managed to influence feed value, it is possible to produce a feed to complement other forages on the farm to improve overall production from forage.

Higher forage dry matter as wholecrop is typically around 40% DM, it is an ideal complement for grass silages. Being drier, it also has a lower acid loading in the rumen. It is more rumen friendly, promoting a healthier rumen.

Rumen friendly the combination of high digestible fibre and slowly digested starch also helps improve rumen health and reducing falls in pH. The physical nature of the fibre helps form an effective rumen mat and it has a high level of scratch factor which together help control rumen flow rates and ensure an efficient rumen. If the crop was taken dry and the grain processed then it is important to remember that starch will be more rapidly digested.

Low protein content cereal wholecrop will be low protein, making it an ideal balancer for grass silage and allowing close control over the overall dietary protein content and breakdown.

One criticism of wholecrop is that it can be a low energy feed, depressing diet total energy density which can have an impact on high yielding cows. All the farmers in our case studies are successfully producing good yields while incorporating wholecrop. The principle reason for this is that mixed forages and in particular the effect of fermented wholecrop on rumen health promote higher dry matter intakes.

The extra energy from a 1kg increase in DMI will far exceed the reduction in diet energy density of incorporating wholecrop at the typical 2-4kgDM/day. Herds are successfully feeding wholecrop at around 8kgDM/day or more.

Table 1 looks at two diets balanced to produce 35 litres. In diet B wholecrop has been increased and the outcome is higher forage intakes and consequently higher margins due to reduced purchased feed costs.

Table 1 How increasing dry matter intake can offest reduced energy density

	Diet A		Diet B	
	Fresh	**DM**	**Fresh**	**DM**
Maize 30% st (kg)	14.00	4.45	14.00	4.45
Grass high D (kg)	14.00	4.48	14.00	4.48
Wholecrop Wheat (kg)	6.00	2.15	10.00	3.58
Chopped Straw (kg)	0.50	0.43	-	-
Concentrate - Blend (kg)	6.50	5.70	5.25	4.60
Concentrate - Parlour (kg)	6.00	5.25	6.00	5.25
DMI (kg)		22.48		22.39
Forage DMI (kg)		11.51		12.51
M/D		11.86		11.83
CP (%)		17.42		17.38
Starch (%)		22.32		19.90
Sugar (%)		3.75		3.75
NDF (%)		33.78		34.84
Outside Feeds	M+24 litres		M+24 litres	
MOPF per cow per day	£5.61		£5.83	
Extra Margin for 200 cows for a 250 day winter			£11,000	

Harvest timing and feed value

By managing harvest date, the trial shows that it is possible to influence the feed value and feeding characteristics of fermented wholecrop.

Cutting earlier will produce a feed with high NDF and lower starch. The later the cutting date, the higher the starch and the lower the NDF will become.

However, digestibility remains fairly constant, meaning the feed will work well in the diet irrespective of harvest date.

Table 2 looks at key parameters of feed analysis for the different crops in the trial and the range seen over the five week harvesting period. They give a guide as to the feed quality that can be achieved.

Table 2 Typical feed analysis for different crops

Crop	DM (%)	ME (MJ/kgDM)	Starch (%)	NDF (%)
Winter wheat	20-51	9.5-10.4	0-25	61-43
Winter barley	27-64	10.6-10.5	10-29	50-50
Winter triticale	30-50	10.1-10.4	5-28	53-40
Winter oats	16-66	10.0-10.2	1-28	46-56
Winter rye	34-54	10.1-10.1	9-28	51-51
Spring wheat	36-73	10.4-10.2	13-28	42-54
Spring barley	34-72	10.4-10.5	17-28	42-51
Spring triticale	38-45	10.4-10.3	14-25	46-40
Spring oats	36-55	10.3-10.0	13-27	44-56
Spring barley and peas	30-70	10.1-10.4	14-25	43-47
Spring barley undersown with grass	34-76	10.5-10.1	14-26	39-53

All results analysed by Wet NIR

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Dietary Scenarios for milking cows

Fermented wholecrop can be used to strategically complement other feeds. In this section we consider how early, mid-term and late cut wholecrop can be used in a diet for a cow yielding 35 litres. They are based on winter wheat and spring triticale harvested during the trial.

It is important to stress it is essential to get your own forage analysed and to base diets on the crop in the clamp and not on standard values.

Early cut fermented wholecrop

Cut at 30-35% dry matter, this crop will provide high levels of digestible structural fibre, moderate protein and medium starch. It can be used to balance:

- Diets high in maize silage
- Diets containing high levels of late cut low D value grass silage
- Diets high in (>20%) rumen fermentable non-structural carbohydrates (cereals and starchy bi-products).

The following diets show how wholecrop could be included.

	Winter wheat		Spring Triticale	
	Fresh	**DM**	**Fresh**	**DM**
Maize 30% st (Kg)	22.0	7.0	15.0	4.8
Maize 22% st (Kg)	-	-	-	-
Grass high D (Kg)	9.5	3.0	-	-
Grass Low D (Kg)	-	-	12.0	4.2
Wheat early (Kg)	9.5	3.0	-	-
Wheat mid (Kg)	-	-	-	-
Wheat late (Kg)	-	-	-	-
Triticale early (Kg)	-	-	10.0	3.8
Triticale mid (Kg)	-	-	-	-
Triticale late (Kg)	-	-	-	-
Concentrate - Blend (Kg)	8.0	7.0	8.75	7.7
Concentrate - Parlour (Kg)	4.0	3.5	4.0	3.5
DMI (%)		23.73		23.99
Forage DMI (%)		13.05		12.8
M/D		11.75		11.63
CP (%)		17.00		16.80
Starch (%)		22.30		20.91
Sugar (%)		3.72		4.64
NDF		33.00		36.26

Mid-season fermented wholecrop

Harvested at about 35-40% drymatter to provide good levels of digestible fibre and high levels of starch but still in a rumen friendly slower digesting form.Higher structural fibre levels with a good scratch factor. This wholecrop will balance:

- Typical diets with 50:50 grass and maize silage
- Diets with high 'D' value grass silage
- Diets where higher levels of wholecrop need to be fed such as if very little or no maize silage is available
- Diets with good levels of maize grain and lower levels of cereal grains
- Diets higher in rumen fermentable protein from clovers and lucerne forages

The following diets show how wholecrop could be included.

	Winter wheat		Spring Triticale	
	Fresh	**DM**	**Fresh**	**DM**
Maize 30% st (Kg)	15.5	5.0	-	-
Maize 22% St (Kg)	-	-	-	-
Grass high D (Kg)	15.5	5.0	22.0	7.0
Grass Low D (Kg)	-	-	-	-
Wheat early (Kg)	-	-	-	-
Wheat mid (Kg)	8.0	2.85	-	-
Wheat late (Kg)	-	-	-	-
Triticale early (Kg)	-	-	-	-
Triticale mid (Kg)	-	-	15.0	6.0
Triticale late (Kg)	-	-	-	-
Concentrate - Blend (Kg)	8.0	7.0	6.0	5.26
Concentrate - Parlour (Kg)	4.0	3.5	6.0	5.26
DMI (%)		23.35		23.50
Forage DMI (%)		12.85		13.0
M/D		11.88		11.75
CP (%)		16.80		17.00
Starch (%)		21.42		20.14
Sugar (%)		3.70		3.62
NDF (%)		33.44		33.50

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Late season fermented wholecrop

Later season fermented Wholecrop at 40-50% dry matter provides good levels of structural fibre and high levels of starch but lower protein.
At higher dry matters it may require processing, so will be more rapidly fermentable in the rumen.

