

Cut and carry

A best-practice guide



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Photography and graphics: AHDB, AFBI and AgriSearch.



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

Foreword

Interest in cut and carry systems, often referred to as zero grazing, 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 cut and carry systems. With this and the increasing popularity of the system in mind, AHDB Dairy and AgriSearch commissioned separate but complementary research studies on cut and carry at Scotland's Rural College and the Agri-Food and Biosciences Institute.



Dr Debbie McConnell
Dairy grassland scientist, AFBI



This research sought to answer key questions as to the potential role of cut and carry 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 (p26).

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

Cut and carry, also referred to as zero grazing, is a feeding system where fresh grass is cut daily and fed to housed cows throughout the grazing season.

Throughout this publication, it will be referred to as cut and carry.

Key messages

- Introducing well-managed fresh grass into the diet of dairy cows can reduce feeds costs and improve profitability (p5)
- Cut and carry is a viable option to increase the proportion of grass in the dairy cow diets, but good grassland management is essential (p10)
- Cut and carry systems can increase grass growth and utilisation (p22)
- Keeping pre-cutting covers below 4000 kg DM/ha is essential to ensure good-quality forage, dry matter intake and cow performance (p13)
- Using specialist cut and carry machinery can lead to improvements in animal dry matter in takes and cow performance (p14)
- A flexible approach to the time of day of cutting is required to optimise grass dry matter content, especially in wet conditions (p14)
- Providing adequate feed space and pushing up regularly is key to achieving good intakes of cut and carry grass (p18)
- A network of good access points to fields will minimise soil damage in wet-weather conditions (p11)
- Avoid cutting swards that have recently been grazed to reduce the risk of manure contamination (p11)
- Fresh grass should be fed to cows at least once every 24 hours to minimise spoilage and wastage (p19)
- Compared with grazing, cut and carry can improve cow performance and margin over feed and forage per hectare, but additional housing costs must be considered (p22)



Introduction

The value of home-grown forage

- Well-managed grazed grass is the cheapest feedstuff available on-farm
- Maximising home-grown forage has the ability to reduce the cost of production
- Better use of home-grown forage drives profitability

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

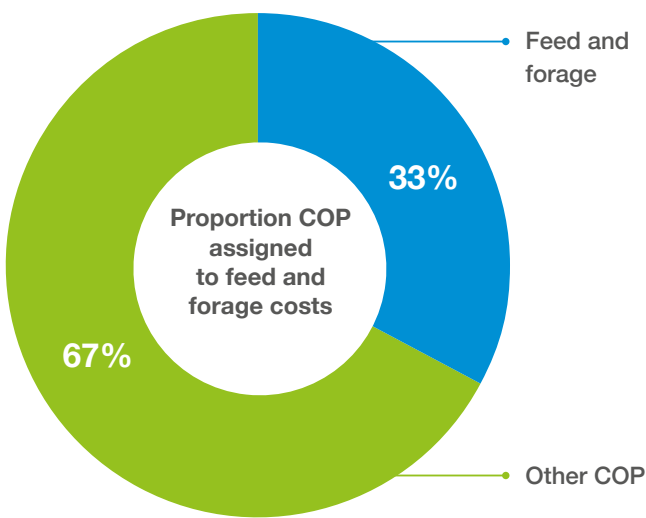


Figure 1. Proportion of the COP assigned to feed and forage costs on GB dairy farms

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

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

	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

Source: CAFRE, 2017

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

Benchmarking results from GB indicate that since 2013, the top 25% of farms ranked on net margin have been £886/cow more profitable than the bottom 25% of farms (Table 1b).

Table 1b. Benchmarking data for the period 2013–2017 ranked on net margin

	Bottom 25%	Top 25%	Difference
Yield per cow (litres)	7,115	7,984	869
Concentrate fed (kg/cow)	2,420	2,531	111
Milk from forage per cow (litres)	2,065	2,385	320
Net profit (£/cow)	-482	404	886

*2 years' worth of data only

**Net profit, including imputed costs

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 increase farm sustainability, resilience and profitability.



Cut and carry systems

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. Cut and carry can be fed with grass silage or total mix ration (TMR). The system is used across mainland Europe, although its use in the UK has been limited so far.

A cut and carry 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 or TMR. Although well-managed grazed grass is the most economical feed available for dairy cows, there is growing interest in the role of a cut and carry system and its potential to reduce feed and forage costs.

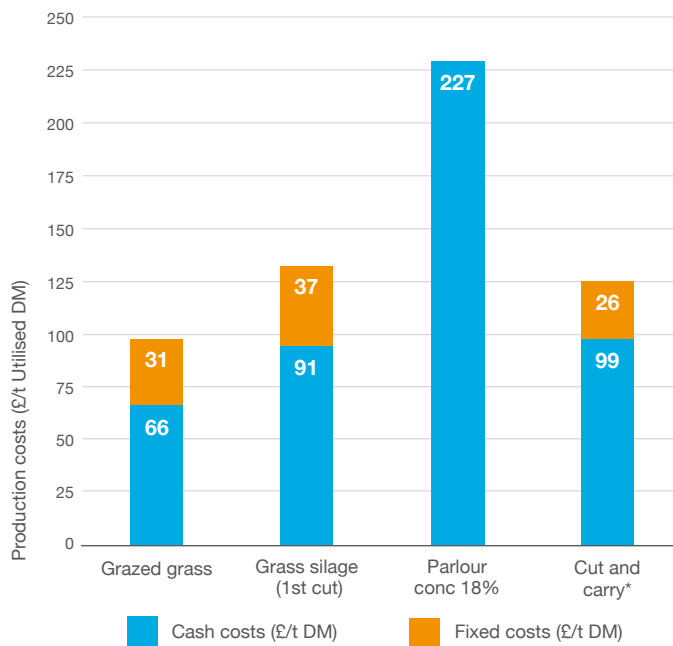


Figure 2. Total production costs (£/t DM) of home-grown forages against bought-in concentrates for GB farms

*based on 4 cutting rotations

Source: Kingshay forage costings report, 2017

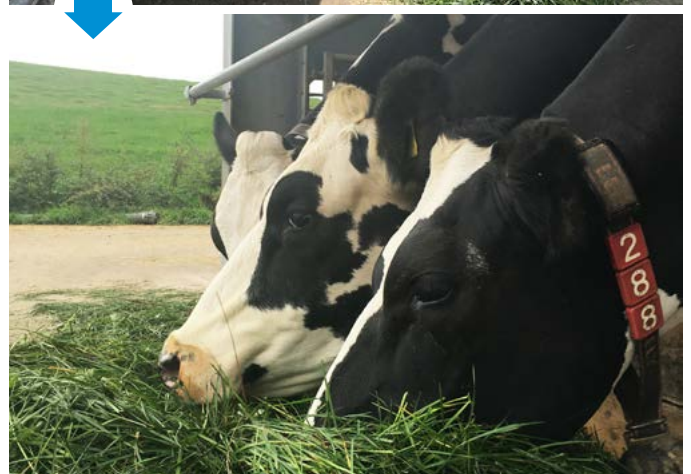


Figure 3. The process of cut and carry

Benefits and challenges

Over recent years, many dairy farmers have implemented a cut and carry 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.

