AgriSearch NI
Driving Excellence and Innovation

Zero-grazing

A best practice guide



afbi Agri-Food and Biosciences Institute

AHDB

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Foreword

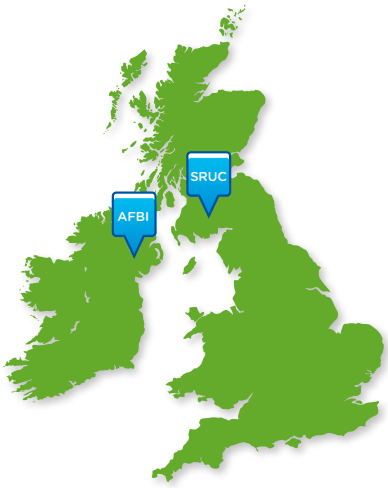
Information in this booklet aims to aid farmers with decisions around implementing a zero-grazing system, allows farmers to decide if a zero-grazing system is right for them and provide practical advice on best practice management to capitalise on the benefits.

Interest in zero-grazing systems has increased considerably over recent years with many farmers either using it during the shoulders of the season or throughout the grazing season.

Key drivers for adoption of this technology have been to increase the proportion of fresh grass included in the diet and as a management tool for fragmented grazing land, wetter summers, expanding herd sizes and in some cases robotic milking systems.

Until recently, there had been almost no research commissioned on zero-grazing systems. With this and the increasing popularity of the system in mind, AHDB Dairy and AgriSearch commissioned separate but complementary research studies on zero-grazing at Scotland's Rural College and the Agri-Food and Biosciences Institute.

This research sought to answer key questions as to the potential role of zero-grazing systems on UK dairy farms as well as to establish best-practice guidelines for farmers. This publication summarises the findings of these research studies with further descriptions of how these studies were conducted available in the appendix (page 41).



Zero-grazing, also referred to as cut and carry, is a feeding system where fresh grass is cut daily and fed to housed cows throughout the year.

Throughout this publication, it will be referred to as zero-grazing.

Contents

Key messages

01	• Introducing well-managed fresh grass into the diet of dairy cows can reduce feeds costs and improve profitability (pg. 03)
02	• Zero-grazing is a viable option to increase the proportion of grass in the dairy cow diets but good grassland management is essential (pg. 10)
03	• Zero-grazing systems can increase grass growth and utilisation (pg. 35)
04	• Keeping pre-cutting covers below 4000kg DM/ha is essential to ensure good quality forage, animal intake and cow performance (pg. 18)
05	• Using specialist zero-grazing machinery can lead to improvements in animal intakes and cow performance (pg.19)
06	• A flexible approach to time of day of cutting is required to optimise grass dry matter content, especially in wet conditions (pg. 19)
07	• A network of good access points to fields will minimise soil damage in wet weather conditions (pg. 11)
08	• Providing adequate feed space and pushing up regularly is key to achieving good intakes of zero-grazing grass (pg. 25)
09	• Fresh grass should be fed to cows at least every 24 hours to minimise spoilage and wastage (pg. 27)
10	• Compared to grazing, zero-grazing can improve cow performance and margin over feed and forage per hectare but additional housing cost must be considered (pg. 32)

1. Introduction

1.1 The value of home-grown forage

Feed and forage is the biggest cost on UK dairy farms which on average accounts for 33 per cent (9.5ppl) of the total production cost (Figure 1). Maximising the use of home-grown forage and reducing the cost of feed and forage on farm remains to be the largest driver for increasing farm profitability.

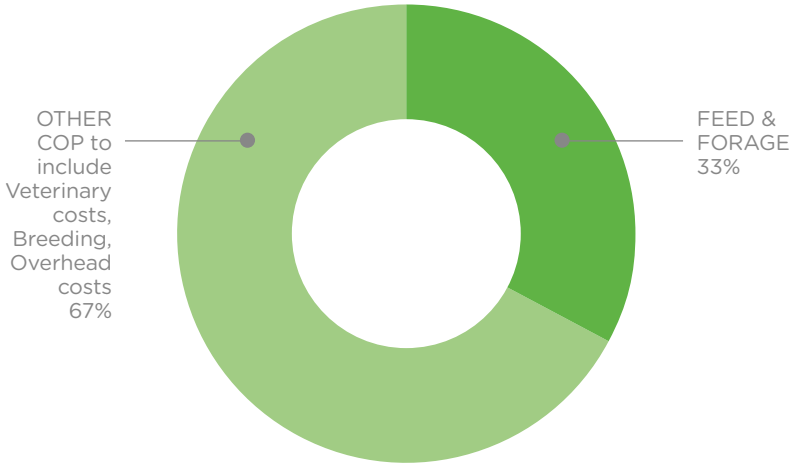


Figure 1: Proportion of the cost of production (COP) assigned to feed and forage costs.

Source: AHDB

- **Well-managed grass is the cheapest feedstuff available on-farm**
- **Maximising home-grown forages has the ability to reduce the cost of production and drive profitability.**

Benchmarking results from Northern Ireland and Great Britain indicate that since 2000, the top 25 per cent of farms ranked on milk from forage have been 3.8ppl (or £264/cow) more profitable than the bottom 25 per cent of farms (Table 1).

	Bottom 25%	Top 25%	Difference
Yield per cow (litres)	6,893	6,943	50
Concentrate fed (kg/cow)	2,675	1,597	-1,078
Milk from forage per cow (litres)	949	3,394	2,445
Net profit (£/cow)	**292**	**556**	**264**

Table 1: Benchmarking data for the period 2000-2016 ranked on milk from forage per cow.

Source: CAFRE, 2017

Sam McElheran
Stranocum, County Antrim

Zero-grazing helps improve milk from forage

High rainfall, heavy clay land and a long narrow farm layout meant zero-grazing was a logical decision for the 200ha farm in County Antrim.

Aiming to make more from home-grown forage. Sam McElheran switched to zero-grazing in 2015 on his 320 cow dairy farm. Prior to this the farm was grazing cows during the summer and housing in winter. This change has helped contribute to an increase in milk from forage from 1,336 litres in 2014 to 2,338 litres in 2017. "I'd like it to be more and it's still going up, but these changes don't happen overnight," Sam says.

Alongside the extra milk from forage there has been a cut in concentrate use, which has fallen from a concentrate usage of 0.39 kg/ litre in 2014 to 0.34 kg/ litre in 2017. This has coincided with an increase in stocking rate from 2.20 cows/ha in 2014 to 2.72 cows/ha in 2017. Grass growth also increased at Stranocum farm, which grew 12.7 tonnes of DM per hectare in 2017.

The routine today on the McElheran family's farm is to complete the morning milking and cut two loads of grass for the low-yielding group.

Road traffic is a major challenge for the farm, Sam believes zero-grazing is a good option for their farm. For anyone considering zero-grazing, he says: "If your farm is fragmented like ours, I would give it a go. Don't do it if you think it's going to be an easy option, because it isn't, theres a huge time commitment involved" he says. "You have to do the fetching, the carrying, the bringing it up to the cows – there's a lot of labour involved."

"If your farm is fragmented like ours, I would give it a go."

The majority of farms in the UK are located in areas with the potential for high grass production. Well-managed grazed grass remains the cheapest feedstuff for UK dairy herds (6p/kg DM) when compared with grass silage (10p/kg DM) and purchased concentrates (25p/kg DM). Utilising this potential and increasing the amount of home-grown forages fed to cows could reduce the feed and forage cost, reduce the effect of external markets volatility, reduce environmental impacts and thereby increases farm sustainability, resilience and profitability.

A zero-grazing system provides an alternative way to increase the amount of home-grown, high-quality forage used on dairy farms during the growing season compared with grazing and feeding grass silage. Although well-managed grazed grass is the most economical feed available for dairy cows, there is growing interest in the role of a zero-grazing system and its potential to reduce feed and forage costs.

- **Each additional 1,000-litres increase in milk from forage is equivalent to a £10,798 difference in net profit on a 100-cow dairy farm.**

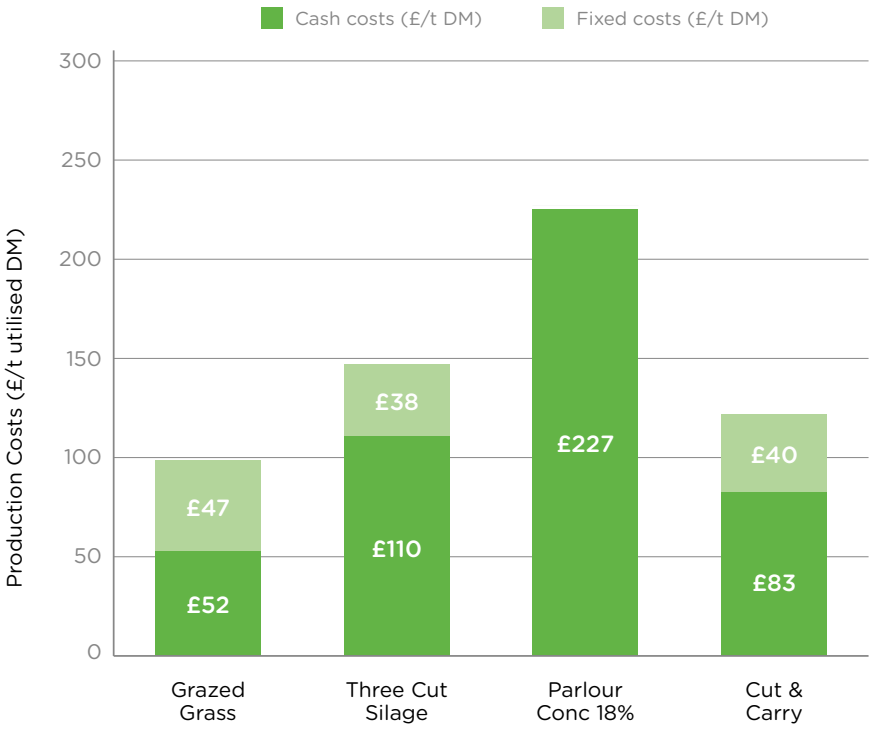


Figure 2: Typical production costs (£/t DM) of home grown forages compared to brought in concentrates for NI farms.