This wholecrop will balance:

Diets with very early cut grass silage (very high 'D' value)

Diets with wet grass silage

Diets with little or no maize silage

Diets with low levels of rapidly fermentable starch and sugars

Diets high in rapidly fermentable rumen protein.

	Winter wheat 3		Spring Triticale 3	
	Fresh	**DM**	**Fresh**	**DM**
Maize 30% st (Kg)	-	-	9.0	2.9
Maize 22% St (Kg)	15.0	4.0	-	-
Grass high D (Kg)	15.5	5.0	20.0	6.4
Grass Low D (Kg)	-	-	-	-
Wheat early (Kg)	-	-	-	-
Wheat mid (Kg)	-	-	-	-
Wheat late (Kg)	8.0	4.0	-	-
Triticale early (Kg)	-	-	-	-
Triticale mid (Kg)	-	-	-	-
Triticale late (Kg)	-	-	9.0	4.0
Concentrate - Blend (Kg)	8.0	7.0	8.0	7.0
Concentrate - Parlour (Kg)	4.0	3.5	4.0	3.5
DMI (%)		23.73		23.98
Forage DMI (%)		13.0		13.3
M/D		11.71		11.73
CP (%)		16.70		17.00
Starch (%)		21.68		20.33
Sugar (%)		3.65		3.66
NDF (%)		34.74		33.22

Dietary scenarios for growing cattle

In the same way that fermented wholecrop is a rumen friendly feed for milking cows, boosting forage intakes, it is an excellent palatable feed for dairy heifers and beef. The table contains example diets for different classes of growing stock

Table 6 Growing cattle diets

	Bulling Heifer	Beef Grower	Beef Finisher
	Fresh	Fresh	Fresh
Grass Silage 11 ME (Kg)	11.0	10.0	-
Fermented wholecrop (Kg)	8.0	6.0	18.5
Ext Rape Meal (Kg)	1.25	0.75	1.0
Rolled Barley (Kg)	0.25	4.00	3.00
Ground Maize (Kg)	-	-	3.50
Minerals (Kg)	0.10	0.10	0.12
DMI (Kg)	7.52	9.31	13.0
M/D	10.9	11.62	11.67
CP (%)	15.86	14.21	12.00
Starch (%)	10.0	25.85	37.34
Sugar (%)	3.75	2.79	3.12
NDF (%)	43.2	35.48	31.00
Predicted DLWG (kg/day)	0.90	1.40	1.60

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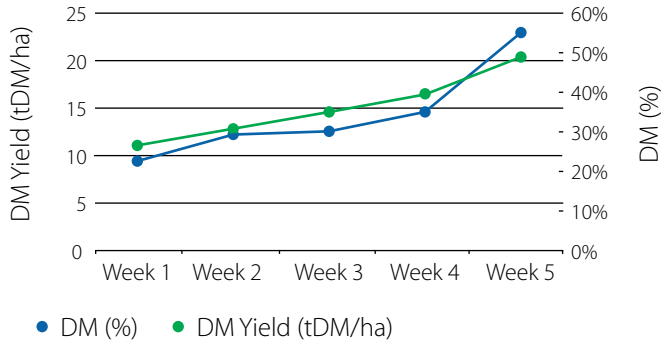
Winter Wheat

Growing Costs (source Lallemand: NIAB Trial 2015)

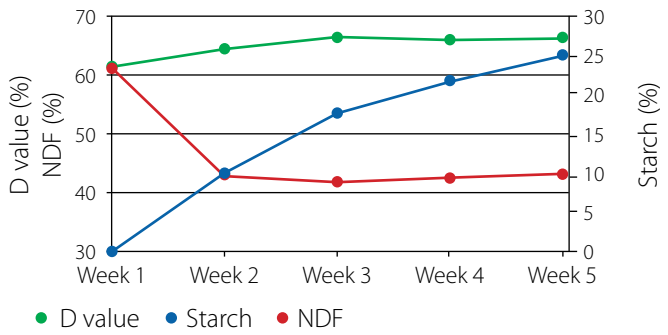
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£10.89	**£4.40**	Tempt 3 Kg/Ha with drilled seed
	Herbicides	£78.93	**£31.89**	Pre emergence Liberator 0.6 L/Ha
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£80.69	**£32.60**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£127.61	**£51.56**	Vortex 3.0 & Ceriax 3.0 l/ha + Bravo 1 L/Ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£101.52	**£41.02**	**Evolution** 73 kg/acre @ £564/tonne
Cultivations	Spraying	£19.01	**£7.68**	2 applications @ £2.56/acre
	Fertilising	£9.75	**£3.94**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£235.13	**£95.00**	Smiths Gore Farm Rents review @ £95/yr
	Total V.C's	£1,053.34	**£425.59**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	11.16	22.51%
Week 2	12.87	29.65%
Week 3	14.46	30.33%
Week 4	16.55	35.34%
Week 5	20.51	55.29%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	61.0	0.0	60.9
Week 2	64.6	10.0	43.3
Week 3	66.5	17.8	42.1
Week 4	66.1	22.0	42.6
Week 5	66.5	25.2	43.4

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Winter Wheat

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **22.51% DM** **11.16 tDM/ha**	Anticipated **29.65% DM** **12.87 tDM/ha**	Anticipated **30.33% DM** **14.46 tDM/ha**	Anticipated **35.34% DM** **16.55 tDM/ha**	Anticipated **55.29% DM** **20.51 tDM/ha**

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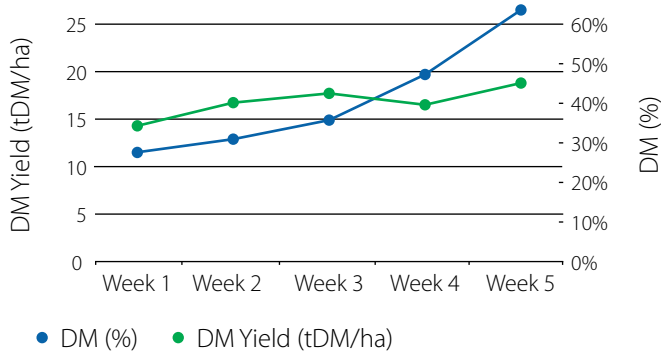
Winter Barley

Growing Costs (source Lallemand: NIAB Trial 2015)