Cut and carry provides valuable opportunities for dairy farmers, including:

- Improvement in grassland productivity, with up to 25% increase in grass growth rates and 15% improvement in grass utilisation when compared with grazing (p22)
- Increased stocking rate possible, which reduces the total area needed for grazing (read Aidan's story on p9)
- 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 p21)
- 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 p17)
- Potential reduction in damage to grass if appropriate machinery and practices are used in correct weather conditions and the avoidance of poaching and rejection sites in pasture (In-field section, p10)

- Avoids opening silage/changing diet when cows require sporadic summer housing and improves cow performance in comparison with grass silage (p24)
- Ability to buffer-feed high-yielding cows with grass silage (p19)

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

- Higher capital investment for specialised machinery and increased fuel costs relative to grazing
- Large daily variation in grass dry matter (DM) content and dry matter intake (DMI) in comparison with grass silage, impacting on animal performance (p19)
- Cut grass spoils within 18–24 hours, particularly in warmer summer temperatures (In-shed management section, p18)
- Added cost of slurry handling, storage and spreading in comparison with grazing system (p22)
- Greater feed space requirements for feeding fresh grass indoors when compared with silage (p18 for infrastructure recommendations)
- High labour demand (estimated one hour/100 cows) for cutting grass on a daily basis



Cost of cut and carry grass

As with all feeding systems, the costs will vary widely from farm to farm and it is best to calculate the cost for each farm when deciding if it is economically viable for your business. Within a cut and carry 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 the 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 example costs for generating cut and carry total costs relative to grazing and grass silage systems are outlined below in Table 2. Further information on the economics are available in Performance and economics on page 22.

Cash cost estimate for cut and carry grass is £97 per tonne of DM.

In comparison, typical cash costs estimates for grazed grass range from £52–£66 and three-cut silage costs from £87–£97 per tonne of DM.

Table 2. Calculating cut and carry costs in 2019

	Grazing	Cut and carry	Silage ¹
Establishment costs (£/ha)			
Seedbed preparation and sowing ²	£216	£216	£216
Seed (@35 kg/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 + Polyethylene)			£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

¹Standard three-cut silage system with tractor and grab feed-out. ²Includes ploughing, 2x power harrow, sowing and rolling.

³All nutrients supplied to The Fertiliser Manual (RB209) recommendations for Index 2 soils in GGC and High SNS. ⁴Assumes one slurry application for cut and carry, three applications for silage. ⁵Assumes seven rotations for cut and carry using owned equipment. Assumes complete three-cut silage system delivered by contractor.

⁶Typically not included in other costings. Grazing feed-out costs include labour costs associated with driving and grass allocation. Cut and carry and silage costs assume feed-out with a tractor and grab. Note: cut and carry machines with delivery conveyors would reduce this cost slightly.

Case study: cut and carry improves milk from forage in the low-yielders

Farmer: Sam McElheran

Farm: Stranocum, County Antrim



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

One bonus from the feeding system includes 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 declined from roughly 3 t/cow/year to 2.55 t/cow/year. On the

farm's costings, this is seen in a concentrate usage per litre of 0.39 kg 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.

For anyone considering cut and carry, Sam 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," he adds. "You have to do the fetching, the carrying, the bringing it up to the cows – there's a lot of labour involved."

Case study: fresh grass supports high milk production

Farmer: Aidan McManus

Farm: Clonliff, County Fermanagh



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

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.

"We have found spring grass usually analyses at a metabolisable energy (ME) of 13 MJ/kg DM and crude protein (CP) is 22–23%. Nothing you can buy comes anywhere near that analysis!" Aidan says.

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 cut and carry 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 cut and carry 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 in the robot.

"With cut and carry, 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% fat and 3.3% protein."

In-field management

The primary benefit of cut and carry 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:



1. Field selection

- Size
- Previous use
- Access



2. Grass

- Varieties
- Nutrients



3. Cutting

- Growth stage
- Time of day
- Machinery

1. Field selection

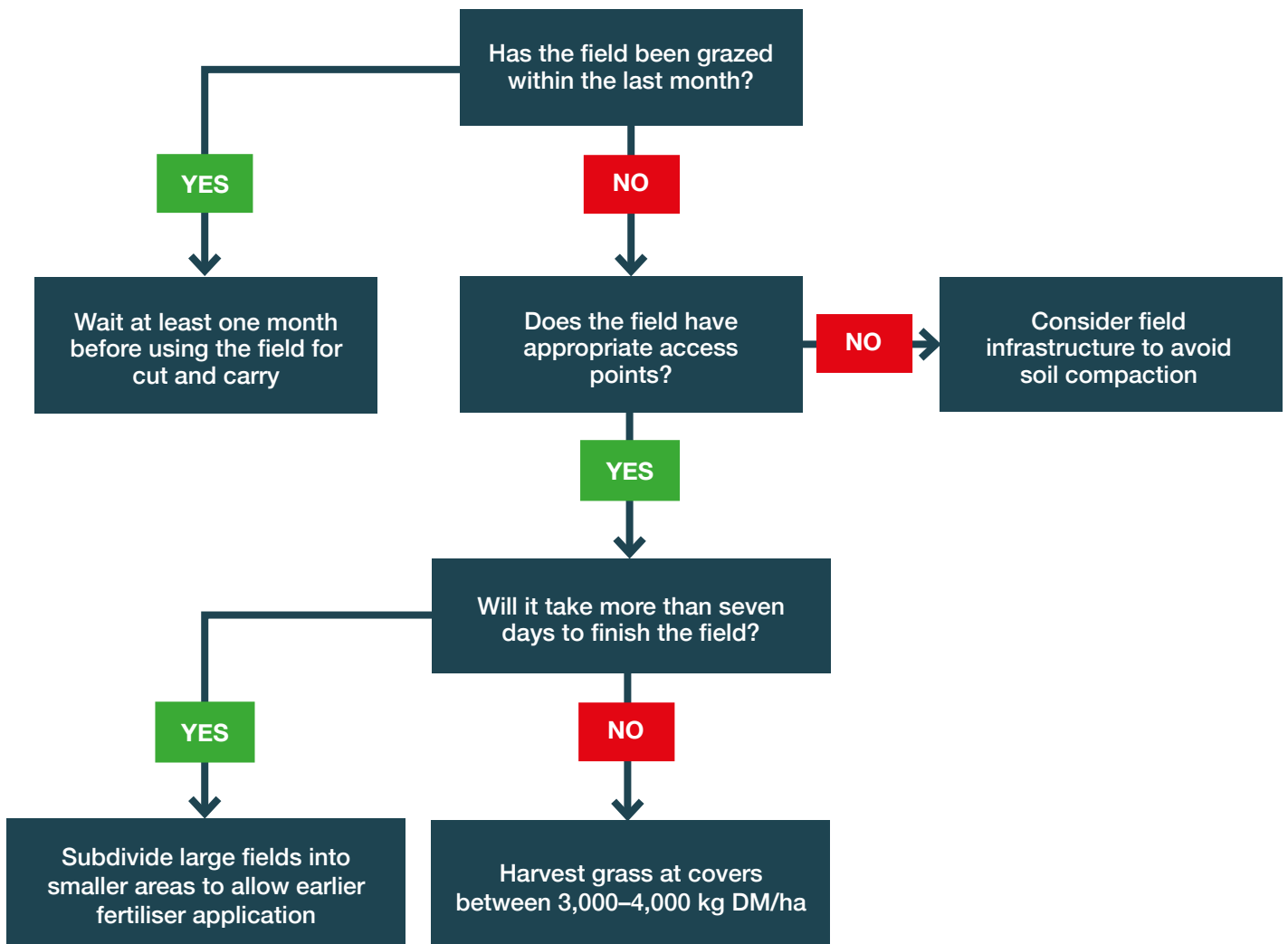


Figure 4. How to select fields for a cut and carry system

When selecting appropriate fields for cut and carry, it is important to take account of:

Field size – Although using large fields for cut and carry 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.

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

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 fresh 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%, also impeding soil drainage and nutrient efficiency.



Figure 5. Uncompacted (A) vs compacted (B) soils

Within cut and carry 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, cut and carry could reduce overall field compaction by 10% when compared with grazing systems.

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

2. Grass

The frequent cutting used in cut and carry systems can change the structure of the grass, influencing the management of cut and carry grass. It is important to consider:

Variety selection – Recent research in Northern Ireland has shown that, compared with grazing, cut and carry reduces the density of ryegrass plants over the course of a season by up to 16% (Figure 6).

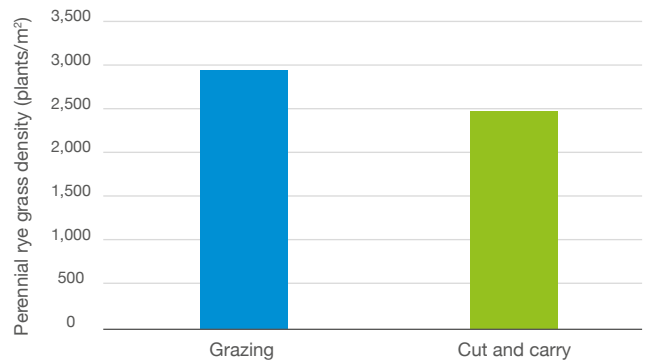


Figure 6. The impact of cut and carry on perennial ryegrass density in leys after one cutting season

Source: AFBI, 2018

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.

“Using a similar checklist to that which you would use for selecting a multi-cut type ley is beneficial for cut and carry. 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 at britishgrassland.com/rgcl

Weed control – Spraying for weed control in the main grass-growing season can be challenging as many plant residues can be harvested with the cut and carry grass, which 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 cut and carry 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 nutrient returns when developing a nutrient management plan. The best method to consider nutrient requirements for cut and carry swards is to work backwards from the recommendations from silage swards, taking account of the lower yield of cut and carry swards (typically 70–75% of silage yield) and the need to distribute this more frequently throughout the season.

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.

Phosphate and potash – Requirements for cut and carry 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

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

Source: *Nutrient Management Guide (RB209)*

Using Table 3, we can see that if 10 t DM/ha of grass is removed, 69 kg of phosphate and 241 kg 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 nutrient is required to support adequate plant growth. Example nutrient requirements for a grass field yielding 10 t DM/ha at different soil indices is presented in Table 4.

Phosphate may be applied in several small applications throughout the season, although positive responses can sometimes 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.

Table 4. Example fertiliser requirements for a cut and carry field yielding 10 t DM/ha.

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

Source: Adapted from *Nutrient Management Guide (RB209)* to take into account lack of nutrients returns by grazing animals

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

Nitrogen – When calculating nitrogen requirements for cut and carry grass, the supply from other sources needs to be considered (Figure 7).

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

- Soil nitrogen status
- Grass growth class
- Yield potential

Again, when calculating nitrogen requirements for cut and carry swards, it is worthwhile reviewing silage recommendations and adjusting this for the lower yield observed under cut and carry 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 – these have been split into different months to reflect more frequent cutting.

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



Figure 7. Example of other sources of nitrogen to consider

Full details of this process and nitrogen recommendations can be found in the *Nutrient Management Guide (RB209)*.

Table 5. Example of nitrogen application rate for different yields for a cut and carry system.

Indicative DM yield (t/ha)	Nitrogen application rate (kg N/ha) per grazing rotation and approximate application date*							Total N application
	Feb	March	April	May	June	July	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%. 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)

3. Cutting

Grass growth stage

Cut and carry 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 cut and carry tend to be 450 kg DM/ha higher on average when compared with grazing farms. This allows higher offtakes while achieving good residuals.

Pre-cutting covers target for cut and carry is between 3,000–4,000 kg DM/ha. Cutting within this range is important in order to maximise grass and animal performance.

However, care must be taken not to use very high grass cover for cut and carry 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 cut and carry system in Northern Ireland, either from:

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

Feeding high-grass covers negatively impacted growth rates and grass quality, see Table 6. An additional 1.86 t 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%) and there was higher wastage at the feed trough by the high-grass-cover group. This reduced overall grass utilisation by 5.7% compared with the low-grass cover.