1.2 Zero-grazing systems

Zero-grazing (also known as cut and carry) is a feeding system where fresh grass is cut daily and fed directly to housed cows. The fresh grass is typically cut standing by one machine which transports the grass instantly from the field. Zero-grazed grass is typically fed as either the sole forage or alongside grass silage or total mixed ration. The system is used across mainland Europe, although its use in the UK has been limited so far.

1.3 Benefits and challenges

Over recent years, many dairy farmers have implemented a zero-grazing system to increase the proportion of fresh grass included in the diet and as a management tool for fragmented grazing land, expanding herd sizes and robotic milking systems.

Zero-grazing provides valuable opportunities for dairy farmers including:

BENEFITS

+ **Improvement in grassland productivity, with up to 25 per cent increase in grass growth rates and 15 per cent improvement in grass utilisation when compared with grazing**
+ **Supports an increase in stocking rate which reduces the total area needed for zero-grazing** (read Aidan's story on pg. 09)
+ **On wetter farms, more flexibility of the grazing platform and the potential to offer fresh grass earlier and later in the season compared with grazing** (read Tom's story on pg. 31)
+ **Extension of the grazing platform to fields which are difficult for cows to access**

+ **Easier to achieve constant grass residuals to maintain grass quality throughout the season** (read Parry's story on pg. 23)
+ **Avoids opening silage/changing diet when cows require sporadic summer housing. Improves cow performance in comparison to grass silage**
+ **Ability to buffer feed high yielding cows with other forages compared to grazing.**

However, as with any system, there are some challenges. These include:

CHALLENGES

- **Higher capital investment for specialised machinery. Increased fuel costs relative to grazing**
- **Large daily variation in grass dry matter (DM) content and dry matter intake (DMI) in comparison to grass silage impacting on animal performance** (see pg. 26 for considerations for managing low DMI)
- **Cut grass spoils within 18–24 hours, particularly in warmer summer temperatures** (see 'In shed management' section pg. 24)
- **Added cost of slurry handling, storage and spreading in comparison to a grazing system**
- **Greater feed space requirements for feeding fresh grass indoors when compared with silage** (see pg. 25 for infrastructure recommendations)
- **High labour demand (estimated one hour/100 cows) for cutting grass on a daily basis.**

1.4 Cost of zero-grazing grass

As with all feeding systems, the costs will vary widely from farm to farm and it is best to calculate the cost for your own farm when deciding if it is economically viable for your business. Within a zero-grazing system, there are a number of variables that can influence how much it costs to grow and harvest the grass. These include:

- Type of machinery used, including the initial purchase price and depreciation, or use of a contractor
- The proximity of cutting fields to the farmyard
- The productivity of fields and the number of rotations achieved
- Labour costs
- Infrastructure costs
- The utilisation rate of grass.

However, to give an indication of likely costs, some typical costs for zero-grazing systems relative to grazing and grass silage systems are outlined over in Table 2.

	Grazing	Zero-grazing	Silage[1]
ESTABLISHMENT COSTS (£/ha)			
Seedbed preparation and sowing[2]	£216	£216	£216
Seed (@35kg/ha)	£132	£132	£132
Lime, fertiliser and spray[3]	£227	£227	£227
Total	**£575**	**£575**	**£575**
Lifespan of sward (years)	10	10	10
Annual establishment costs	**£57.54**	**£57.54**	**£57.54**
GROWING COSTS (£/ha)			
Fertiliser (+ application)[3]	£269	£338	£240
Spray (+ application)	£15	£15	£15
Grass management (topping)	£30		
Slurry application[4]		£68	£204
Grass harvesting[5]		£200	£476
Ensiling (Additive+ Polythene)			£107
Annual growing costs	**£313.44**	**£620.16**	**£1041.60**
OTHER COSTS			
Land charge (£/ha)	£246	£246	£246
Depreciation costs (£/ha)	£134	£150	£184
Feed out costs (£/t DM)[6]	£4.91	£14.17	£14.17
GRASS PRODUCTION			
Annual harvested yield (t DM/ha)	10.6	12	13.8
Utilisation rate (%)	75	82	84
Utilised yield (t DM/ha)	7.95	9.84	11.5
Cash cost grown (£/ha)	**£371**	**£678**	**£1,099**
Total cost grown (£/t ha)	**£751**	**£1,074**	**£1,530**
Cash costs per tonne fed and utilised (£/t DM)	**£52**	**£83**	**£110**
Total cost per tonne fed and utilised (£/t DM)	**£99**	**£123**	**£148**

Table 2: Calculating zero-grazing costs in 2018.

Source: AFBI, 2018

[1] Standard three cut silage system with tractor and grab feed-out

[2] Includes ploughing, 2x power harrow, sowing and rolling

[3] All nutrients supplied to The Fertiliser Manual (RB209) recommendations for Index 2 soils in GGC and High SNS

[4] Assumes one slurry application for zero-grazing, three applications for silage

[5] Assumes seven rotations for zero-grazing using owned equipment. Assumes complete three cut silage system delivered by contractor

[6] Typically not included in other costings. Grazing feed out costs include labour costs associated with droving and grass allocation. Zero-grazing and silage costs assume feed out with a tractor and grab. Note: zero-grazing machines with delivery conveyors would reduce this cost slightly.

Further information on the economics are available in Section 4 Performance and Economics on page 32.

- Cash cost estimate for zero-grazed grass is £83 per tonne of DM.

  In comparison, typical cash costs estimate for grazed grass range from £52 – £66 and three cut silage costs from £87 – £110 per tonne of DM.

Aidan McManus
Clonliff, County Fermanagh

Fresh grass supports high milk production

Aidan introduced a succession of management changes to his 120-head milking herd from 2013. Changing to a zero-grazing system was the first of these which saw production increase from roughly 6,000 to 7,000 litres. A new cubicle house shortly followed and finally the instalment of two robots in 2016.

"Zero-grazing has helped us improve our soil structure and improved grass utilisation on our farm."

The cutting season typically begins in early April and extends until early November at Clonliff. During that time, the rotation length ranges from around 35 days at the outset to 25 days at times of peak growth, while grass quality has been found to remain high throughout.

Aidan takes part in the AgriSearch GrassCheck project which means they analyse their fresh grass regularly. "We have found spring grass usually analyses at a metabolisable energy (ME) of 13MJ/kg DM and crude protein (CP) is 22–23 per cent. Nothing you can buy comes anywhere near that analysis!" Aidan said.

To maintain grass quality Aidan avoids going into covers higher than 3900 kg DM/ha as the grass will be more mature and less leafy and will have a lower ME. The zero-grazing system has led to cleaner swards with fewer weeds and better grass utilisation at Clonliff farm. This has resulted in stocking rates rising from around 2.5 cows per hectare to 4.8 cows per hectare.

Aidan believes that the trick to maintaining intakes with zero-grazing is to cut twice a day, minimise grass damage by using a suitable mower, push up regularly and have an adequate length of feed face for the cows. From a nutritional perspective, Aidan balances the grass – particularly important when the sward is young and leafy – with a high-fibre, low-protein nut fed via the robot.

"With zero-grazing, we feel we get the best of all worlds," he says. "On our farm we have better soil structure, improved grass utilisation and better nutrition for the cows giving 9,500 litres at 3.9 per cent fat and 3.3 per cent protein."

2. In field management

The primary benefit of zero-grazing systems is an improvement in grass utilisation, offering potential to increase stocking rates and increase farm output and net margin per hectare. However, to achieve these improvements in grass utilisation, there are three key areas to consider:

2.1 Field selection

- Size
- Previous use
- Access

2.2 Grass

- Varieties
- Nutrient requirements

2.3 Cutting

- Growth stage
- Time of day
- Machinery

2.1 Field selection

When selecting appropriate fields for zero-grazing, it is important to take account of:

FIELD SIZE – Although using large fields for zero-grazing often makes cutting easier, employing very large areas can delay fertiliser applications and reduce growth rates. Square or rectangular fields will ease cutting and improve grass utilisation.

PREVIOUS USE – Using fields which have been grazed within the past month is best avoided as it carries a risk of harvesting grass which has been contaminated with manure. This has the potential to lower cow intakes and increase the rate of spoilage of grass at the feed trough.

ACCESS – Having appropriate access points is key to minimising the risk of soil compaction in any field. AHDB-funded research carried out in Scotland has shown that compaction from machinery and livestock can reduce grass yields by as much as 22 per cent, also impeding soil drainage and nutrient efficiency.

As a general rule of thumb, if it takes over seven days to finish a field, it is worth subdividing this into smaller areas.

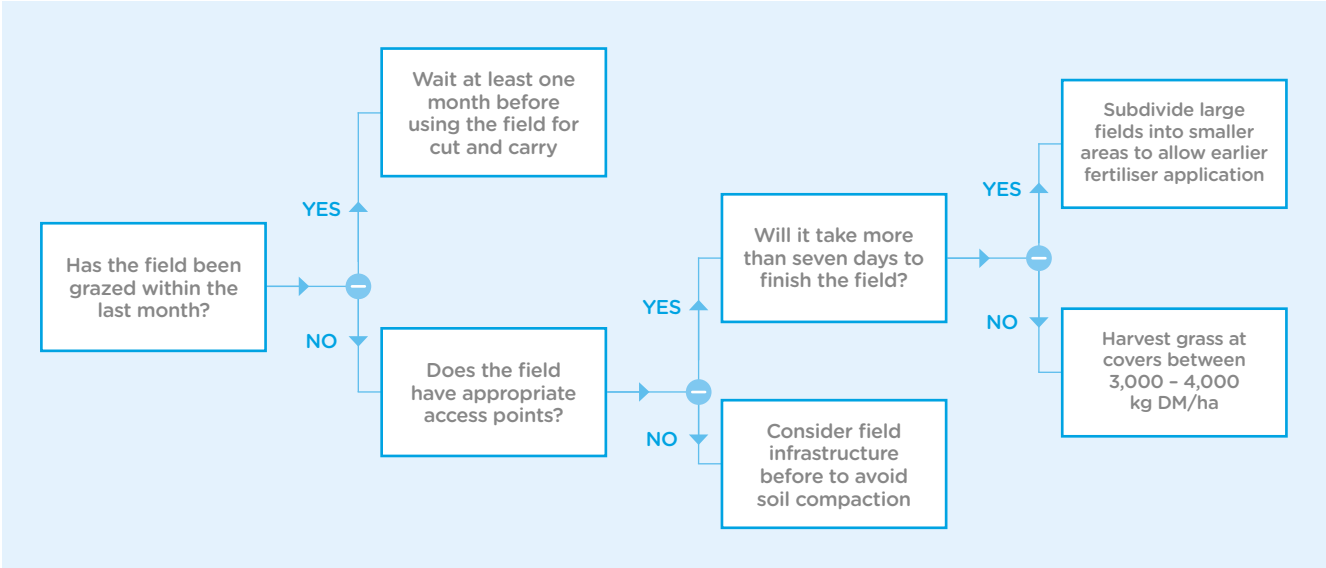


Figure 3: Decision tree for selecting fields for a zero-grazing system.