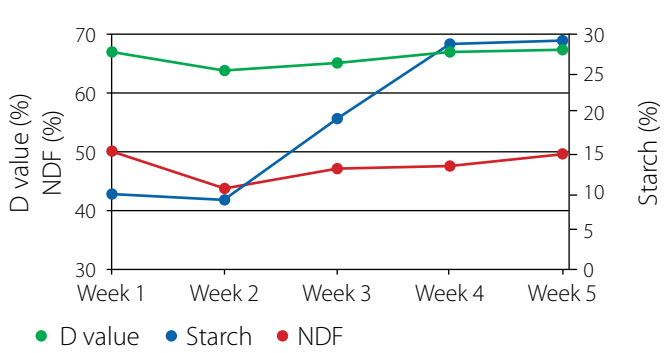
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£10.89	**£4.40**	Tempt 3 Kg/Ha with drilled seed.
	Herbicides	£71.65	**£28.95**	Pre emergence Liberator 0.6 L/Ha
	Insecticide	£0.00	**£0.00**	Nil applied
	Nitrogen + Sulphur	£80.69	**£32.60**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil applied
	Fungicides	£113.13	**£45.71**	Vortex 3.0 & Ceriax 3.0 l/ha + Bravo 1 L/Ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£84.89	**£34.30**	**SY Volume** 61 kg acre @ £566/tonne
Cultivations	Spraying	£19.01	**£7.68**	2 applications @ £2.56/acre
	Fertilising	£9.75	**£3.94**	2 applications @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£235.13	**£95.00**	Smiths Gore Farm Rents review @ £95/yr
	Total V.C's	£1,014.95	**£410.08**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	14.12	27.46%
Week 2	16.75	31.05%
Week 3	17.64	35.73%
Week 4	16.44	46.87%
Week 5	18.78	62.10%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	66.8	9.8	50.2
Week 2	63.8	9.1	43.5
Week 3	65.3	19.4	47.4
Week 4	67.0	28.7	47.6
Week 5	67.5	29.1	49.7

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Winter Barley

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **27.46% DM** **14.12 tDM/ha**	Anticipated **31.05% DM** **16.75 tDM/ha**	Anticipated **35.73% DM** **17.64 tDM/ha**	Anticipated **46.87% DM** **16.44 tDM/ha**	Anticipated **62.10% DM** **18.78 tDM/ha**

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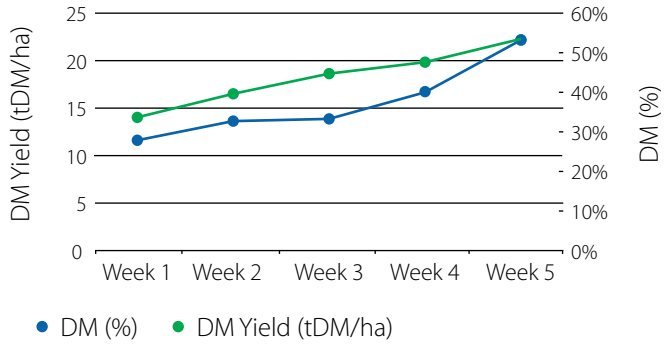
Winter Triticale

Growing Costs (source LallemandI: NIAB Trial 2015)

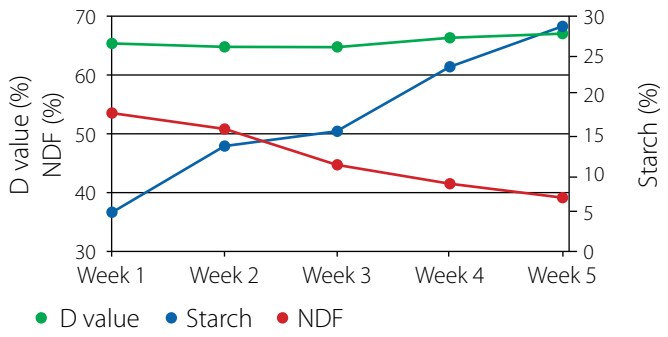
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£10.89	**£4.40**	Tempt 3 Kg/Ha with drilled seed.
	Herbicides	£78.93	**£31.89**	Pre emergence Liberator 0.6 L/Ha
	Insecticide	£0.00	**£0.00**	Nil applied
	Nitrogen + Sulphur	£80.69	**£32.60**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil applied
	Fungicides	£127.61	**£51.56**	Vortex 3.0 & Ceriax 3.0 l/ha + Bravo 1 L/Ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£111.67	**£45.12**	**KWS Fido** 65 kg/acre @£698/tone
Cultivations	Spraying	£19.01	**£7.68**	2 applications @ £2.56/acre
	Fertilising	£9.75	**£3.94**	2 applications @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£235.13	**£95.00**	Smiths Gore Farm Rents review @ £95/yr
	Total V.C's	£1,063.48	**£429.69**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	14.05	27.93%
Week 2	16.60	32.49%
Week 3	18.64	32.79%
Week 4	19.64	40.43%
Week 5	22.24	53.55%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	64.8	5.1	53.0
Week 2	64.3	13.5	50.7
Week 3	64.5	15.3	44.9
Week 4	65.9	23.3	41.7
Week 5	66.6	28.3	39.3

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Winter Triticale

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **27.93% DM** **14.05 tDM/ha**	Anticipated **32.49% DM** **16.60 tDM/ha**	Anticipated **32.79% DM** **18.64 tDM/ha**	Anticipated **40.43% DM** **19.64 tDM/ha**	Anticipated **53.55% DM** **22.24 tDM/ha**

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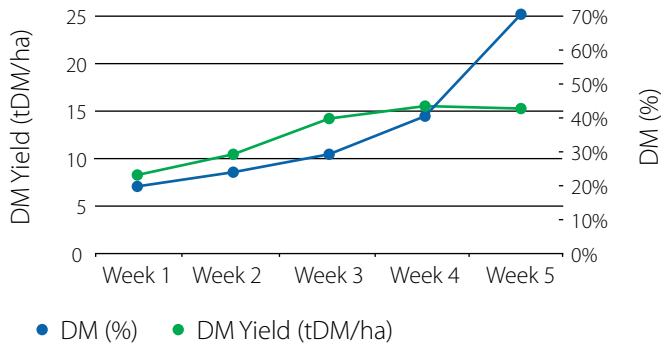
Winter Oats

Growing Costs (source Lallemand: NIAB Trial 2015)

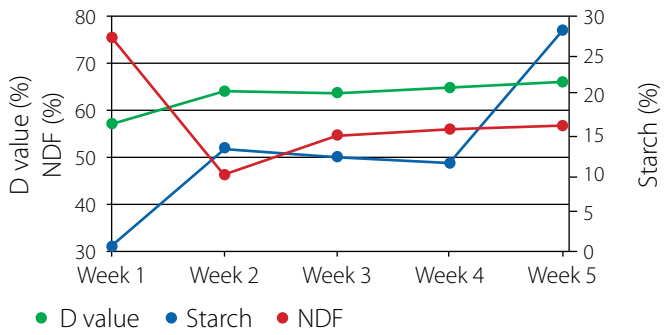
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£10.89	**£4.40**	Tempt 3 Kg/Ha with drilled seed.
	Herbicides	£71.65	**£28.95**	Pre emergence Liberator 0.6 L/Ha
	Insecticide	£0.00	**£0.00**	Nil applied
	Nitrogen + Sulphur	£80.69	**£32.60**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil applied
	Fungicides	£113.13	**£45.71**	Vortex 3.0 & Ceriax 3.0 l/ha + Bravo 1 L/Ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£114.89	**£46.42**	**Rhapsody** 61 kg/acre @ £766/tonne
Cultivations	Spraying	£19.01	**£7.68**	2 applications @ £2.56/acre
	Fertilising	£9.75	**£3.94**	2 applications @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£235.13	**£95.00**	Smiths Gore Farm Rents review @ £95/yr
	Total V.C's	£1,044.95	**£422.20**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	8.01	19.49%
Week 2	10.02	23.88%
Week 3	14.05	28.75%
Week 4	15.18	39.93%
Week 5	15.04	69.64%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	56.9	0.8	74.5
Week 2	63.9	13.2	45.8
Week 3	63.5	12.0	54.8
Week 4	64.8	11.1	55.9
Week 5	65.6	27.9	56.4