Table 6. Impact of pre-cutting grass cover on grassland 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

Source: AFBI, 2018

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).

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.

“I go into covers of 3,500–3,800 kg DM/ha. Grass is cut to a residual of 1,800 kg DM/ha to avoid hitting stones. By maintaining these targets, I find that grass recovers faster.”

– Sam McElheran

Rotation length – Targeting pre-cutting covers 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. When calculating rotation length, remember to take into account rate of grass growth and herd demand.

Time of day – The DM content and the sugars and fructans, known as water-soluble carbohydrate (WSC), content of grass increases throughout the day, with peak DM content usually observed in the early-mid-afternoon (around 2pm) in dry conditions.

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

“Cutting is always undertaken after 2pm, by which time DM of grass has increased and WSC has accumulated”

– Parry Walters

In wet conditions, flexibility is key! If possible, it is worth cutting later in the day after conditions improve. It can be challenging in bad weather conditions and might be worth looking at providing buffer feed.

Machinery – Although specialist machinery has been developed for cut and carry 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 cut and carry machinery (more details in appendix, p26).

Key results (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 DMI was 0.6 kg DM/cow/day lower from double-chop techniques compared with 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

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

– Aidan McManus

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

	Low-grass cover	High-grass cover
Grass growth rate (kg DM/ha/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

Source: AFBI, 2018

Table 8. Sward characteristics and performance of dairy cows fed grass harvested by either double-chop or specialist cut and carry machinery

	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 (%)	76.1	76.2
Total grass utilisation	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

Source: AFBI, 2018



Figure 8. Double chop (A) vs cut and carry grass (B)

Source: AFBI

Worksheet – calculating the amount of fresh grass to cut daily

Table 9. Dry matter percentage ranges for fresh grass based on weather conditions

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

See appendix Calculating DM of samples (p29) for step-by-step guide on how to calculate DM content of fresh grass for a more accurate estimation.

Table 10. Daily dry matter intake estimator*

Live weight (kg)	Estimated intake (kg DM/day)
450	13.5–15.8
500	15.0–17.5
550	16.5–19.2
600	18.0–21.0
650	19.5–22.8

*High-yielders will require an additional source of fresh grass to achieve target DMI.

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

Cut and carry pasture cover targets

Pre-cutting cover 3,000–4,000 kg DM/Ha

Post-cutting cover 1,800 kg DM/Ha

Example

Step 1: Calculate grass DM available:

3,500 (Pre-cut cover) - 1,800 (Post-cut cover) = 1,700 kg (DM available)^[A]

Step 2: Calculate daily dry matter requirement for herd:

Cow demand: (cow live weight) 600 kg^[B] x 3.5% = 21 kg daily requirement per cow^[C]

21 kg DM^[D] x 100 (No. of cows) = 2,100 kg DM (10% surplus)^[E] = 2,310 kg DM required^[F] + 210 kg DM

Step 3: Calculate area to cut:

1 hectare divided by 1,700 kg DM (DM available) = 0.0006^[G]

0.0006*2310^[F] (herd requirement) = 1.36 ha (area required to be cut)^[H]

Input your own figures here to calculate the area required to be cut:

Step 1: Calculate grass DM available:

(Pre-cut cover) - (Post-cut cover) = ^[A] kg DM/ha (DM available)

Step 2: Calculate daily dry matter requirement for herd:

Cow demand: (cow live weight) ^[B] kg x 3.5% = ^[C] kg

^[D] kg DM x (Number of cows) = kg DM + ^[E] kg DM (10% surplus) = ^[F] DM (total required)

Step 3: Calculate area to cut:

1 ha divided by kg DM (grass available) = ^[G]

^[G] Multiply by ^[F] = ^[H] ha (area required to be cut)

Case study: top-notch grassland management key to success

Farmer: Parry Walters

Farm: Manor Farm, Warwickshire



Cut and carry is not often associated with beef farming systems, but as Midlands beef and sheep producer Parry Walters approaches his sixth season of the practice, he says he would never look back.

Having switched from a more traditional UK grazing-based system, 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.

“We started cut and carry because we knew we had to increase the output of the farm,” says Parry. “We considered a year-round total mixed ration as an alternative, but I’m very happy we chose the grass-based option.”

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 kilogram of meat per animal.”



In-shed management

A cut and carry system offers 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:



1. Infrastructure

- Space allowance
- Feeding area



2. Feeding management

- Inclusion
- Mixing time
- Feed delivery
- Feed face



3. Diet

- Grass quality
- Testing fresh grass
- Low DM content

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 cut and carry. 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 11. It is likely that cut and carry fresh grass will encourage simultaneous feeding, so sufficient feeding space is recommended.

Table 11. Feed space width recommendations for cattle of different weights

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

Source: Adapted from Red Tractor Dairy Assurance Standards 2017

“We allow 70 cm 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

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, stainless steel or a gel-coat finish will provide a smooth surface, 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 10 cm above the standing surface will increase consumption rate and reduce refusals.



2. Feeding management

Inclusion rate

If cows are cleaning up all of the fresh grass offered with no refusals after 24 hours, investigate if you need to increase the amount of fresh grass offered as you may be limiting their production by not providing an actual ad-lib diet. It is worth noting that TMR composition, grass quality and management can vary, so the optimal rate of fresh grass inclusion may change accordingly.

Mixing time

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 been added.

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

Feed delivery

Ideally, fresh grass should be cut and delivered at least once a day and fed as often as necessary to avoid heating as this will lead to refusals.

Managing the feed face

Ensure cows have continuous access to feed to help increase DMI. Avoid over-piling fresh grass and clean out any refusals daily to avoid quality deterioration.

Fresh grass should ideally be pushed up 3–4 times per day.

“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

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

3. Diet

A number of research studies have investigated the yield of milk that can be sustained from grazed grass when offered as the sole feed, with these studies indicating that approximately 25 kg milk/cow/day can be sustained in late May, with this value declining to approximately 14 kg/cow/day by mid-September. However, where high-yielding cows are consuming fresh grass, assuming more modest maintenance-plus levels of 21 kg milk/cow/day in late May, falling to 11.5 kg/cow/day in mid-September is often more realistic (Figure 9).