Figure 4: Uncompacted (LHS) vs compacted (RHS) soils.

Within zero-grazing systems, having multiple, wide entrance and exit points is essential to minimise any risk of soil damage. Research has shown that with a good network of entrance points to paddocks, zero-grazing can reduce overall field compaction by 10 per cent when compared with grazing systems.

More information on identifying and managing soil compaction is available from *AHDB's Healthy Grassland Soils guide*.

2.2 Grass

Good grass management is essential to optimise cow performance. This involves selecting the right sward and applying the correct rate of fertiliser.

VARIETY SELECTION – Recent research in Northern Ireland has shown that, compared to grazing, zero-grazing reduces the density of ryegrass plants over the course of a season by up to 16 per cent (Figure 5).

Although this may not have a negative effect on grass yield, it creates a more open sward and may increase the risk of soil damage, particularly on wet soils. When reseeding, selecting varieties with a higher sward density may help combat this.

The frequent cutting used in zero-grazing systems can change the structure of the grass influencing the management of zero-grazed grass.

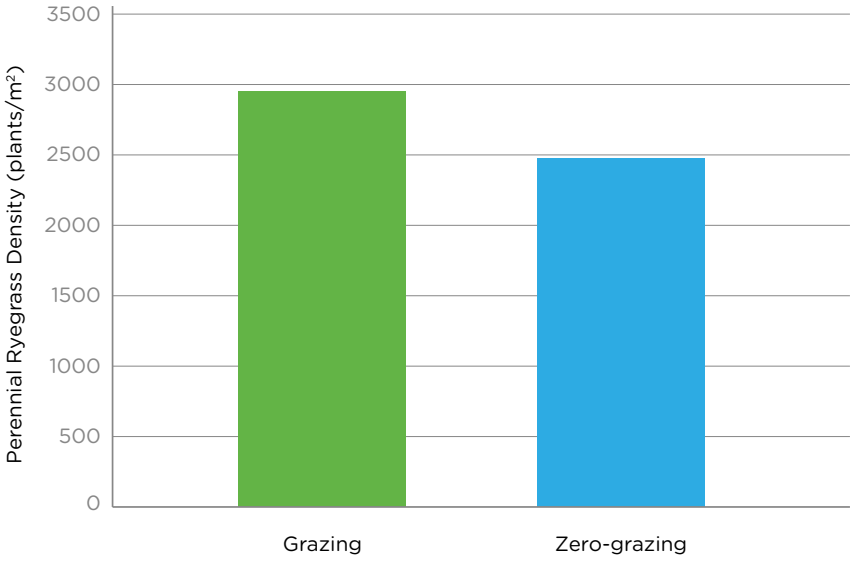


Figure 5: The impact of zero-grazing on perennial ryegrass density in leys after one cutting season.

Source: AFBI

"Using a similar check list to that you would use for selecting a multi-cut type ley is beneficial for zero-grazing. The desired traits to consider are:

- ✓ High grass quality
- ✓ Early season growth
- ✓ Good ground cover
- ✓ Narrow heading date for easier management

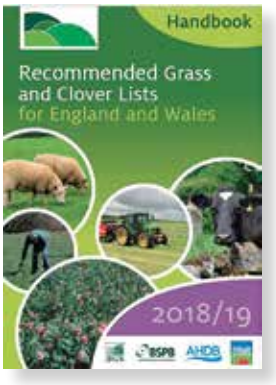
Current guidance is to use a 50/50 diploids and tetraploids mixture of 50/50 intermediate and late perennial ryegrass."

Helen Mathieu, Germinal

For more information see the Recommended Grass and Clover Lists, available to download at: britishgrassland.com/rgcl

You will also find an online tool to compare the performance of perennial ryegrasses.

The Recommended Grass and Clover Lists are updated on an annual basis.



As with all nutrient management planning, an up-to-date soil test every 3-4 years is vital to allow the most effective and cost-effective use of fertilisers and manures.

WEED CONTROL – Spraying for weed control in the main grass growing season can be challenging as many plant residues can be harvested with the zero-grazed grass. This may negatively impact animal intakes. Spraying management at the shoulders of the season will reduce this risk.

NUTRIENT MANAGEMENT – Nutrient requirements for swards managed under zero-grazing systems will be greater than those under grazing systems, due to the lack of nutrient returns from grazing animals. It is crucial to take into account the lack of nutrients returns when developing a nutrient management plan. The best method to consider nutrient requirements for zero-grazed swards is to work backwards from the recommendations from silage swards taking account of the lower yield of zero-grazed swards (typically 70-75% of silage yield) and the need to distribute fertiliser applications more frequently throughout the season.

Crop Nutrients

Phosphate and potash – Requirements for zero-grazed swards can be calculated by considering expected offtake yield. Typical values of phosphate and potash content in grass and expected offtake at three different grass yield levels are shown in Table 3.

Table 3: Plant nutrient content and total nutrient offtake at three different grass yield bands throughout one season.
Source: Nutrient Management Guide RB209, 2017

	Plant content (kg/t DM)	Total nutrient offtake (kg/ha/year) at different yield levels		
		7.5t DM/ha	10t DM/ha	12t DM/ha
Phosphate	7	52	69	82
Potash	24	181	241	289

Using Table 3, we can see that if 10t DM/ha of grass is removed, 69kg of phosphate and 241kg of potash need to be replaced. In addition, if soils are below index 2 additional phosphate and potash are required. Where soils are in excess of index 2 only a small amount of potash is required to support adequate plant growth. This can easily be supplied by slurry or organic manures. Example nutrient requirements for a grass field yielding 10t DM/ha at different soil indices is presented in Table 4.

Table 4: Example fertiliser requirements for a zero-grazed field yielding 10t DM/ha.
*Adapted from: Nutrient Management Guide RB209, 2017**

	P or K index				
	0	1	2	3	4+
Phosphate (kg/ha)	110	90	70	15*	0
Potash (kg/ha)	300	265	240 (2-) 150(2+)	80	0

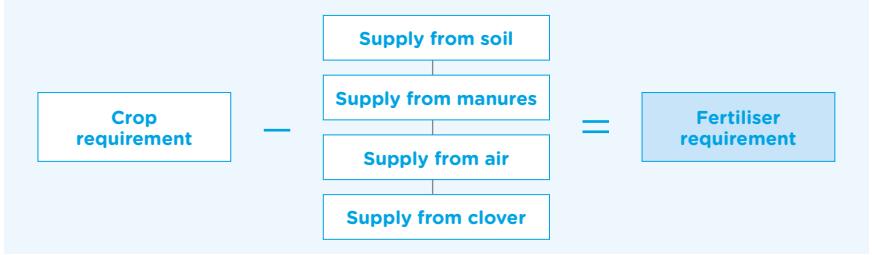
* Adapted to take into account lack of nutrients returns by grazing animals
Chemical P applications are not permitted on index 3 soil. Plant requirements can be met by use of organic manures or slurry.

Phosphate may be applied in several small applications throughout the season, although positive responses can often be seen from early-spring applications.

Potash may be applied in several small applications during the season. Where there is a known risk of grass staggers, application of potash in spring should be avoided and nutrients applied the previous autumn.

For more information on nutrient content of manures, see Section 2 Nutrient Management Guide (RB209).

Nitrogen – When calculating nitrogen requirements for zero-grazed grass, the supply from other sources need to be considered.



It is also important to take into account the factors below when calculating nitrogen:

- Soil nitrogen status
- Grass growth class
- Yield potential

Remember to deduct all nutrients applied as animal manure when calculating how much artificial fertiliser to apply.

Full details of this process and nitrogen recommendations can be found in the *Nutrient Management Guide (RB209) for GB farms or in RB209 7th Edition for Northern Ireland.*

Again, when calculating nitrogen requirements for zero-grazed swards, it is worthwhile reviewing silage recommendations and adjusting this for the lower grass yield observed under zero-grazed swards and the need for more frequent applications. As an example typical silage nitrogen requirements for swards at different yield levels are presented in Table 5 below – these have been split into different months to reflect more frequent cutting regimes as seen with zero-grazing.

Table 5: Example of nitrogen application rate for different yields for a zero-grazing system.

Source: Nutrient management Guide RB209, 2017

Indicative DM yield (t/ha)	Nitrogen application rate (kg N/ha) per grazing rotation and approximate application date							Total N application
	Feb	Mar	Apr	May	June	Jul	Aug	
7–9		40		30	30	30		130
9–12	20	40	40	50	40	30	30	250

* The recommendations are applicable to grass swards with low clover content in a very good/good grass growth class (GGC) and moderate soil nitrogen supply (SNS) situation. Target dry matter yield will be different for individual farms, dependent on grass growth class and livestock requirements. Good/very good GGC sites with 2–10-year-old swards are likely to achieve target dry matter yield values at the higher end of the range. New leys with modern varieties may exceed the upper dry matter yield range by 10–20 per cent. Poor/very poor GGC sites are likely to achieve dry matter yield levels towards the lower end of the range in most years. Adapted from Nutrient Management Guide (RB209).

2.3 Cutting

Grass growth stage

Zero-grazing offers the potential to cut at a higher level of grass cover than typical target grazing covers. Research in Northern Ireland has shown that pre-cutting covers on commercial farms using zero-grazing tend to be 450 kg DM/ha higher on average when compared to grazing farms. This allows higher offtakes and improved cutting efficiency.