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Winter Oats

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **19.49% DM** **8.01 tDM/ha**	Anticipated **23.88% DM** **10.02 tDM/ha**	Anticipated **28.75% DM** **14.05 tDM/ha**	Anticipated **39.93% DM** **15.18 tDM/ha**	Anticipated **69.64% DM** **15.04 tDM/ha**

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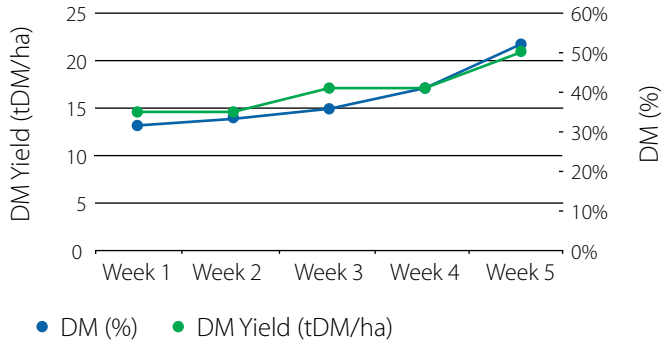
Winter Rye

Growing Costs (source Lallemand: NIAB Trial 2015)

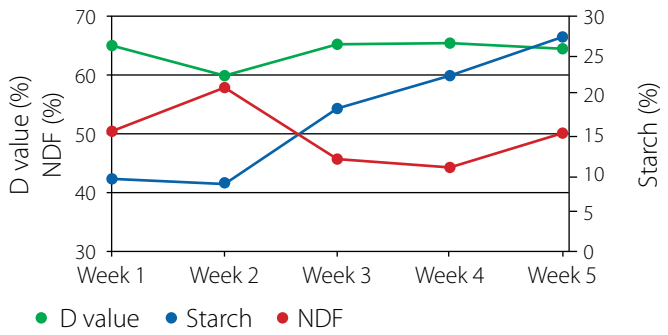
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£10.89	**£4.40**	Tempt 3 Kg/Ha with drilled seed.
	Herbicides	£78.93	**£31.89**	Pre emergence Liberator 0.6 L/Ha
	Insecticide	£0.00	**£0.00**	Nil applied
	Nitrogen + Sulphur	£80.69	**£32.60**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil applied
	Fungicides	£127.61	**£51.56**	Vortex 3.0 & Ceriax 3.0 l/ha + Bravo 1 L/Ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£94.99	**£38.38**	**KWS Progas** 65 kg/acre @£698/tone
Cultivations	Spraying	£19.01	**£7.68**	2 applications @ £2.56/acre
	Fertilising	£9.75	**£3.94**	2 applications @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£235.13	**£95.00**	Smiths Gore Farm Rents review @ £95/yr
	Total V.C's	£1,046.80	**£422.95**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	14.53	31.76%
Week 2	14.55	33.89%
Week 3	17.05	35.70%
Week 4	17.17	40.50%
Week 5	20.82	52.15%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	64.9	9.4	50.7
Week 2	59.9	8.9	58.0
Week 3	65.3	18.5	45.7
Week 4	65.3	22.5	44.6
Week 5	64.6	27.5	50.3

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Winter Rye

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **31.76% DM** **14.53 tDM/ha**	Anticipated **33.89% DM** **14.55 tDM/ha**	Anticipated **35.70% DM** **17.05 tDM/ha**	Anticipated **40.50% DM** **17.17 tDM/ha**	Anticipated **52.15% DM** **20.82 tDM/ha**

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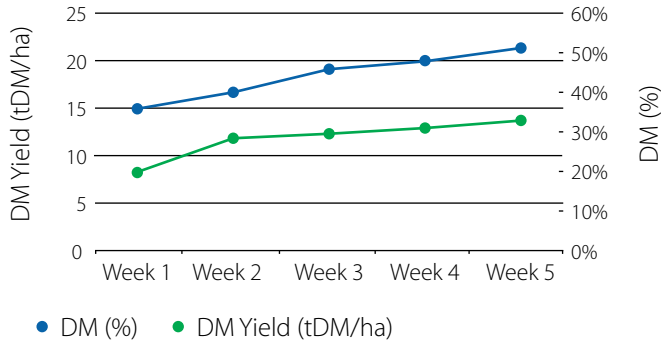
Spring Wheat

Growing Costs (source Lallemand: NIAB Trial 2015)

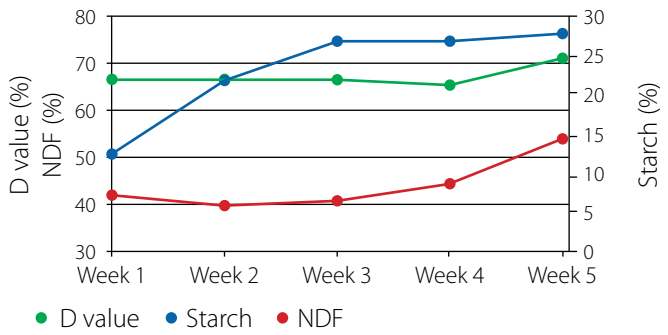
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed.
	Herbicides	£35.91	**£14.51**	Pre emergence Liberator 0.3 L/Ha
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£52.57	**£21.24**	Ceriax 3.0 l/ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£126.00	**£50.91**	**Mulika** 81 kg/acre @ £616/tonne
Cultivations	Spraying	£12.67	**£5.12**	2 applications @ £2.56/acre
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£832.91	**£336.53**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	8.39	35.50%
Week 2	11.84	40.04%
Week 3	12.21	45.22%
Week 4	12.94	47.73%
Week 5	13.59	50.73%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	66.6	12.8	42.3
Week 2	66.5	21.9	39.9
Week 3	66.6	26.6	40.8
Week 4	65.3	26.7	44.6
Week 5	71.0	27.7	53.6

The Wholecrop Guide

Spring Wheat

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **35.50% DM** **8.39 tDM/ha**	Anticipated **40.04% DM** **11.84 tDM/ha**	Anticipated **45.22% DM** **12.21 tDM/ha**	Anticipated **47.73% DM** **12.94 tDM/ha**	Anticipated **50.73% DM** **13.59 tDM/ha**

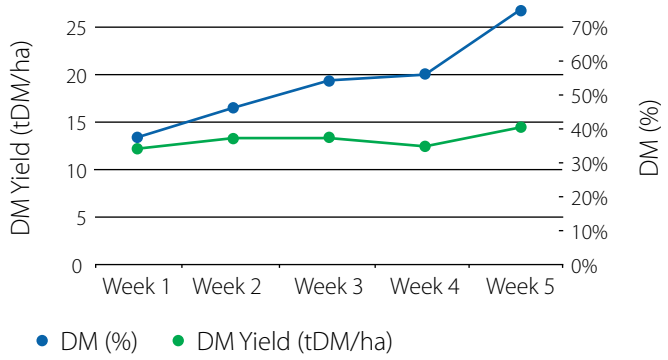
The Wholecrop Guide

Spring Barley

Growing Costs (source Lallemand: NIAB Trial 2015)