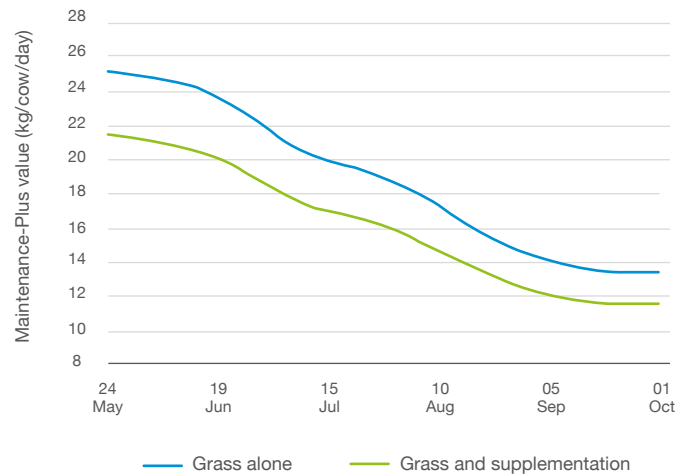


Figure 9. Theoretical milk from grass

Source: AFBI, 2018

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 cut and carry system will not improve the nutritional value of low-quality grass.

It is important that the fresh grass offered through cut and carry is of the same quality as what you would offer cows to graze. Grass quality data collected from AHDB's Forage for Knowledge contributor farms demonstrates how grass quality varied across the 2018 grazing season.

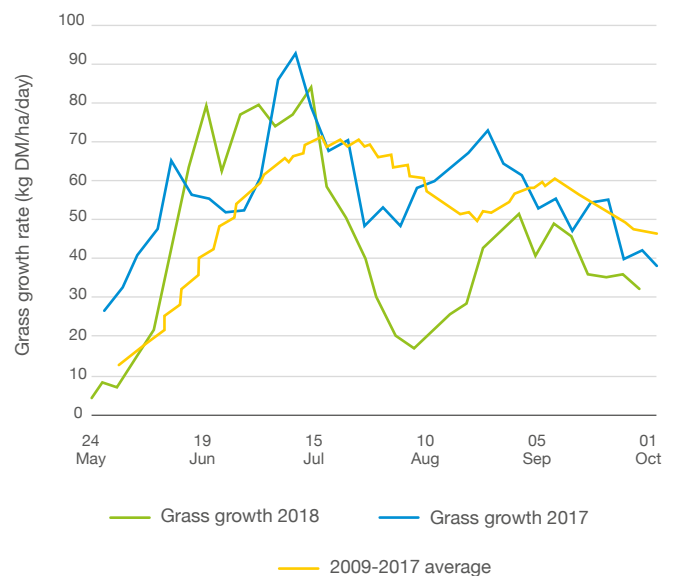


Figure 10. Average grass quality across Forage for Knowledge contributor farms in 2009–2018

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

“I plate meter every six to nine days, and as part of the AgriSearch GrassCheck project, I have the grass analysed every two weeks. This April, analysis of 20% DM, ME 12 MJ/kg DM, crude protein 23.5% and WSC 17.1% is typical for the season”

– Sam McElheran

Sign up to GrassCheck for Northern Ireland and Forage for Knowledge for GB weekly grass-quality updates.

The oil content of fresh grass, either cut or grazed, can be high, above 5%, especially in spring, and can reduce butterfat content.

Top tips for prevention:

1. Measure grass growth weekly.
2. Cut pasture at the three-leaf stage, as less leaves will supply insufficient amount of structural fibre.
3. Cut down to the target residual, 1500–1600 kg DM/ha, to harvest the stemmy part of the plant.
4. Analyse fresh grass for an indication of quality.

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 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.

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 (p29).

Monitoring DMI is key to achieving the best cow performance. Unlike grazing, a cut and carry 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 how much of a low-DM grass cows can eat.

Be aware of factors that can cause low DMI 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

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 cut and carry system. A successful cut and carry 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



Case study: cut and carry flexibility extends the grazing season

Farmer: Tom Kimber

Farm: Stavordale Farm, Somerset

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

Using a second-hand specialised machine, the grass is cut at covers of around 3,000–3,200 kg DM/ha and leaving residuals of 1,900 kg/ha usually from March onwards when one feed of fresh grass replaces one feed of TMR. This sees 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. Switching from a 36% crude protein blend to one containing 16% protein usually saves them £50/tonne.

As the summer approaches, the cows go out by day and only receive the cut and carry 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 cut and carry grass from our better-drained fields," Tom says.

The system goes into reverse in the autumn months, with cows continuing to graze by day and given cut and carry by night.

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

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



Performance and economics

Research studies in Northern Ireland and Scotland have looked at a range of feeding systems in comparison with cut and carry, including grass silage, grazing and TMR systems of feeding. Cow performance is summarised in Table 12, but for more details on each study, please see the appendix (p26).

Table 12. Average* daily cow performance

	Grazing	Grass silage	TMR	Cut and carry
Forage intake (kg DM/day)	11.2	11.6	11.3	12.1
Concentrate intake (kg/day)	7.5	7.5	8.0	7.5
Daily milk yield (kg/day)	27.9	25.7	36**	29.5
Milk-fat-plus-protein yield (kg/cow/day)	2.01	1.82	2.44	2.15
Live weight (kg)	585.5	589.1	635	616.9

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

**Maize silage was included in the TMR diet.

Source: AFBI, 2018

Cut and carry vs grazing

Operating a cut and carry system has been found to benefit both grass growth and utilisation when compared with traditional grazing systems. Studies carried out in Northern Ireland have shown an average increase of 15% 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% (Figure 11).

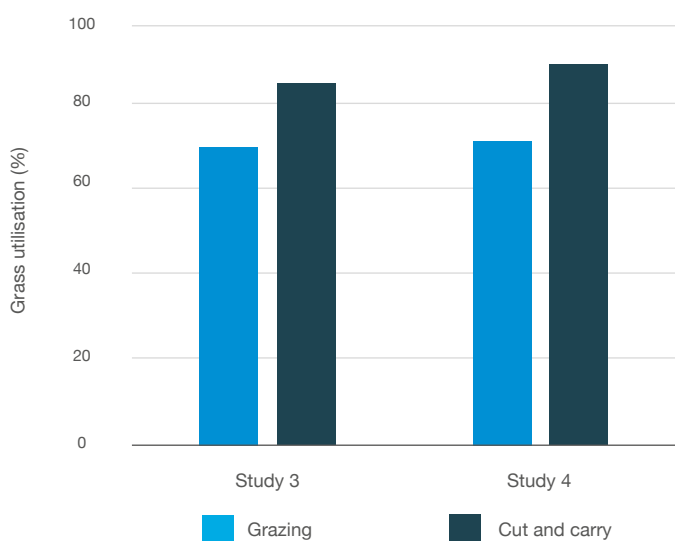


Figure 11a. Measured grass utilisation from cut and carry and grazing systems in two studies in Northern Ireland during 2016 and 2017