However care must be taken not to use high grass covers for zero-grazing as this can impact overall grass quality and cow performance as shown by a recent trial conducted to determine optimum pre-cutting height. Two groups of cows were fed fresh grass via a zero-grazing system in Northern Ireland, either from:

1. Low-grass-covers (3,650 kg DM/ha)
2. High-grass-covers (4,750 kg DM/ha)

Feeding high-grass-covers negatively impacted growth rates and grass quality, see Table 6. An additional 1.86t DM/ha was produced from the low-grass-cover compared with the high-grass-cover over the 90-day study. In both cases grass utilisation was greater than that measured in grazed swards (75 – 80 per cent), there was higher wastage at the feed trough by the high-grass-cover group. This reduced overall grass utilisation by 5.7 per cent compared with the low-grass-cover.

Watch AHDB how to use a plate meter video to learn more: https://www.youtube.com/watch?time_continue=4&v=aBlUzLeTINA

Pre-cutting covers target for zero-grazing is between 3000 kg DM/ha and 4000 kg DM/ha.

Cutting within this range is important to maximise grass and animal performance.

	Low-grass-cover	High-grass-cover
Grass growth rate (kg DM/ha/day)	82.1	61.4
Rotation length (days)	25.9	46.1
Total grass utilisation (%)	91.9	86.2
Grass acid detergent fibre (ADF) content (%)	30.2	31.3
Grass metabolisable energy (ME) content (MJ/kg DM)	11.1	10.9

Table 6: Impact of pre-cutting grass cover on grassland performance.
(Source: AFBI)

Cow performance was also lower by using high-grass-cover swards, with reductions evident in both milk yield and milk fat and protein yield, (Table 7).

	Low-grass-cover	High-grass-cover
Grass intake (kg DM/day)	13.8	12.9
Milk yield (kg/cow/day)	25.5	23.7
Milk fat (%)	4.4	4.4
Milk protein (%)	3.5	3.4
Milk fat + protein yield (kg/cow/day)	2.0	1.8

Table 7: Impact of pre-cutting grass cover on dairy cow performance.
Source: AFBI

Monitoring grass growth

To ensure the optimal pre-cutting cover is achieved grass management is essential.

Using a plate meter

There are two types of plate meter; the mechanical and the electronic. Both work in the same way and provide an accurate and convenient way to measure and assess field covers. Most plate meters now sold are the electronic version.

The plate meter measures both height and density of the sward. This average height of the paddock is measured in compressed centimetres and then converted into kilos of dry matter per hectare via an equation. The method generally used in the UK is x 124 + 608.

An example this is how it works; the average rising plate meter reading of a particular field measures 6.68. So 6.68 x 124 + 608 = 1436, so the cover is 1436 kg of dry matter per hectare.

The accuracy of a plate meter decreases at high covers (>3500 kg DM/ha) and quadrant cutting may be beneficial for an accurate grass growth measurement.

How to use the plate meter

Walk the field or paddock to be measured and take a minimum of fifty readings (plonks) as you walk across a representative part of the area, this will take into account the better and worse areas, giving you a true cover assessment. It is advisable to take the same route across the field week after week so that you have comparable data. Do not "choose" where to plonk, it must be random so that you get the best and worse measurements representative of the field, if you just plonk the best parts of the field then you are only deceiving yourself into thinking there is more there than there is.

The reason you need to take a minimum of fifty plonks is to even out the extremes of growth you may encounter.

Plate meters are designed for grass clover swards and are not for use on cereals or other crops. They are most accurate between 1200 and 3200kg DM/ha. (Read the manufacturers recommendations on calibration.)

"I plate meter every six to nine days which allows me to determine which fields are ready to be cut. I go in to covers of 3,500–3,800kg DM/ha. Grass is cut to a residual of 1,800kg DM/ha to avoid hitting stones. By maintaining these targets I find that grass recovers faster."

Sam McElheran

"We are going in to covers at about 3,900kg DM/ha and cutting to as low as 1,800–1,900kg DM/ha which pays dividends as grass quality analysis remain high through the season."

Aidan McManus

3000 kg DM/ha

4000 kg DM/ha

Rotation length – Hitting target pre-cutting covers 3,500 kg DM/ha will help achieve high palatability of fresh cut grass. To achieve this on farm aim for a rotation length of 21 days in May increasing to around 28 days in August. This will vary through-out the season. Therefore when calculating rotation length, remember to take into account rate of grass growth and herd demand.

Time of day – The DM content and water-soluble carbohydrate (WSC) content of grass increases throughout the day, with peak DM content usually observed in the early–mid-afternoon in dry conditions.

Harvesting at this time will minimise the risk of grass spoilage, which deteriorates more rapidly with low DM forages.

In wet conditions, lexibility is key and cutting should be carried out when the sward is at its driest, if possible. Buffer feed may be required in wet weather conditions where DM is low (Table 10: Dry matter percentage).

"Cutting is always undertaken after 2pm, by which time DM of grass have increased and WSC have accumulated."

Parry Walters

Machinery – Although specialist machinery has been developed for zero-grazing systems, some farmers have opted to use cheaper alternatives, such as double chop harvesters. Recent research in Northern Ireland involved assessing grass and animal performance resulting from different cutting machines. Two groups of dairy cows were fed fresh grass harvested either by double chop or specialist zero-grazing machinery, more details in appendix page 44.

"Using a specialist machine, which just lifts and cuts, helps prevent damage to the fresh grass which reduces heating and refusals."

Aidan McManus

Key results (see Table 8):

- No difference in grass growth or utilisation between machinery
- Quality of grass offered was marginally lower from double chop, with grass DM content and WSC decreasing more rapidly in the 48-hour period post-cutting
- Grass dry matter intake (DMI) was 0.6kg DM/cow/day lower from double chop techniques compared to the specialist machinery
- Daily milk yields were 0.5 litre/cow/day lower from the double chop technique, but there was no impact on milk quality.

Table 8: Sward characteristics and performance of dairy cows fed grass harvested by either double chop or specialist zero-grazing machinery.
Source: AFBI

	Double chop technique	Specialist machinery
Pre-cutting cover (kg DM/ha)	4,177	4,135
Post-cutting cover (kg DM/ha)	1,901	1,898
Total grass utilisation (%)	86.1	85.3
Grass DM content (%)	14.2	14.8
Grass ME content (MJ/kg DM)	10.9	11.0
Grass chop length (cm)	13.8	26.5
Grass intake (kg DM/cow/day)	13.7	14.3
Milk yield (litres/cow/day)	31.5	31.9

Figure 6: Grass harvested via double chop (LHS) or zero-grazer (RHS).
Source: AFBI

Worksheet – calculating the amount of fresh grass to cut daily

The area to cut each day will depend on grass cover and DM content (see Table 10). The worksheet below helps to estimate cow demand and area required to be cut daily.

EXAMPLE

Zero-grazing: Pasture cover targets
Pre-cutting cover 3000-4000 kg DM/Ha
Post-cutting cover 1800 kg DM/Ha

Step 1: Calculate grass DM available
3500 (Pre-cut cover) - 1800 (Post-cut cover)
= 1700 kg DM/ha (DM available)

Step 2: Calculate daily grass DM requirement for herd
Total herd grass demand:
Typical daily grass intake / cow = 15 kg DM
No. of cows = 100
Utilisation rate = 0.8
Total herd demand = 15 x 100 divided by 0.8 = 1875

Step 3: Calculate area to cut

$$\frac{\text{Herd requirement (1875 kg DM)}}{\text{Grass DM available (1700 kg DM/ha)}} = 1.1 \text{ hectares (area required to be cut)}$$

Typical Holstein/ Friesian cows can eat approximately 3 – 3.5 per cent of their body weight in DM each day.

Parry Walters
Manor Farm, Warwickshire

Top-notch grassland management key to success

Midlands beef and sheep producer, Parry Walters, approaching his sixth zero-grazing season of the practice, says good grassland management is essential for the system to work.

"We started zero-grazing because we knew we had to increase the output of the farm," says Mr Walters. "We considered a year-round total mixed ration as an alternative, but I'm very happy we chose the grass-based option."

Having switched from a more traditional UK grazing-based system in 2013, stocking rates have increased from 2.5 livestock units/ha to 3.5 LSU/ha. The key to achieving good results has been to harvest high-quality grass, and in this endeavour, grassland management is at the top of the agenda. Target annual grass production of over 17 tonnes DM/ha is routinely exceeded through the cutting season, which runs from early-April until late-November. Rapid regrowth of the swards leads to short summer rotations, which are generally around 19 days between April and August but extend to as much as 27 days later in the season.

However, his advice to other producers is not to embark on the system unless they have their grassland management right from the start. "Grass is the cheapest feed source on the farm and every blade of grass is a contribution to each kg of meat per animal."

"Parry advises other producers to only embark on the system if they have good grassland management as it is essential to operating a zero-grazing system."

3. In shed management

A zero-grazing system offers to the opportunity to feed more home-grown forage. Due to the variable quality of grass and the higher nutrient requirements of cows there are three key areas of management to consider when feeding fresh grass:

3.1 Infrastructure

- Space allowance
- Feeding area

3.2 Feeding management

- Inclusion
- Mixing time
- Feed delivery
- Testing fresh grass quality

3.3 Diet

- Grass quality
- Low DM content

3.1 Infrastructure

SPACE ALLOWANCE – Cows will typically spend between four and six hours eating a TMR, and possibly even longer for high volumes of fresh grass fed via zero-grazing. Cows prefer to eat as a group and ideally, there should be enough space for all of the cows to feed together at the same time. The Red Tractor feed space width recommendations are highlighted in Table 9. It is likely that zero-grazing fresh grass will encourage simultaneous feeding so sufficient feeding space is recommended.

Animal weight (kg)	Width of feed barrier (mm per animal)	Ad-lib feeding (mm)
200	400	150
300	500	150
400	550	190
500	600	240
600	650	280
700	700	320
800	750	320

Table 9. Feed space width recommendations for cattle of different weights.

Source: Adapted from Red Tractor Dairy Assurance Standards 2017

FEEDING AREA – Ensuring that the feed barrier and neck rail is correctly positioned will help improve cow comfort and DMI. Observe cows for hair loss, swelling and/or wounds on their necks as this may indicate that adjusting the neck rail in either the feeding area or cubicles would be beneficial.

Lining feeding areas with ceramic tiles, plastic coatings, highly floated concrete or a gel-coat finish will provide a smooth surface in the feeding area which will encourage DMI and ease of cleaning refusals.