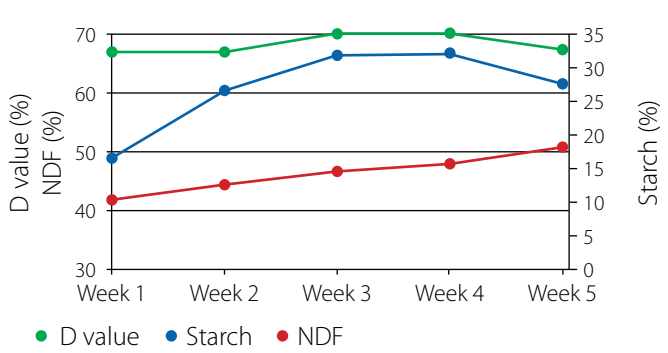
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed.
	Herbicides	£35.84	**£14.51**	Pre emergence Liberator 0.3 L/Ha
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£52.57	**£21.24**	Ceriax 3.0 l/ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£92.39	**£37.33**	**Westminster** 61 kg/acre @ £616/tonne
Cultivations	Spraying	£12.67	**£5.12**	2 applications @ £2.56/acre
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£799.23	**£322.95**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	12.09	37.95%
Week 2	13.36	46.71%
Week 3	13.61	54.20%
Week 4	12.34	56.14%
Week 5	14.49	73.76%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	66.7	16.7	41.7
Week 2	66.7	26.8	44.0
Week 3	70.0	31.9	46.3
Week 4	70.0	32.0	47.5
Week 5	67.4	27.6	50.5

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Spring Barley

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **37.95% DM** **12.09 tDM/ha**	Anticipated **46.71% DM** **13.36 tDM/ha**	Anticipated **54.20% DM** **13.61 tDM/ha**	Anticipated **56.14% DM** **12.34 tDM/ha**	Anticipated **73.76% DM** **14.49 tDM/ha**

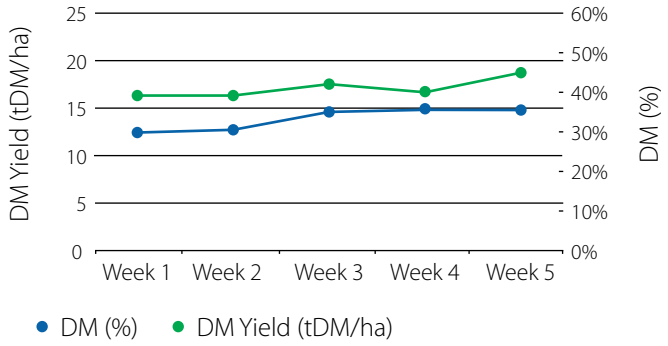
The Wholecrop Guide

Spring Triticale

Growing Costs (source Lallemand: NIAB Trial 2015)

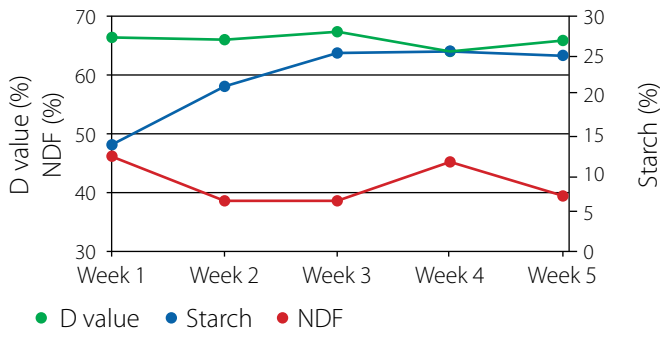
	Spring Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed
	Herbicides	£35.91	**£14.51**	Pre emergence Liberator 0.3 L/Ha
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£52.57	**£21.24**	Ceriax 3.0 l/ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£141.99	**£57.37**	**Dublet** 81 kg/acre @ £616/tonne
Cultivations	Spraying	£12.67	**£5.12**	2 applications @ £2.56/acre
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£848.90	**£342.99**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	12.31	38.72%
Week 2	12.81	39.39%
Week 3	14.59	41.99%
Week 4	14.82	40.27%
Week 5	14.62	44.54%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	66.4	13.7	46.3
Week 2	65.9	20.9	38.5
Week 3	67.1	25.2	38.6
Week 4	63.7	25.4	45.4
Week 5	65.9	25.1	39.6

The Wholecrop Guide

Spring Triticale

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **38.72% DM** **12.31 tDM/ha**	Anticipated **39.39% DM** **12.81 tDM/ha**	Anticipated **41.99% DM** **14.59 tDM/ha**	Anticipated **40.27% DM** **14.82 tDM/ha**	Anticipated **44.54% DM** **14.62 tDM/ha**

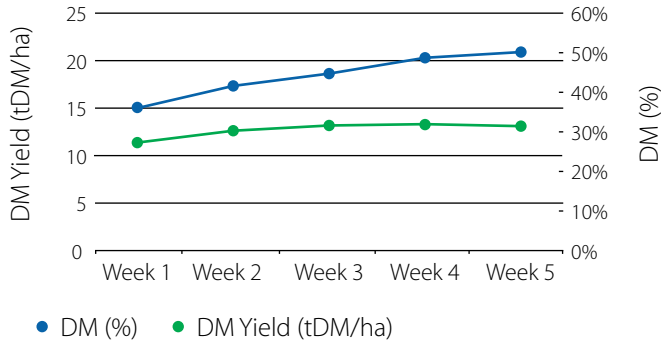
The Wholecrop Guide

Spring Oats

Growing Costs (source Lallemand: NIAB Trial 2015)

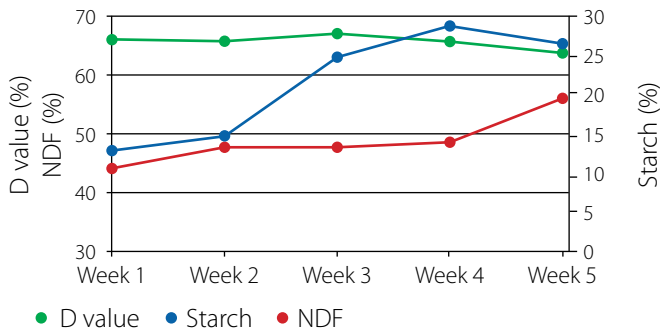
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed.
	Herbicides	£0.00	**£0.00**	Nil Applied
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£52.57	**£21.24**	Ceriax 3.0 l/ha
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£92.69	**£37.45**	**KWS Valdez** 61 kg/acre @ £616/tonne
Cultivations	Spraying	£6.34	**£2.56**	1 application @ £2.56/acre
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£757.35	**£306.00**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	11.29	36.30%
Week 2	12.68	41.13%
Week 3	13.11	44.83%
Week 4	13.26	48.61%
Week 5	13.02	49.88%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	65.9	12.8	44.4
Week 2	65.7	14.8	47.9
Week 3	67	24.9	47.9
Week 4	65.8	28.6	48.8
Week 5	63.9	26.5	56.1

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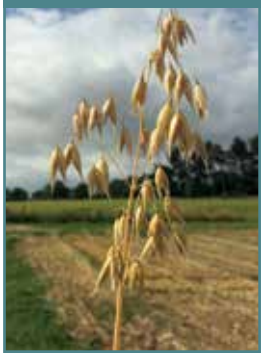
Spring Oats