Source: AFBI, 2018

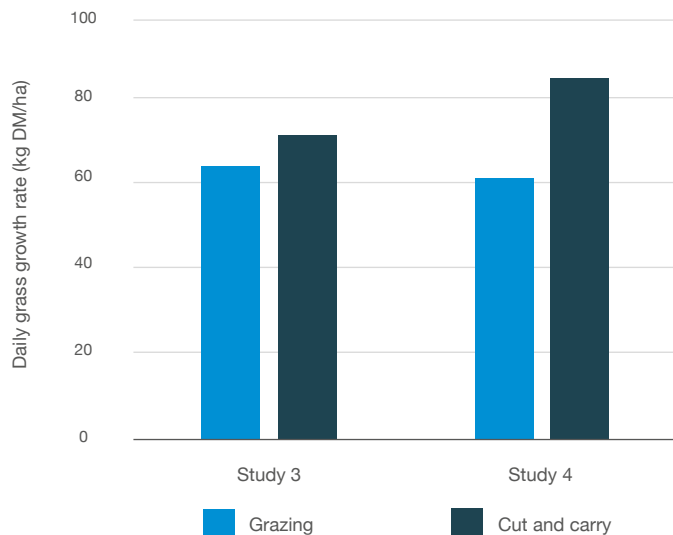


Figure 11b. Grass growth rate from cut and carry and grazing systems in two studies in Northern Ireland during 2016 and 2017

Source: AFBI, 2018

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 15 kg DM/cow/day of fresh grass throughout the season would require 10.4 ha less under a cut and carry system (assuming a 10% increase in grass growth rate and 15% increase in grass utilisation from cut and carry; Table 13).

Table 13. Potential differences in land area requirements and stocking rates with cut and carry systems compared with grazing

	Grazing	Cut and carry	Difference
Total area required (ha)	34.2	23.7	-10.4
Stocking rate cows (ha)	2.9	4.2	+1.3

Source: AFBI, 2018

Farmers may be considering moving to cut and carry systems from grazing. A study conducted in Northern Ireland assessed dairy cow performance from grazing compared with cut and carry 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 cut and carry fed daily. Both treatments were supplemented with concentrates in the parlour.

Cow performance

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

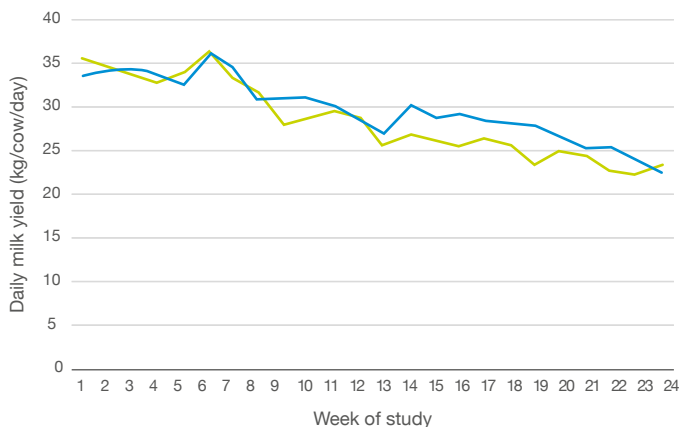


Figure 12. Daily milk yields for dairy cows managed under cut and carry systems or full-time grazing

Source: AFBI, 2018

Table 14. Dairy cow performance from animals managed on cut and carry or full-time grazing systems

	Cut and carry	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

Source: AFBI, 2018

Financial implications

- Estimated total costs per kilogram of forage DM were 19% lower for grazed grass (£0.10/kg DM) compared with cut and carry systems (£0.12/kg DM), reducing overall feed costs by 66p/cow/day
- However, for cut and carry, 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 cut and carry compared with grazing (£4.99)

- Both grass growth (+8 kg DM/ha/day) and utilisation (+15%) were higher on the cut and carry system compared with grazing. This improvement in grass productivity and utilisation led to an increase in stocking rate on the cut and carry system (4.45 cows/ha) compared with grazing (3.57 cows/ha)
- This higher stocking rate increased milk output per hectare (+5,000 kg/ha) and margin over feed and forage costs by £505/ha for cut and carry systems

However, if shifting to cut and carry 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 1 m³. A dairy cow yielding 6000–9000 litres on average produces 1.59 m³ 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

Table 15. Cost comparison of dairy cows managed on cut and carry systems or full-time grazing

	Cut and carry	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	3.357
Margin over feed and forage (£/ha)	3,336	2,830

Source: AFBI, 2018

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

Cut and carry vs silage

For some farmers, moving to cut and carry 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 cut and carry or grass-silage-based diets, and fed supplementary concentrates
- Cut-and-carry-fed animals had higher milk yields and quality than those fed grass silage and concentrate. On average, milk yields increased by 10%, while milk protein improved by 0.22% (Figure 12)

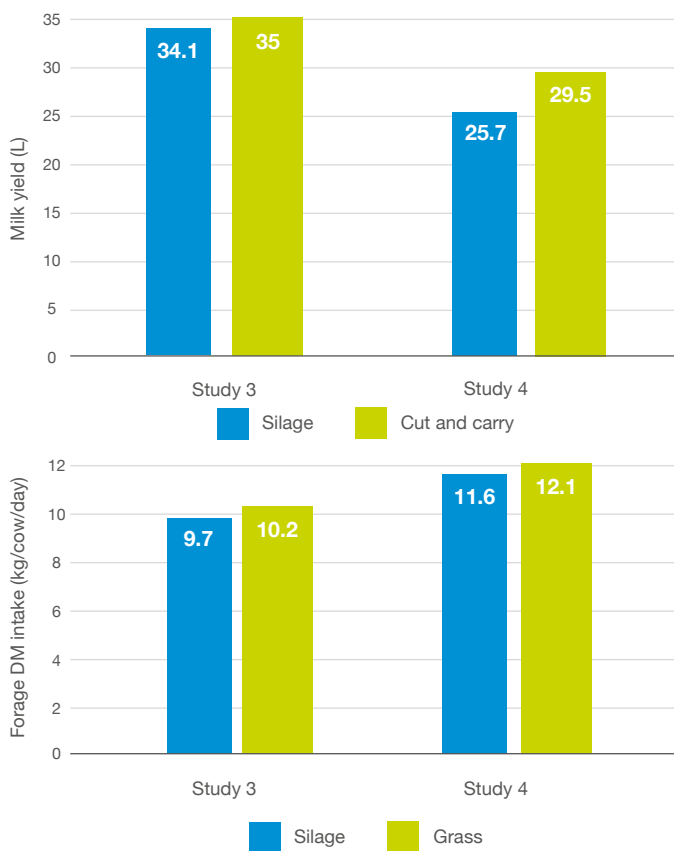


Figure 12. Daily milk yield per cow from two studies of cows fed either silage or cut and carry grass-based diets