As cows may spend longer eating a fresh grass diet it is important to consider the standing surfaces at the feeding area to optimise cow comfort and to encourage visits for feeding. Raising the feeding area by 10cm above the standing surface will increase consumption rate and reduce refusals.

Fresh grass is best fed alone but if using a feeder wagon only mix fresh grass for 2–3 minutes.

3.2 Feeding management

FEED RATE – Feed demand of the herd can vary with cow size (total DMI is typically 3.5% of cow body weight), stage of lactation, milk output and supplementation rate.

For cows receiving zero-grazed grass as the sole forage source, grass intakes as high as 18 kg DMI/cow/day have been recorded in trials. However at high concentrate feed rates or at low grass DM contents, intakes can be significantly lower. As a result, it is important to constantly monitor intake levels. A good policy can be to feed 110% of the daily herd requirement to minimise any potential impact on animal dry matter intake and subsequent performance.

Weather will determine grass DM content which can range from 10 to 22% in wet and dry conditions (Table 10: Dry matter table).

Table 10: Dry matter percentage ranges for fresh grass based on weather conditions.

Source: AHDB, Beef and Lamb. Planning Grazing Strategies Manual for Better Returns

Weather	DM %
Continuous rain	10-12
Mixed sunshine and rain (Small amount of surface moisture)	13-16
Mainly dry (No surface water)	17-19
More than five dry days and high temperatures	20-22
Drought	23-24

This variation impacts on the physical volume of grass cows need to consume to meet their target DMI (Table 11: below). Low DM grass can increase the time spent by animals at the feed fence and increase the need for regular push-ups.

Table 11: Fresh weight grass intake requirements to achieve 15 kg DMI at different grass DM contents.

Grass dry matter content (%)	12.5	15	17.5	20
Fresh weight of grass required for 15 kg DMI (kg)	120	100	86	75

- The delivery and management of fresh grass is critical and good practice can improve feed intakes by 10 per cent.

"We allow 70cm of feed space for every cow. If you don't have at least that, the grass is so bulky in the feed trough that you'll find you spend the whole day pushing it up."

Aidan McManus

"For us the trick to maintaining intakes with zero-grazing is to cut twice a day. We cut morning and evening which helps prevent the grass from heating up. Due to the fields close proximity to the yard and our management strategy it takes me 15 to 20 minutes to leave the yard, cut enough for the day and be back to the cows."

Aidan McManus

INCLUSION WITH TMR – Common advice is to feed grass separately and not to mix it into the wagon with the TMR. Overmixing grass and TMR in the mixer could lead to a loss of structure in the grass and increase the risk of overheating in the feed trough resulting in refusals. If fresh grass is mixed with a TMR it is important that mixing time is short once the fresh grass has added.

TESTING FRESH GRASS – A basic laboratory analysis of fresh grass will provide useful information on various nutritional parameters (ME, D-value, DM, CP, NDF and WSC). This is a useful guidance to use when formulating diets and to decide if, and what level of, supplementation is needed. Additional fibre and/or a different energy source may be necessary for more efficient feed utilisation and to support high-yielders' requirements.

FEED DELIVERY – Ideally fresh grass should be cut and delivered 1–2 times a day and fed as often as necessary to avoid heating as this will lead to refusals. Ensuring cows have continuous access to grass will help increase DMI. avoid over-pilling fresh grass and clean out any refusals daily to avoid quality deterioration.

"We can have 200 cows fed in an hour with the specialised machinery which probably takes no longer than herding that number of cows out and in to paddocks each day. Then we spend 10 minutes twice a day pushing grass up to cows."

Sam McElheran

"We push up at 9am and again at 4pm, and by 5 o'clock – the time of the next cut – the feed has all gone."

Aidan McManus

Fresh grass should be pushed-up 2–3 times per day.

Sign up to Grass Check, Northern Ireland for weekly grass quality updates.

3.3 Diet

GRASS QUALITY – Knowing the grass quality is a critical aspect of feeding fresh grass to dairy cows. It is important to understand that implementing a zero-grazing system will not improve the nutritional value of low-quality grass.

AFBI AgriSearch GrassCheck monitoring has shown that grass if managed can achieve high quality throughout the grazing season, maintaining ME values of 11.5 MJ ME/kg DM into the autumn.

MANAGING LOW DRY MATTER INTAKE – Knowing the DM content of grass can help you determine the potential DMI. To measure DM content of fresh grass on farm see appendix (pgs. 47–48).

Monitoring DMI is key to achieving the best cow performance. Unlike grazing, a zero-grazing system allows you to estimate and monitor herd DMI and to promptly recognise any drop in feed consumption.

The reasons for a decreased DMI may be varied and not necessarily related to the diet. Common feed-related factors that can negatively influence fresh grass intake are poor digestibility (low D-Value) and low fresh grass DM. Fresh grass with a low DM will decrease the overall nutrient consumption as a larger quantity of grass will be needed to achieve the target daily nutrient intake. Physical constraints will limit the quantity low DM grass cows can eat.

For information on the sustainable control of parasites visit Control Of Worms Sustainably (COWS) http://www.cattleparasites.org.uk/

Be aware of factors that can cause low dry matter intake when feeding fresh grass:

- Wet grass will be low in DM and will fill up the rumen before the cow has satisfied her hunger
- Low digestibility of grass
- Chop length
- Poor cow health.

If low dry matter intake is an issue consider:

+ Buffer feeding with high DM silage
+ Cutting fresh grass more regularly throughout the day
+ Adjusting the cutting height of the grass.

When introducing fresh grass into the diet of dairy cows, it is important to understand any changes in cow behaviour that may occur as these may contribute to shifts in feed intake, milk yields or milk quality.

Recording cattle performance makes it much easier to manage the zero-grazing system. A successful zero-grazing system should measure and monitor:

- ✓ Rumen fill
- ✓ Manure consistency
- ✓ Body condition changes. Act on cow condition changes immediately, by altering concentrate fed
- ✓ Mobility. Intervene at the first signs of cows with an imperfect gait to prevent loss of body condition.

Tom Kimber
Stavordale Farm, Somerset

Zero-grazing flexibility extends the grazing season

The Kimber family's 220-head herd of Friesians and Shorthorns use zero-grazed grass to extend the grazing season at their 210-hectare farm in Somerset. Stavordale Farm comprises a mix of light and heavy land benefit from the flexibility a zero-grazing system offers, particularly during a wet season.

"Including fresh grass in diets has allowed a lower protein concentrate to be fed, reducing costs"

Using a second-hand specialised machine, the grass is cut at covers of around 3,000–3,200kg DM/ha and leaving residuals of 1,900kg/ha usually from March onwards when one feed of fresh grass replaces one feed of TMR. This see's yields boosted by 1.5–2 litres/cow/day.

A further benefit of this change is the high protein introduced through the fresh grass. This has allowed a lower protein and cheaper blend to be fed in the TMR saving £50/tonne of concentrates.

As the summer approaches, the cows go out by day and only receive the zero-grazed grass while they're housed at night and, eventually, during the summer they will graze full-time and only receive concentrates in the parlour.

"We have some heavy clay soils and sometimes have to bring the cows back in when the summer is very wet, but rather than opening a silage clamp and changing the diet, we now keep them on zero-grazed grass from our better drained fields," Tom said.

The system goes into reverse in the autumn months, with cows continuing to graze by day and given zero-grazed grass by night.

After the herd are fully housed, they will have one feed of TMR and one of zero-grazed grass, which continues as the season allows – often to late October – before finally moving on to the full TMR.

"For us, zero-grazing will always be for the shoulders of the season as our Friesian/Shorthorn herd, currently giving 7,000 litres at 4.4 per cent fat and 3.45 per cent protein, need to be out grazing."

4. Performance and economics

Research studies in Northern Ireland and Scotland have looked at a range of feeding systems in comparison with Zero-grazing, including grass silage, grazing and TMR systems of feeding. Cow performance and economics is summarised in Table 12 but for more details on each study is available in the appendix.

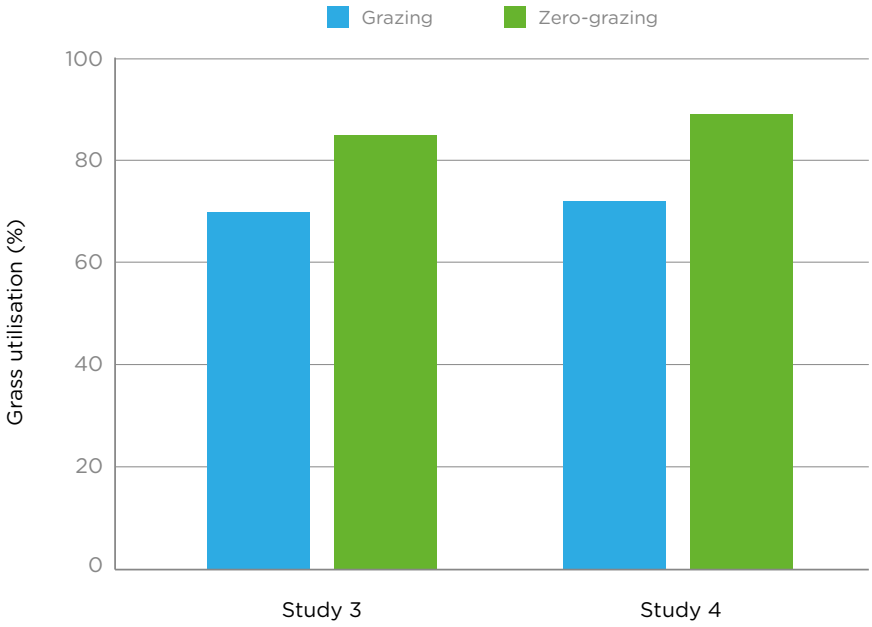
Table 12: Systems summary of cow performance and economics for grazing, grass silage and zero-grazing systems.

	Grazing	Grass silage	Zero-grazing
Forage intake (kg DM/day)	11.2	11.6	**12.1**
Concentrate intake (kg/day)	7.5	7.5	**7.5**
Daily milk yield (kg/day)	27.9	25.7	**29.5**
Milk fat-plus-protein (kg/cow/day)	2.01	1.82	**2.15**
Live weight (kg)	586	589	**617**
Margin over feed and forage (£/cow/day)	5.15	3.08	**4.87**
Stocking rate (cows/ha)	3.57	5.1	**4.45**
Margin over feed and forage (£/ha/day)	18.37	15.7	**21.66**

These values are averages and performance and production will vary for each individual farm.