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **36.30% DM** **11.29 tDM/ha**	Anticipated **41.13% DM** **12.68 tDM/ha**	Anticipated **44.83% DM** **13.11 tDM/ha**	Anticipated **48.61% DM** **13.26 tDM/ha**	Anticipated **49.88% DM** **13.02 tDM/ha**

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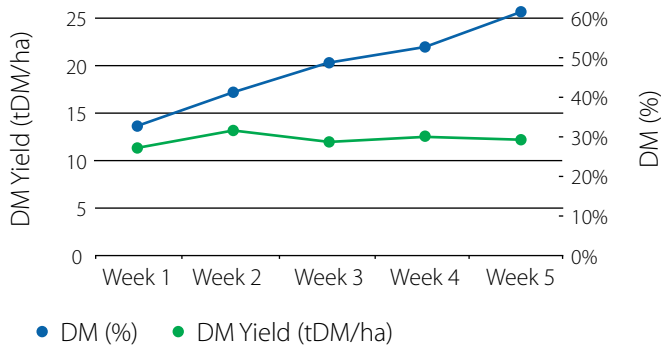
Spring Barley and Peas

Growing Costs (source Lallemand : NIAB Trial 2015)

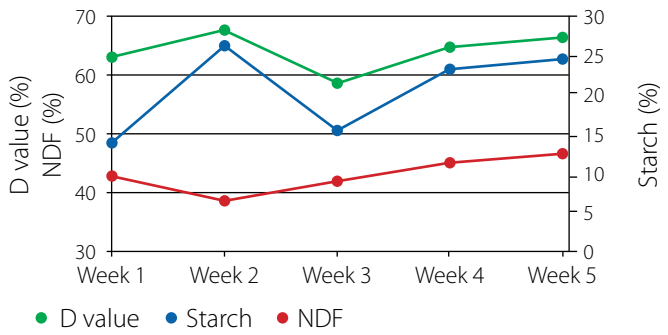
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed.
	Herbicides	£35.91	**£14.51**	Pre emergence Liberator 0.3 L/Ha
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£0.00	**£0.00**	Nil Applied
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/ac
	Seed	£125.78	**£50.82**	**Wholecrop** BPX 67 kg/acre @ £726/tonne
Cultivations	Spraying	£6.34	**£2.56**	1 application @ £2.56/acre
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£773.78	**£312.64**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	11.21	32.51%
Week 2	12.98	41.21%
Week 3	11.94	48.65%
Week 4	12.52	52.59%
Week 5	12.11	61.04%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	63.1	14.2	42.8
Week 2	67.4	26.4	38.9
Week 3	58.3	15.3	42.1
Week 4	64.6	23.2	45.4
Week 5	66.5	24.6	46.7

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Spring Barley and Peas

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **32.51% DM** **11.21 tDM/ha**	Anticipated **41.21% DM** **12.98 tDM/ha**	Anticipated **48.65% DM** **11.94 tDM/ha**	Anticipated **52.59% DM** **12.52 tDM/ha**	Anticipated **61.04% DM** **12.11 tDM/ha**

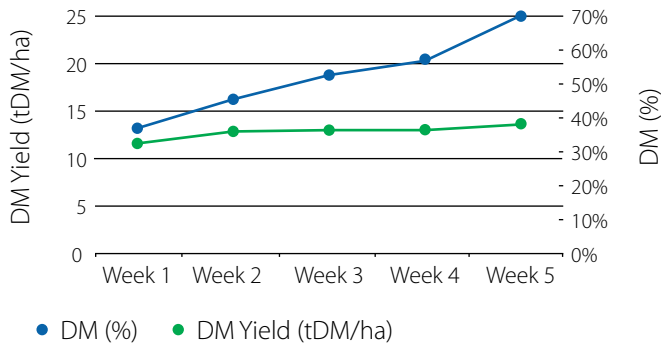
The Wholecrop Guide

Spring Barley Undersown with Grass

Growing Costs (source Lallemand: NIAB Trial 2015)

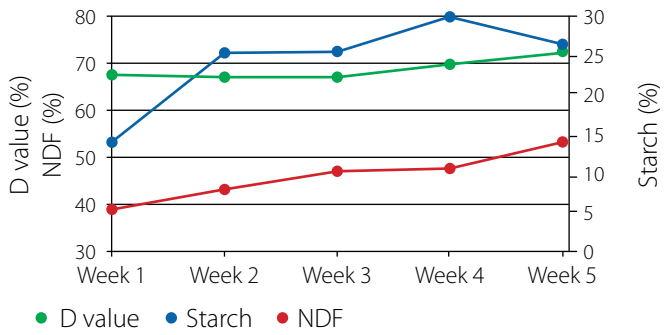
	Winter Trial	Cost/Ha	Cost/acre	Summarised Input Details. Incs NAAC costs
Inputs	Molluscicide	£7.33	**£2.96**	Tempt 2 Kg/Ha with drilled seed.
	Herbicides	£0.00	**£0.00**	Nil Applied
	Insecticide	£0.00	**£0.00**	Nil Applied
	Nitrogen + Sulphur	£62.67	**£25.32**	Total applied Nitrogen 117 kg/ha & 30 KgSO3/Ha
	PGR	£0.00	**£0.00**	Nil Applied
	Fungicides	£0.00	**£0.00**	Nil Applied
	Additive	£86.63	**£35.00**	£3.50/t @ 10t/acre
	Seed	£73.93	**£29.87**	**Westminster** 48 kg/acre @ £616/tonne PRG + WC
Cultivations	Spraying	£0.00	**£0.00**	Nil Applied
	Fertilising	£4.88	**£1.97**	1 application @ £1.97/acre
	Ploughing	£63.11	**£25.50**	NAAC figures
	Combination Drilling	£59.40	**£24.00**	NAAC figures
	Cambridge Roll	£17.33	**£7.00**	NAAC figures
	Harvest & Ensiling	£163.35	**£66.00**	3 trailers, forager and buckrake
	Rent & Interest	£141.08	**£57.00**	Smiths Gore Farm Rents review (0.6 years @ £95/yr)
	Total V.C's	£679.68	**£274.62**	

DM Yield vs DM%



	DM Yield (tDM/ha)	DM (%)
Week 1	11.55	36.81%
Week 2	12.97	45.55%
Week 3	12.88	52.41%
Week 4	13.00	56.96%
Week 5	13.57	69.90%

Analysis



	D value (%)	Starch (%)	NDF (%)
Week 1	67.6	14.1	39.3
Week 2	67.0	25.3	43.6
Week 3	67.1	25.5	47.1
Week 4	69.9	29.9	47.8
Week 5	72.8	26.4	53.3

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Spring Barley Undersown with Grass

Week 1	Week 2	Week 3	Week 4	Week 5
				
				
				
Anticipated **36.81% DM** **11.55 tDM/ha**	Anticipated **45.55% DM** **12.97 tDM/ha**	Anticipated **52.41% DM** **12.88 tDM/ha**	Anticipated **56.96% DM** **13.00 tDM/ha**	Anticipated **69.90% DM** **13.57 tDM/ha**

Case Study 1 - Wil Armitage, Leicestershire

Wholecrop integral to system success

Fermented wholecrop plays a significant part in the farming system at Keythorpe Farms, Tugby near Leicester and has so done for nearly 20 years, during which time the business has moved from being the highest yielding herd in the UK to developing a successful organic system.