Source: AFBI, 2018

Table 16. Dairy cow performance from animals fed either grass silage or cut and carry grass in two separate trials in Northern Ireland

	Study 5 – lasting for 7 weeks		Study 6 – lasting for 22 weeks	
	Silage	Cut and carry	Silage	Cut and carry
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

Source: AFBI, 2018

- Improved animal performance from cut and carry was driven by higher animal forage intakes. The difference between systems was, on average, +0.5 kg DM/cow/day greater forage intakes on cut and carry systems across the whole grazing season
- There was no impact of diet on BCS or animal live weight

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 cut and carry (£0.12/kg DM)
- Improvements in cow performance from cut and carry resulted in an increase in an average margin over feed and forage of +£1.36 per cow per day from cut and carry compared with 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, Cut and carry = 0.82)
- Although increased stocking rates from silage feeding increased output per hectare, significantly better animal performance from cut and carry again resulted in this having the greatest margin over feed and forage per hectare

Cut and carry vs TMR

Some farmers may be considering moving to cut and carry systems from TMR. Studies were conducted in Scotland to assess dairy cow performance from TMR compared with cut and carry systems in spring 2014 (see table 17 overleaf).

Table 17. Total cost* comparison of dairy cows managed on diets with silage or cut and carry grass as the sole forage source

	Study 5 – lasting for 7 weeks		Study 6 – lasting for 22 weeks	
	Silage	Cut and carry	Silage	Cut and carry
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

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

Source: AFBI, 2018

Cow performance

- Cows were managed either on full-time TMR or diets providing 25% or 50% of the DMI as fresh grass
- Cut-and-carry-fed animals had lower milk yields than those fed a full TMR diet, by an average of 12% for cows fed 50% fresh grass, and 15% for cows fed 25% fresh grass (Figure 13)

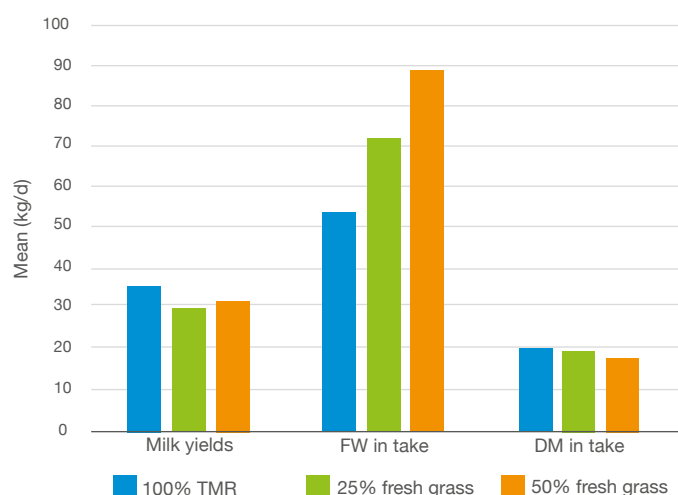


Figure 13. Average milk yields, fresh weight intake and dry matter intake for dairy cows managed under three different diets

- Intakes of feed by fresh weight were highest for 50% grass-fed cows, lower for 25% grass-fed cows and were lowest for TMR-fed cows. However, intakes of DM were lowest for 50% grass-fed cows, higher for 25% grass-fed cows and highest for TMR-fed cows
- This resulted in a reduction in milk yield of 4.3 litres/cow/day, compared with an average 35.7 litres/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 0.18 kg/week more than those in the cut and carry group and 0.64 kg/week more than those in the TMR group

Adding fresh grass to a TMR diet as part of a cut and carry system was demonstrated to reduce milk yields without affecting milk quality but at a lower cost of production. Cut and carry is most cost-effective for systems with high feed costs. 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 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 of production, land rental and equipment depreciation
- Under these costs, if the milk price was 32 ppl or lower, then the low-cost 50% grass-fed strategy delivered the highest surplus
- If the milk price was 33 ppl 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 17–35 ppl, despite the higher milk production
- TMR-only system deliver margin over feed per cow per day at 22 ppl
- Cut and carry system feeding 6 kg grass DMI returned margin over feed at £2.24/day
- Fresh grass in the diet at 50% 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% grass and 50% 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

Appendix – Description of studies

This cut and carry best-practice guide has been compiled using six studies recently carried out 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

Key cow parameters:

- 30+ litres per day
- Recently calved cows
- DMI of different treatments: TMR 20.0 kg/cow/day; 25% grass 19.0 kg/cow/day; 50% grass 18.0 kg/cow/day

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 14). These diets varied in the ratio of fresh grass to TMR, with a proportion of the TMR 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% 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%TMR).
2. 25% of the DMI was provided as fresh grass and remaining 75% as TMR (25% grass).
3. 50% of the DMI was provided as fresh grass and remaining 50% as TMR (50% grass).

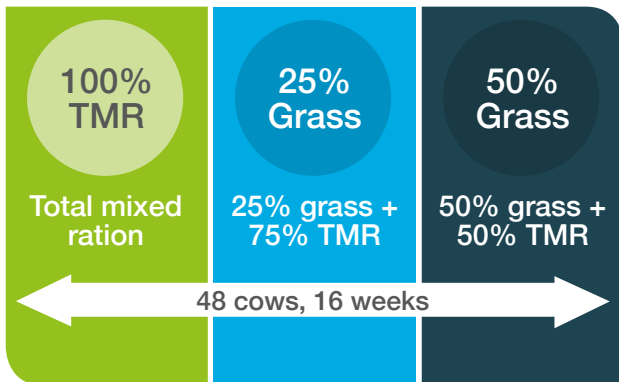


Figure 14. Three diets were offered to recently calved high-yielding dairy cows over a 16-week period starting on 28 April 2014

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.