4.1 Zero-grazing vs grazing

Operating a zero-grazing systems has been found to benefit both grass growth and utilisation when compared with traditional grazing systems. Studies carried out at in Northern Ireland have shown an average increase of 15 per cent in grass utilisation (measured by accounting for wastage in-field and at the feed trough) and increases in grass growth rate of between 11 and 35 per cent (Figure 7b).



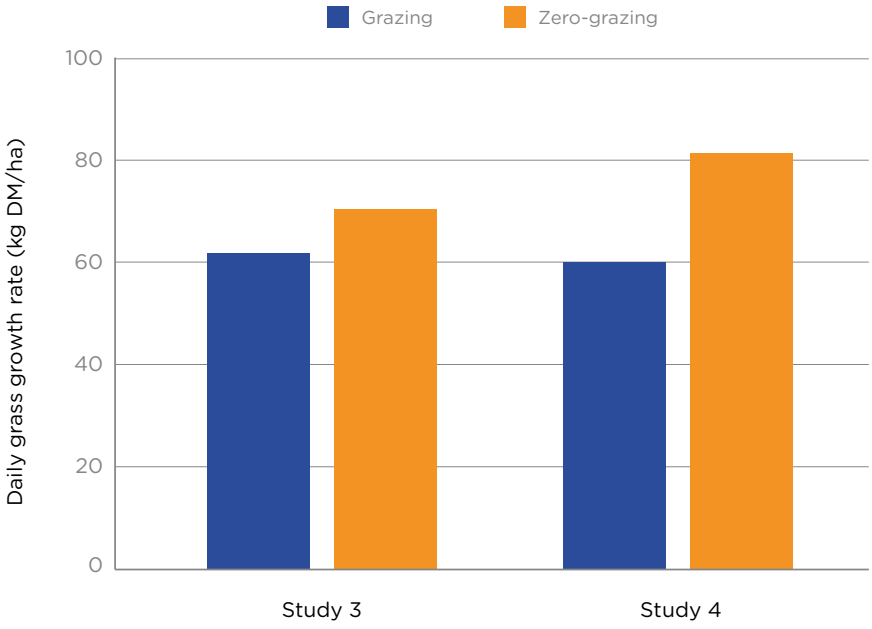


Figure 7: Measured grass utilisation (a) and grass growth rate (b) from zero-grazing and grazing systems in two studies at Northern Ireland during 2016 and 2017.

Source: AFBI

- The improvements in grass utilisation offer the potential to increase stocking rate and/or reduce the total area required for grazing.

As an example; a 100-cow herd, eating 15kg DM/cow/day of fresh grass throughout the season would require 10.4ha less under a zero-grazing system (assuming a 10 per cent increase in grass growth rate and 15 per cent increase in grass utilisation from zero-grazing; Table 13).

	Grazing	Zero-grazing	Difference
Total area required (ha)	34.2	23.7	-10.4
Stocking rate (cows/ha)	2.9	4.2	+1.3

Table 13: Potential differences in land area requirements and stocking rates with zero-grazing systems compared with grazing.

Source: AFBI

Farmers may be considering moving to zero-grazing systems from grazing. A study conducted in Northern Ireland assessed dairy cow performance from grazing compared to zero-grazing systems, during the 2016 grazing season. In the study, cows were split into two groups and managed either on full-time grazing using 24-hour paddocks, or zero-grazing fed daily. Both treatments were supplemented with concentrates in the parlour.

Cow performance

- Both groups were offered 14kg DM/cow/day. Grass dry matter intake was 0.9kg DM/cow/day higher on cows fed zero-grazed grass compared to grazing cows
- This additional forage intake (plus a reduction in energy expenditure due to grazing and walking) resulted in better milk yields (+1.6kg/cow/day) compared with grazed cows
- Milk quality was also significantly improved on zero-grazing diets, with an additional +0.14kg fat and protein yield per cow per day.

Figure 8: Daily milk yields for dairy cows managed under zero-grazing systems or full-time grazing.
Source: AFBI

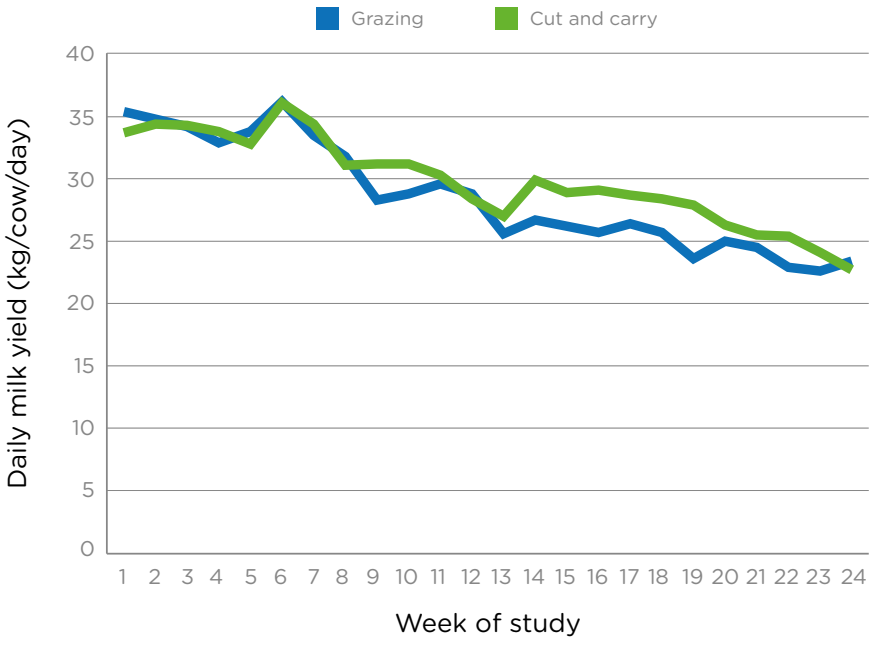


Table 14: Dairy cow performance from animals managed on zero-grazing or full-time grazing systems.
Source: AFBI

	Zero-grazing	Grazing
Concentrate intake (kg DM/cow/day)	5.3	5.3
Forage intake (kg DM/cow/day)	12.1	11.2
Milk yield (kg/cow/day)	29.5	27.9
Milk fat (%)	4.32	4.05
Milk protein (%)	3.46	3.39
Milk fat + protein yield (kg/cow/day)	2.15	2.01

Financial implications

- Estimated total costs per kilogram of forage DM were 19% lower for grazed grass (£0.10/kg DM) compared to zero-grazing systems (£0.12/kg DM), reducing overall feed costs by 66p/cow/day
- However, for zero-grazing, improvements in milk yield and quality accounted for an increase in milk income of 39p/cow/day, resulting in a lower margin over feed and forage per cow per day of £4.71 for zero-grazing compared to grazing (£4.99)
- Both grass growth (+8kg DM/ha/day) and utilisation (+15 per cent) were higher on the zero-grazing system compared to grazing. This improvement in grass productivity and utilisation led to an increase in stocking rate on the zero-grazing system (4.45 cows/ha) compared to grazing (3.57 cows/ha)
- This higher stocking rate increased milk output per hectare (+5000kg/ha) and margin over feed and forage costs by £505/ha for zero-grazing systems.

	Zero-grazing	Grazing
Concentrate cost (£/cow)	207	207
Forage cost (£/cow)	246	141
Total feed costs (£/cow)	453	348
Margin over feed and forage (£/cow)	750	793
Stocking rate (cows/ha)	4.45	3.57
Margin over feed and forage (£/ha)	3,336	2,830

** Cost assumptions: concentrate cost = £243/t DM, base milk price = 25ppl.*

Table 15: Cost comparison of dairy cows managed on zero-grazing systems or full-time grazing.

Source: AFBI

However, if shifting to zero-grazing from full-time, there will also be additional costs associated with housing cows. These include:

- Additional slurry storage and spreading costs. Typically, spreading costs equate to £0.85 per $1m^3$. A dairy cow yielding 6000–9000 litres on average produces $1.59m^3$ per month. Over a 180-day summer period, additional spreading costs would be equivalent to £5.10 per cow
- Electricity usage. Although small, additional costs for automatic scrapers and lighting will need to be considered in any costings
- Bedding costs. These will vary depending on the material used; however, typical costs for sawdust bedding equates to £3.20 per cow per month. Over a 180-day summer period, this equates to approximately £20 per cow.

Even if the cost of additional slurry spreading, bedding and electricity are included in the 22-week study above, the zero-grazing system still retains a higher margin over feed and forage of +£390/ha over the study period.

- **Remember: when comparing the cost of zero-grazing and grazing to include housing costs for: Slurry storage, Bedding and Electricity.**

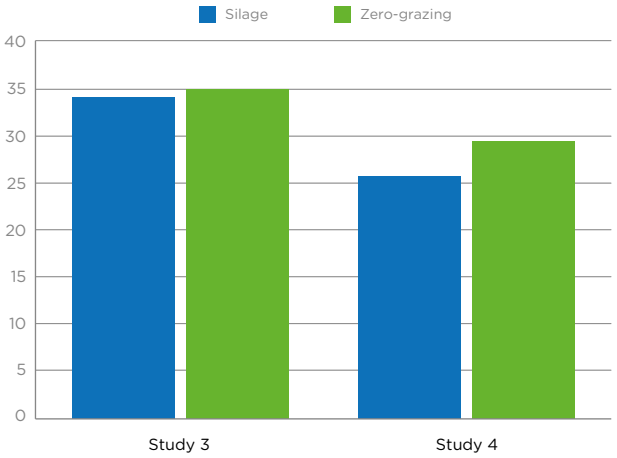
4.2 Zero-grazing vs silage

For some farmers, moving to zero-grazing may involve a simple switch of replacing straight grass silage, fed in blocks or via an easy-feed system, with fresh grass. Recent research has shown that this can have a positive impact on cow performance.