Wil Armitage

"We initially introduced wholecrop in 2000 when we were averaging over 12,000 litres," comments Wil Armitage who has been at the farm since 1990 and overseen a period of considerable evolution. *"At that time we had been growing alkalage as we needed a source of effective fibre for the high yielding herd.*

"We are a marginal farm for maize and maize is lower in effective fibre, so I used alkalage for fibre and purchased maize grain to get starch in the diet."

100 day growing season

In 2005 the decision was taken to go organic and for the last seven years, fermented wholecrop has been an integral part of the farming system. *"It fits the farm, the system and the diet,"* Wil comments. *"Currently we will grow in the region of 60 acres, looking for a significant dry matter yield in around 100 growing days.*

"We grow a spring mix of barley, oats, peas, beans and some triticale which follows a grass ley. Grass is ploughed out in April and the wholecrop is harvested allowing a grass reseed in the autumn. I am looking for 5tDM/acre, giving me around 300tDM in total, while getting an effective break from grass.

"The legumes are an important part of our system, fixing nitrogen and also producing a higher protein feed."

The crop will usually be harvested in the second or third week of July, but the exact timing of cutting will depend on the other forages harvested. In addition to wholecrop, Wil grows red clover and Lucerne for silage.


A heavy crop -
this wholecrop was planted in late April and this picture taken on 20th July 2015

He will vary wholecrop cutting date based on the maturity and dry matter of the other forages. If they are lower dry matter, he will take wholecrop later. By so doing, this allows him to manipulate the overall dry matter of the forage portion of the diet. Whenever the crop is taken, it will be ensiled using Magniva Platinum Wholecrop to help reduce aerobic spoilage at feedout.

"This year I would expect to take the wholecrop drier as some of the first cut was rained on and so will be a wetter crop. In the past, we have taken the wholecrop very dry and have had to crack the grain, but we don't usually have to do this."

The wholecrop is a significant portion of the diet for the 350 autumn calved cows and will also be fed to the 220 cow spring calved herd which is currently being set up.

The autumn calved herd will calve between 1st September and 30th November and Wil's objective is that they are all in calf again by the time they go out to graze in late February. As such he doesn't push yield, putting condition and fertility ahead of extra litres. They will typically be housed in early November but have access to silage before housing. At housing, fodder beet replaces grazing in the diet.

Diet benefits

The winter diet comprises red clover, fermented wholecrop and Lucerne silages, fodder beet and meal which includes ground maize, oats, soya and sunflower. The maximum feed rate is 7kg/cow.

Wholecrop will make up one third of the forage portion of the diet and Wil feeds 3-4kgDM/day, believing it brings several advantages.

"Wholecrop is often labelled as a low energy feed, but I am not a greater believer in analyses. It is what the cows tell me that matters. It is a great source of ADF which drives rumen health. It improves the presentation of the diet and promotes intakes. Higher intakes compensate for any small reduction in energy density.

"It is also a flexible feed which, by tailoring dry matter at harvest allows me to get the most from my other forages."

Keythorpe Farm facts

- 1300 acres (526ha)
- Organic system for 11 years
- 350 autumn round calving Holsteins, averaging 7600 litres from 1800kg concentrates, targeting 50% of milk from forage
- 230 cow spring calved herd being established
- Grass clover silage, Lucerne silage and 60 acres (24ha) wholecrop

Case Study 2 - Tom Matthews, Oxfordshire

Wholecrop delivers consistently

Fermented wholecrop has been one of the foundation of a successful dairy business for 15 years, proving it's worth year on year

Tom Matthews farms at Common Farm, Uffington in the Vale of the White Horse. The farm has 450 acres of arable and 400 acres of grass. Soils are predominantly heavy clay loam.

He runs a herd of 230 Holstein/Friesian cows crossed with Scandinavian Reds, having been cross-breeding for seven year. Like all dairy farmers he is focussed on maximising the value of milk sold under his contract while maximising production from forage to help control costs. The cows are managed as autumn and spring calving blocks to maximise the seasonality payments and he is looking to increase milk solids.

Cows will typically graze from early April until late October and are buffer fed, mainly to support the spring calvers as they get back in calf. Autumn calvers are housed by night as they calve. Winter feeding is based on a TMR with dairy compound is fed through a system of out of parlour feeders.

Initially tried maize

"Around 25 years ago we decided to look at feeding mixed forages to increase intakes and production from forage," Tom comments. *"Like many farmers we decided to try maize and grew it for around 10 years but never really got on with it.*

"The initial varieties may have been suited to growing in Europe but did not get on with our soils. We had problems getting crops established and despite always going for early varieties, invariably found it difficult to establish follower crop.

"Although we were growing enough to feed 15-20kg/cow/day we found we were fighting at both ends of the season and struggling to get a quality crop. Maize is costly to grow if you only get a mediocre crop, so we decided to try wholecrop as we thought it would be better suited to the farm and were already growing cereals."

For the last 15 years, Tom has been growing winter triticale for fermented wholecrop, with a similar acreage to that previously used for maize. The crop has averaged 12t/acre but in a good year can yield 15t/acre. This is enough to allow 17-20kg/cow/day throughout the winter with enough left for buffer feeding where it helps maintain butterfats.

Triticale works well on land not suited to wheat, spreads the harvest window reducing workload in peak harvest period and is cheaper to grow than wheat although Tom stresses it is important to treat cereals for wholecrop the same as a combinable crop.

"We look to cut the crop slightly green and cut it shorter as we find it ensiles better. The crop is treated with Magniva Platinum Wholecrop and the result is a very stable feed with minimal waste which analyses well (see table). The clamp face is 30 feet wide and we aim to get across in a week. In the summer we only take half grabs to make sure we cover the face quickly.

"The cows milk well on the forage and it really suits the farm, delivering consistent yields year after year. It comes off in good conditions, allowing us to follow it with oilseed rape.

"The other great advantage is flexibility. We can look at first cut grass and decide what stocks will be like for the winter. If we think we are going to be tight it is easy to harvest an extra field of wheat for wholecrop.

"It you grow maize and find stocks are going to be tight, your only options are to accept a yield reduction or get the cheque book out, something no-one wants to do with current milk prices. Wholecrop is helping us improve consistency and ensure good production from forage."

	2014	2015
DM (%)	45.3	40.2
Crude protein (%)	9.3	8.0
D value (%)	65.4	65.5
ME (MJ/kgDM)	10.2	10.2
NDF (%)	36.4	32.9
Starch (%)	25.2	25.6

Common Farm Facts

- 850 acres (344ha)
- 240 cross bred cows averaging 8750 litres at 4.2% fat and 3.3% protein with 2700 litres from forage.
- Winter diet comprises 50:50 grass silage: fermented triticale wholecrop, HiPro Soya, home-grown urea treated wheat, ground maize, soya hulls, molasses, fat and minerals.
- 60-80 acres (24-32ha) winter triticale grown for wholecrop, averaging 12t/acre

The Wholecrop Guide

Case Study 3 - Diane Guitane, Kent

Quality forage central to system success

Diane Guitane, dairy farm manager at Henden Manor Farm, is a firm believer that if you keep cows healthy and in-calf then the rest will follows. She says achieving this requires a consistent diet based on sufficient, high-quality forage.