Study 2: Investigating the value of fresh grass in the diet of high-yielding dairy cows

Key cow parameters:

- 37.9 litres per day
- 110 days in milk
- DMI of different treatments: TMR 24.1 kg/cow/day, cut and carry 23.0 kg/cow/day and grazing 24.1 kg/cow/day

The purpose of this study was to explore the value of fresh grass in the diet of the high-yielding dairy cow and to compare different delivery methods of feed during the day. The grass was offered through a cut and carry feeding system or grazed in the field. Forty-eight Holstein-Friesian dairy cows yielding 37.9 litres per day and averaging 110 days in milk were allocated to one of three diets as part of this 12-week trial (Figure 15 and Table 18).

1. One hundred per cent TMR, based on grass silage, maize silage and concentrates, with no grass offered. The cows in this group were housed 24 hours per day.
2. Cut and carry, based on fresh grass offered once per day (from morning to evening) using cut and carry. Overnight, the cows were given access to a TMR. The cows in this group were housed 24 hours per day.

Table 18. Daily diet allocation and location

	TMR		Cut and carry		Grazing	
Morning–afternoon	TMR	Housed	Grass	Housed	Grazing	Pasture
Afternoon–night	TMR		Grass		Grazing	Pasture
Night–morning	TMR		TMR		TMR	Housed

Source: AFBI, 2018

3. Grazing whereby cows were turned out to graze between milking's (morning to afternoon and afternoon to night). The cows were housed overnight and given access to TMR.

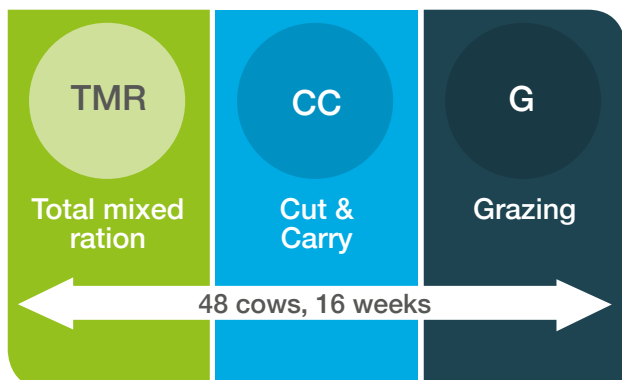


Figure 15. Three diets were offered to high-yielding dairy cows over a 12-week period starting on 11 May 2015

Study 3: Impact of harvesting technique on animal performance and grass utilisation in cut and carry systems

Key cow parameters:

- 27.8 litres per day
- 119 days in milk
- Dry matter intake of different treatments:
low-grass cover 13.8 kg/cow/day, high-grass cover 12.9 kg/cow/day

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 3,650 kg DM/ha (LGC)
- High-grass covers at an average of 4,750 kg DM/ha (HGC)

Grass was harvested each morning using specialised cut and carry 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 19, 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.

Table 19. Cow performance and grass quality throughout the study

	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

Source: AFBI, 2018



Figure 16. Low- and high-grass covers

Source: AFBI, 2018

Study 4: Impact of harvesting technique on animal performance and grass utilisation in cut and carry systems

Key cow parameters:

- 34.7 litres per day
- 102 days in milk
- Dry matter intake of grass differed between treatments, with double-chop group eating 13.7 kg/cow/day and specialised cut and carry machinery group at 14.3 kg/cow/day

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 cut and carry machinery

Grass was harvested each morning using specialised cut and carry 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.



Figure 17. Feed boxes at AFBI used to monitor DMI

As shown in Table 20, providing cows with grass harvested using specialised cut and carry 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 with grass harvested with specialised cut and carry machinery.

Table 20. Cow performance and grass quality throughout Study 4

	Double chop	Cut and 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

Source: AFBI, 2018

Study 5: Cut and carry vs grazing vs silage over a whole season

Key cow parameters:

- 34.3 litres per day
- 89 Days in milk
- Forage intake differed between treatments: grazing 11.2 kg DM/day, grass silage 11.6 kg DM/day and cut and carry 12.1 kg DM/day

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 cut and carry grass

Grazed cows were managed in a rotational system and offered fresh grass daily. Targeted pre- and post-grazing grass covers were 3,200 and 1,800 kg DM/ha respectively. For cows on the cut and carry treatment, fresh grass was cut on a daily basis using specialist cut and carry 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 22, offering housed cows cut and carry grass resulted in improvements in forage intake, milk yield and milk quality when compared with cows maintained in a conventional grazing system or housed and offered grass silage. Cows offered cut and carry grass also maintained a consistent weight advantage over those managed in a grazing system.

Table 22. Cow performance throughout the study

	Grazing	Grass silage	Cut and Carry
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

Source: AFBI

Study 6: Cut and carry vs silage in making the most of autumn grass

Key cow parameters:

- 34.8 litres per day
- 76 days in milk
- DMI differed between treatments, with grass-silage-based-diet group having a total intake of 18.7 kg DM/cow/day, compared with the cut and carry group at 20.5 kg DM/cow/day

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
- Cut-and-carry-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, was measured over the seven 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 were 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

	Grass silage	Cut and Carry
Daily milk yield (kg/day)	34.1	35.5
Milk-fat-plus-protein yield (kg/cow/day)	2.72	2.81
Grass DM content (%)	118	122
Grass ME content (MJ/kg DM)	629	648
Grass ADF content (g/kg DM)	2.6	2.6

Source: AFBI

For more details and full reports, visit dairy.ahdb.org.uk and afbini.gov.uk

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 100 mm) and put sample into the bucket.
4. Mix the sample by hand so that the sample is evenly distributed.

In the feed kitchen:

5. Pre-weigh the microwave dish (Weight 1) and then zero the scales.
6. Accurately weigh approximately 100 g 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.
7. Place approximately 100 ml of water in a glass and put it in the back of the microwave oven. This is important as it prevents the sample from setting on fire.
8. Place the sample in the microwave oven and set to

Formulae for calculating DM:

$$\frac{\text{Weight 4} - \text{Weight 1}}{\text{Weight 2}} \times 100$$

80% of power rating.

9. Set the time to 10 minutes.
10. Remove the sample and weigh (Weight 3).
11. Dry for a further 2 minutes, 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 minutes and repeat the weighing. Drying time will ultimately depend on microwave power.

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.

$$\frac{\text{Previous forage allocation} \times \text{old DM}}{\text{new DM}} = \text{New forage allocation}$$

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

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

So our need feed allocation will be 4,153kg



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