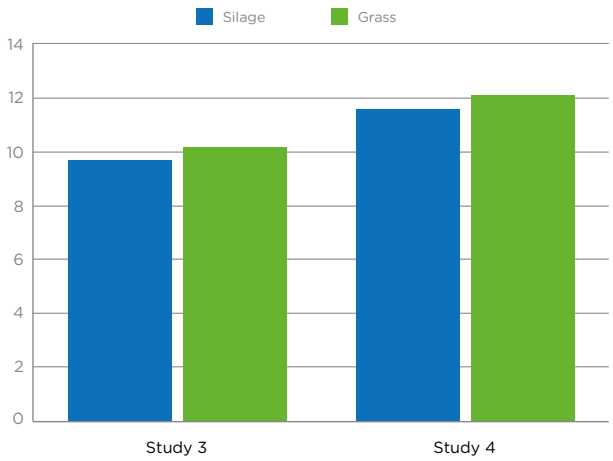
Cow performance

- In two separate trials conducted in Northern Ireland, cows were managed on either full-time zero-grazing or grass-silage-based diets, and fed supplementary concentrates
- Zero-grazed fed animals had higher milk yields and quality than those fed grass silage and concentrate. On average, milk yields increased by 10 per cent, whilst milk protein improved by 0.22 per cent (Figure 10)
- Improved animal performance from zero-grazing was driven by higher animal forage intakes. The difference between systems was, on average, +0.5kg DM/cow/day greater forage intakes on zero-grazing systems across the whole grazing season
- There was no impact of diet on BCS or animal live weight.

Figure 9: Daily milk yield per cow from two studies of cows fed either silage or zero-grazing grass-based diets.
Source: AFBI



Milk yield



Forage DM intake

	Study 5 lastingfor 7 weeks		Study 6 lasting for 22 weeks	
	Silage	Zero-grazing	Silage	Zero-grazing
Concentrate intake (kg DM/cow)	467	488	836.9	845.6
Forage intake (kg DM/cow)	457	443	1,901	1,991
Total milk (kg/cow)	1,384	1,472	3,840	4,481
Milk fat (%)	4.67	4.52	4.29	4.32
Milk protein (%)	3.32	3.45	3.14	3.46
Milk fat + protein yield (kg/cow/day)	2.72	2.81	1.82	2.15

Table 16: Dairy cow performance from animals fed either grass silage or zero-grazed grass in two separate trials at Northern Ireland.
Source: AFBI

** Cost assumptions: concentrate cost = £243/t DM, base milk price = 25ppl.*

Financial implications

- In both studies Total feed costs were higher from the silage treatment driven by a higher total cost of production of silage (£0.15/kg DM) relative to zero-grazing (£0.12/kg DM).
- Improvements in cow performance from zero-grazing resulted in an increase in an average margin over feed and forage of +£1.36 per cow per day from zero-grazing compared to a silage and concentrate diet
- While milk production per cow can be a major driver of efficiency within dairy systems, land availability is a limiting factor on many local dairy farms. As a result, it is important to consider the effect of feed systems on milk output per hectare
- Stocking rates were, on average, 0.68 livestock units higher per hectare under silage management, due to higher grass yields from silage production. Forage utilisation rates were similar across both treatments (Silage = 0.84, Zero-grazing = 0.82)
- Although increased stocking rates from silage feeding increased output per hectare, significantly better animal performance from zero-grazing again resulted in this having the greatest margin over feed and forage per hectare.

	Study 5 lastingfor 7 weeks		Study 6 lasting for 22 weeks	
	Silage	Zero-grazing	Silage	Zero-grazing
Concentrate cost (£/cow)	112	108	205	207
Forage cost (£/cow)	68	54	281	246
Total feed costs (£/cow)	180	162	486	453
Margin over feed and forage (£/cow)	166	214	475	750
Stocking rate (cows/ha)	7.31	6.40	5.10	4.45
Margin over feed and forage (£/ha)	1,215	1,372	2,417	3,336

Table 17: Total cost* comparison of dairy cows managed on diets with silage or zero-grazed grass as the sole forage source.
Source: AFBI

** Cost assumptions: concentrate cost = £243/t DM, base milk price = 25ppl.*

4.3 Zero-grazing vs TMR

Some farmers may be considering moving to zero-grazing systems from TMR. Studies were conducted in Scotland to assess dairy cow performance from TMR compared to zero-grazing systems in spring 2014.

Cow performance

- Cows were managed either on full-time TMR or diets providing 25 per cent or 50 per cent of the DMI as fresh grass
- Zero-grazed fed animals had lower milk yields than those fed a full TMR diet, by an average of 12 per cent for cows fed 50 per cent fresh grass, and 15 per cent for cows fed 25 per cent fresh grass (Figure 12)

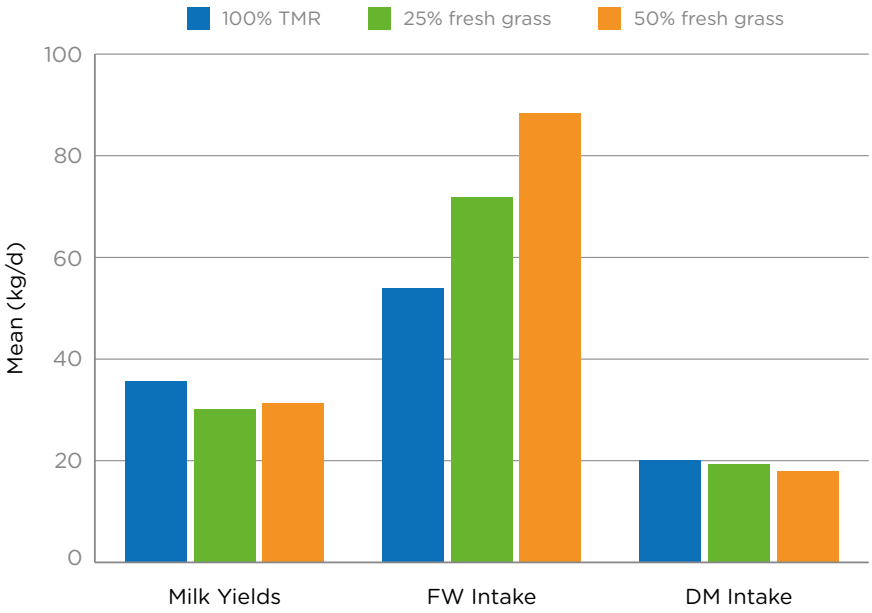


Figure 10: Average milk yields, fresh weight intake and dry matter intake for dairy cows managed under three different diets.
Source: AFBI

- Intakes of feed by fresh weight were highest for 50 per cent grass-fed cows, lower for 25 per cent grass-fed cows and were lowest for TMR-fed cows. However, intakes of DM were lowest for 50 per cent grass-fed cows, higher for 25 per cent grass-fed cows and highest for TMR-fed cows
- This resulted in a reduction in milk yield of 4.3litres/cow/day, compared with an average 35.7litres/cow/day on the full TMR
- All cows gained weight over the 12 weeks and differences between dietary treatments were relatively small. On average, cows in the grazing group gained 0.18kg/week more than those in the zero-grazing group and 0.64kg/week more than those in the TMR group.

Adding fresh grass to a TMR diet as part of a zero-grazing system was demonstrated to reduce milk yields without affecting milk quality but at a lower cost of production. Increasing the proportion of fresh grass in the diets of higher yielding cows can be a viable option to reduce feed and production costs.

Financial implications

- TMR fed cows delivered higher milk yields but at a higher costs of production than the grass-fed groups
- During the study, TMR were costed at £84.12 per tonne and £15 per tonne for the cost of grass. These are total costs, including costs production, land rental and equipment depreciation
- Under these costs, if the milk price was 32ppl or lower then the low cost 50 per cent grass-fed strategy delivered the highest surplus
- If the milk price was 33ppl or higher then the high yielding TMR-fed group delivered the highest surplus
- When comparing cost, TMR only diet was the least profitable over a range of milk prices from 17-35ppl, despite the higher milk production
- Fresh grass in the diet at 50 per cent of the DMI reduced feed costs per cow by £16.80 over a 16-week study period, equating to just over £25,000 for a typical 150-cow herd
- Mixing TMR with grass, in particular in a combination of 50 per cent grass and 50 per cent TMR, can deliver a higher margin over feed costs than a TMR alone, depending on the relative costs of grass and the TMR, as well as milk price.

As with all analysis, costs will vary significantly from farm to farm and it is important to carry out an economic assessment with the specific costs for your business and against a backdrop of variable milk prices and other less immediate financial benefits, such as reduced risk from economic volatility of purchased feeds.

Jeltsje and Gerben Algera
Brittany, France

By Mathieu Merlhe, Chambre régionale d'agriculture de Bretagne. Translation by Valerie Brocard, Idele.

Boosting grass utilisation on fragmented land

Zero-grazing has been the key to boosting grass utilisation on a fragmented dairy farm in Brittany. Jeltsje and Gerben have been operating a zero-grazing systems on their 59ha farm since 1994 to optimise utilisation of their ryegrass and white clover mix swards. Monitoring grass growth throughout the season is an essential routine to ensure the grass is cut at its highest quality to limit the amount of purchase feed needed.

From March, the 65 Holstein herd are transitioned from a diet of baled silage and maize silage to fresh grass. They start by introducing one trailer of freshly cut grass after morning milking and followed by maize silage. As grass growth increases through the spring the amount of fresh grass in the diet increases to two trailers per day.

Jeltsje says: "We are currently producing nearly 9,000 litres per cow per year with only 1,300kg of concentrates per cow per year."

Excellent grassland management within the system is the key to their low forage and feed cost of 0.07pence per litre. In 2016, Jeltsje and Gerben noted their gross margin to be 0.20 pence per litre at a milk price of 0.27pence per litre.

"We are currently producing nearly 9,000 litres per cow per year with only 1,300kg of concentrates per cow per year."

For more information on EuroDairy visit Eurodairy.eu

Appendix

Appendix – Description of studies

This zero-grazing best-practice guide has been compiled using six studies recently carried out at in Scotland and Northern Ireland and more detail is provided on each study here.