Diane Guitane

"If we can get quality forage and plenty of it, this is the best way to cut costs. With only 121ha for 240 cows, we need to work hard to make sure we achieve this."

To produce sufficient forage, they operate a three crop system including double cropping. A proportion of maize is sown after first cut is taken with winter wheat wholecrop following maize. Diane believes wholecrop is an excellent contributor to the system, increasing total forage production while providing a valuable ingredient in the diet.

"Without wholecrop we would not be able to produce enough quality forage. As well as increasing the tonnage available, it provides a good source of scratch factor, meaning we maintain good rumen health which is key."

Winter wheat fits the bill

Over the years, they have decided that winter wheat is the crop best suited to the farm which comprises mainly heavy clays and is a cold, late farm. Triticale has been tried in the past but was felt to produce too much straw which affected feed quality.

The wheat is treated as a combinable crop with a full fertiliser and agrochemical programme including a growth regulator. Diane says that while using a growth regulator will reduce crop bulk, it ensures a better ratio of grain to straw and an overall better quality feed.

The wholecrop is short chopped and clamped using Magniva Platinum Wholecrop to improve aerobic stability as the crop is cut at a target 40-45% dry matter.

"We look to cut it dry so that it will balance out grass and maize, both of which will be around 30% dry matter. We could cut drier but this would mean we need to crack the grain.

Taking at 40% saves this task and means there is less rumen available starch. Winter wheat cut at this stage is the best wholecrop for our circumstances, although other farmers will find other systems suit them better."

While wholecrop and grass are important forages, maize is the mainstay of the diet although, despite being in Kent, the farm is not best suited to the crop. The combination of heavy soils, being a cold farm and delayed drilling mean the crop is always harvested late and rarely better than 30% dry matter.

Mixed forages drive intakes

"We feed a true TMR with nothing in the parlour. I am looking for cows to produce 40 litres a day and to keep producing at this level. Mixed forages help drive high intakes and minimize the duration of negative energy balance so cows get in calf quickly.

"Wholecrop provides the balance in the diet and means we can introduce a starch based forage sooner," Diane continues. *"Feeding 6kg/day of wholecrop we can produce enough for around 240 days while we look to feed maize 365 days a year.*

"Wholecrop gives us options which is important as it helps us manage risk. I would like to feed it all year round, but can't grow any more on the current farm with the rotation we have.

"Wholecrop costs around £38 per tonne freshweight (£85/tDM) while maize is around £23 (£77/tDM) but this isn't the key issue. We need sufficient total forage. Each tonne of wholecrop at 45% dry matter means we can feed around 400kg less concentrate which would cost far more than £38.

"What is important is what wholecrop gives us. It give flexibility, it allows us to produce more forage from the same land area and it gives us valuable scratch factor and boosts intakes to help keep the rumen and the cows healthy. If we can do this they will produce milk efficiently at less cost per litre."

Henden Manor Farm facts

- 121 ha forage
- 240 all year round calving Holsteins plus youngstock
- Average yield 10,000 litres at 3.8% far and 3.3% protein
- 44ha maize annually, 28ha drilled after first cut
- 20ha wholecrop wheat
- 2015 wholecrop analysis 45.7%DM, 66.3 D value, 10.3ME, 28% starch, 116 intake potential
- Target daily DMI 25kg/cow
- Winter diet 6kg grass silage, 6kg wholecrop, 22kg maize silage, 5kg crimped maize, 1kg soya, 3kg rape, 0.5kg molasses plus Dynalac and minerals

The Wholecrop Guide

Case Study 4 - Michael Wilson, Cumbria

Wholecrop balances grass DM for optimum diet

In an area where growing maize is not an option, wholecrop cereals are providing a flexible second forage for a leading Montbeliarde herd, being used to fine tune silage production.

Michael Wilson runs the Blackcombe herd at Monk Foss Farm, Millom with his partner Laura Teasdale, his brother Brian and parents John and Isobel. Initially a Holstein herd, black and whites have been phased out over the last 14 years.

"We were driven by a desire to have a more durable, longer lasting cow with better cull cow and calf values," he explains. *"We have a strong market for beef calves and a lower replacement rate but we also needed a cow that could convert forage into milk efficiently.*

"Having breed for yield, we are now breeding for fat and protein to suit the contract. By concentrating calving towards the autumn we can also make the most of seasonality payments. High yielders are housed all year with 120 cows kept in at any one time"

Quality forage is at the heart of the system and Michael has always wanted to feed mixed forages. As the farm and area are not suited to maize production, wholecrop cereals have been successfully integrated into the farming system and the diet.

Normally 24-33 hectares of cereals will be grown, either spring barley or winter wheat.

"As we have a mix of soils types we will vary the crop grown to suit. Whatever we grow, we manage it as a combinable crop with full fertiliser, herbicide and fungicide treatments as advised by our agronomist. Winter wheat will get 140 units of nitrogen, while spring barley gets 60 units.

"It is vital to treat it as a combinable crop because you are looking for good grain weight and you want a clean crop, not least as in some years the grain might be crimped or sold depending on how forage stocks look.

"Wholecrop also fits into our system really well. We look to reseed 12-16 hectares of grass every year so we go in behind the wholecrop and this means we get the crop established and away early."

Timing of wholecrop harvest depends on the quality of first and second cut grass. Working with Lallemand Regional Business Manager Mike Burns, the aim is to produce a TMR with an average dry matter of around 40% to promote optimum dry matter intakes.

Harvesting flexibility

"We always take first cut early and are one of the first in the area, usually around May 11th so we have an analysis of first and second cuts before wholecrop is harvested. Actual cutting date depends primarily on grass dry matter and then on the weather. The wetter the grass, the later we leave the wholecrop. While we prefer to take it at around 40%DM we have taken it as high as 50%.

"The beauty of wholecrop is that it lets you make this sort of decision, allowing you to take management decisions to influence overall forage quality."

Integration of forages extend to cutting lengths. Grass silage is picked up by forage wagon to give a longer particle size in the mix, while wholecrop is precision chopped to improve consolidation.

The wholecrop is treated with Magniva Platinum Wholecrop. "We want to minimise waste. With dairy forage the inoculant will improve aerobic stability, while with a lower dry matter crop it will also improve the rate of the initial fermentation. The wholecrop goes in a 34' clamp so we move across it quickly which also helps reduce the risk of spoilage

"We will start using the wholecrop around 14 days after cutting and feed it all year round, giving us a consistent diet promoting good rumen health."

Monk Foss Farm facts

- 113 ha owned plus 53ha rented
- 60" annual rainfall
- 240 all year round calving Montbeliardes, with bias to summer/early autumn
- High yielders housed all year round
- Average yield 8,650 litres at 4.12% far and 3.42% protein, milk sold to Arla. Targeting 3000 litres from forage
- 3-4 cuts grass silage and 24-33ha wholecrop
- 2015 first cut analysis 32.2%DM, 75.8 D value, 12.1 ME, 124.2 Intake Potential
- 2015 wholecrop analysis 33.3%DM, 65.1 D value, 10.2 ME, 23.0% starch, 99.0 intake potential
- High yielder winter diet 28kg grass silage, 10kg wholecrop. 6kg caustic wheat, 2.75 kg blend, 0.3kg straw plus minerals and Lalemand SC Gold yeast. Diet provides M+30 litres with 14kgDM from forage. Diet average DM is 44.8%