Study 1: Investigating the effects of increasing the proportion of grass in the diets of high-yielding dairy cows

Forty-eight Holstein-Friesian cows yielding 30+ litres per day were allocated to one of three diets as part of this 16-week trial (Figure 13). These diets varied in the ratio of fresh grass to TMR, with a proportion of the TMR dry matter (DM) replaced by fresh grass every morning. By balancing the grass inputs on a DM basis, the proportion of fresh grass included was increased without increasing the total amount of DM available to the cows. The diets were:

1. 100 per cent of DMI was from the TMR, which was based on grass silage, maize silage, straw and concentrates and formulated to provide sufficient nutrients to high-yielding cows. No fresh grass was included (100 per cent TMR)
2. 25 per cent of the DMI was provided as fresh grass and the remaining 75 per cent as TMR (25 per cent grass)
3. 50 per cent of the DMI was provided as fresh grass and the remaining 50 per cent as TMR (50 per cent grass).

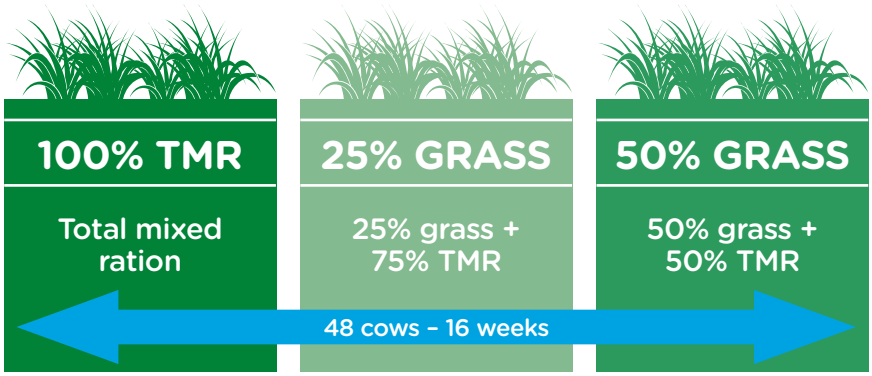


Figure 11: Three diets were offered to recently calved high-yielding dairy cows over a 16-week period starting on 28 April 2014.
Source: AHDB

There was no effect of diet on the weight of the cows. Body weight remained consistent across the 16 weeks of the trial. For all three groups, cows lost condition over the 16-week trial, but there were no differences in body condition loss between groups.

Appendix – Description of studies

Study 2: Impact of harvesting technique on animal performance and grass utilisation in zero-grazing systems

This study involved 40 spring-calving Holstein-Friesian cows, 16 of which were in their first lactation, and took place between June and September 2017. Cows were full time housed and offered fresh grass from one of two treatments:

- Low grass covers at an average of 3650 kg DM/ha (LGC)
- High grass covers at an average of 4750 kg DM/ha (HGC)

Grass was harvested each morning using specialised zero-grazing machinery and offered twice daily following the morning and afternoon milkings. Average rotation length was 26 and 46 days for LGC and HGC treatments, respectively. All cows received additional concentrate feeding in the parlour at a rate of 7.5 and 5.5 kg/day for cows and heifers respectively. Animal performance and eating behaviour along with grass quality, utilisation and growth were monitored throughout the study.

As shown in Table 18, results indicated improved grass quality, utilisation and production with the low grass cover. An increase in grass intake, milk yield and milk fat-plus-protein yield was also observed in the cows offered grass from low cover swards.

Figure 12: Low and high grass covers.
Source: AFBI

	Low grass cover	High grass cover
Daily milk yield (kg/day)	25.5	23.7
Milk fat-plus-protein yield (kg/cow/day)	2.0	1.8
Grass growth rate (kg DM/ha/day)	82.1	68.1
Total grass utilisation (Field + Feeding, %)	91.9	86.2
Grass ME content (MJ/kg DM)	11.1	10.9
Grass CP content (g/kg DM)	175	162

Table 18: Cow performance and grass quality throughout the study.
Source: AFBI

Appendix – Description of studies

Figure 13: Feed boxes at AFBI used to monitor DMI.

Study 3: Impact of harvesting technique on animal performance and grass utilisation in zero-grazing systems

This study involved 40 spring-calving Holstein-Friesian cows, 10 of which were in their first lactation, and took place between May and August 2017. Cows were full time housed and split into two groups and fed fresh grass harvested using either:

- Double chop harvester
- Specialist zero-grazing machinery

Grass was harvested each morning using specialised zero-grazing machinery and offered twice daily following the morning and afternoon milkings. Average rotation length was 28 days across treatments.

All cows received concentrates via out of parlour feeders (7 and 4 kg/day for cows and heifers respectively) plus an additional 4 kg/day in the parlour during milking. Animal performance, feeding behaviour and activity as well as grass quality and utilisation were monitored throughout the study.

As shown in Table 19, providing cows with grass harvested using specialised zero-grazing machinery resulted in improvements in daily intake and milk yield, however, there were no improvements in milk quality. Cutting grass with the double chop harvester resulted in a marginal reduction in grass quality when compared to grass harvested with specialised zero-grazing machinery.

Table 19: Cow performance and grass quality throughout the study.
Source: AFBI

	Double Chop	Cut & Carry
Daily milk yield (kg/day)	31.5	31.9
Milk fat-plus-protein yield (kg/cow/day)	2.35	2.36
Grass DM content (%)	14.2	14.8
Grass ME content (MJ kg DM)	10.85	11.00
Grass ADF content (g kg DM)	31.5	30.7
Fresh grass chop length (cm)	13.8	26.5

Appendix – Description of studies

Study 4: Zero-grazing vs grazing vs silage over a whole season

This study involved 114 spring-calving Holstein-Friesian cows, 29 of which were in their first lactation, and took place between April and September 2016. Cows were split into 3 groups and assigned to either:

- Conventional grazing system
- Full time housing and offered grass silage
- Full time housing and offered zero-grazing grass

Grazed cows were managed in a rotational system and offered fresh grass daily. Targeted pre- and post-grazing grass covers were 3200 and 1800 kg DM/ha respectively. For cows on the zero-grazing treatment, fresh grass was cut on a daily basis using specialist zero-grazing machinery, with targeted pre-cutting herbage masses of 3200-3800 kg DM/ha. Cows on all treatments received 7.5 kg day concentrates through the parlour. Animal performance, milk production and milk quality along with grass growth and utilisation were measured throughout the study.

As shown in Table 20, offering housed cows zero-grazing grass resulted in improvements in forage intake, milk yield and milk quality when compared to cows maintained in a conventional grazing system or housed and offered grass silage. Cows offered zero-grazing grass also maintained a consistent weight advantage over those managed in a grazing system.

	Grazing	Grass Silage	Zero-grazing
Forage intake (kg DM/day)	11.2	11.6	12.1
Daily Milk Yield (kg/day)	27.9	25.7	29.5
Milk fat-plus-protein yield (kg/cow/day)	2.01	1.82	2.15
Live weight (kg)	585.5	589.1	616.9

Table 20: Cow performance throughout the study.
Source: AFBI

Appendix – Description of studies

Figure 14: Fresh grass being fed out to housed cows.

Study 5: Zero-grazing vs silage in making the most of autumn grass

This study involved 60 autumn-calving Holstein-Friesian cows, 16 of which were in their first lactation, and took place between September and October 2016. Cows calved onto the study, were full time housed, and allocated to either:

- Grass silage based diet
- Zero-grazing grass based diet

Concentrate feeding amounts were the same across treatments, with heifers increasing from 4.75-9.75 kg/day and cows increasing from 6-13 kg/day in the first 15 days post-calving via in- and out-of parlour feeders. Animal performance including feed intake, live weight, milk production and milk quality were measured over the 7 weeks of the study.

As shown in Table 21, offering fresh grass to cows improved dry matter intake, milk production and milk quality compared with those offered grass silage. Cow live weight and body condition score was similar across treatments. Although grass quality has previously been considered to be of low nutritive value over the autumn period, metabolisable energy content was consistently over 11 MJ/ kg DM during September – October.

Table 21: Cow performance throughout the study.
Source: AFBI

	Grass Silage	Zero-grazing
Milk yield (kg/cow/day)	34.1	35.5
Milk fat-plus-protein yield (kg/cow/day)	2.72	2.81
Milk energy output (MJ/cow/day)	118	122
Live weight (kg)	629	648
Body condition score	2.6	2.6

For more details and full reports visit dairy.ahdb.org.uk and www.agrisearch.org

Appendix – Calculating DM of samples

The procedure described below is a simple test that can be performed on farm to measure DM; ideally on a weekly basis.

In the field

1. If weather conditions are stable a weekly sample will suffice. However, where weather is variable then samples need to be taken more frequently to adjust pasture DM allocation.
2. Using clippers take a sample representative of the grazing area.
3. Cut the sample into manageable lengths (50 to 100mm) and put sample into the bucket.
4. Mix the sample by hand so that the sample is evenly distributed.

In the kitchen

1. Pre-weigh the microwave dish (Weight 1) and then zero the scales.
2. Accurately weigh approximately 100g or a quantity that comfortably fits in the microwavable dish and record weight (Weight 2). Ensure all sample is contained within the dish as any 'overhang' may fall off and give a false DM.
3. Place approximately 100ml of water in a glass and put it in the back of the microwave oven. This is important as it prevents the sample from going on fire.
4. Place the sample in the microwave oven and set to 80% of power rating.
5. Set the time to 10 minutes.
6. Remove the sample and weigh (Weight 3).
7. Dry for a further 2 min, remove and weigh, if the weight is the same as Weight 3 then the sample is dry (Weight 4). If it is lower, then dry for a further 2 min and repeat the weighing. Drying time will ultimately depend on microwave power.

Appendix – Calculating DM of samples

Formulae for calculating DM

$$DM\% = \frac{\text{Weight 4 – Weight 1}}{\text{Weight 2}} \times 100$$

Once you have analysed the forage for DM content it is important that one acts upon the information gathered. This will involve readjusting the allocation of forage, whether it is in the paddock if one is using cut and weigh for pasture allocations or if forages then adjusting the quantity added to the diet feeder. This can be done quite readily by using the formula below:using cut and weigh for pasture allocations or if forages then adjusting the quantity added to the diet feeder. This can be done quite readily by using the formula below:

$$\frac{\text{Previous forage allocation x old DM}}{\text{New DM}} = \text{New Forage allocation}$$

Example: If the DM of the forage goes from 30 % down to 26 % and the feed offered was 3,600kg then:

$$\frac{3600 \times 30}{26} = 4{,}153\text{kg}$$

So our new feed allocation will be 4,153kg

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