3 Planning your feeding

In most cases the basic system by which feeds are provided to the cows is relatively fixed by the current constraints of the dairy unit and previous investment decisions.

Almost every herd does, however, have the opportunity to plan ways of fine-tuning its feeding system to improve cow performance, reduce feed costs and make the best use of available labour.

At the same time, there are numerous actions herds can undertake to increase the cost-effectiveness of their system, such as planning to assess more accurately and monitor bulk feed stocks, minimise feed wastage and improve feed access and presentation.

Putting in place a simple way of measuring the efficiency with which feeds are used to produce milk will further be invaluable in monitoring both the present position and future improvements.

What's in this section?

- Understanding the various different feeding systems available
- Assessing bulk feed stocks, wastage and feed presentation
- Measuring and improving feed efficiency.

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Summary

- Good forward planning is an essential element in successful dairy feeding
- The feeding system is the most important determinant of feeding value for most herds
- While total mixed ration (TMR) can be extremely valuable, it is important to appreciate that large machinery doesn't always fit easily into old buildings and that mixed rations generally demand more diet formulation skills and more sophisticated feed storage facilities than forage box feeding
- Any significant change in feeding system must be undertaken following a careful examination of all the specific farm, herd and management constraints as well as financial implications
- Good measurements of the quantity as well as quality of forages enable accurate advanced planning of feed purchasing to ensure sufficient supplies are always on hand and secured at the most favourable prices
- Monitoring the quality of forage available is at least as important to effective feeding planning as monitoring its quantity
- Effective clamp management to minimise silage losses can save up to £5000/year or 0.35p/litre for a 200 cow unit with silage valued at £15/tonne
- While mixer wagons are a convenient way of providing a thoroughly mixed ration, they are not necessary to provide effective mixed rations in all cases and can cause over-mixing problems if not used correctly
- Improving feed conversion efficiency from 1.2 litres/kg DM to 1.3 litres/kg DM can increase the milk production of an 8000 litre cow by 8.5% or reduce the amount of feed needed to support this yield by more than 1kg DM per day.

See also...

Section 2:	Planning your nutrition
Section 4:	Assessing your feed options
Section 5:	Managing your forage feeds
Section 6:	Managing your non-forage feeds
Section 7:	Managing your feeding
Section 11:	Factsheet 1: Metabolic disorders Factsheet 2: Common feed analysis terms
Section 12:	Worksheet 1: Clamped silage quantity Worksheet 2: Silage requirements

Action plan

For the most cost-effective milk production you must.

1. Develop a forward plan

Identify the key requirements, capacities and limitations governing your feeding as the basis for effective improvement planning (**Page 3:4**).

2. Evaluate your feeding regime

Evaluate your current feeding regime against the main systems available to establish whether any change or fine-tuning could be beneficial (**Page 3:5**).

3. Assess your feed stocks

Measure your feed stocks and develop an effective budgeting system that ensures feed availability always meets feeding needs (**Page 3:11**).

4. Ensure good feed storage and presentation

Plan your feed storage to minimise wastage and your feeding arrangements to ensure sufficient access and palatability (**Page 3:17**).

5. Establish your feed conversion efficiency

Calculate the feed conversion efficiency of various groups of cows and examine ways in which this might be improved (**Page 3:22**).

The Grass+ programme provides practical advice on making the most of grass.

For detailed guidance on pasture assessment see Section 3.

For additional guidance on silage budgeting see Section 8.

For additional guidance on silage stocks assessment see Section 9.

Feed planning

Good forward planning is an essential element in successful dairy feeding.

It ensures feeding regimes that are practicable within the constraints and resources of the unit as well as ones which meet the nutritional needs of the cows as cost-effectively as possible.

Important factors to consider in feed planning include:

- The number and type of cows to be fed
- The calving pattern
- The length of the winter feeding period
- The quantities of different feeds likely to be required
- The farm storage capacity for different feeds
- The area and type of forages grown
- The yield and quality of forages grown
- The availability of different non-forage feeds
- The system by which both forages and concentrates are to be fed.

Feeding systems

The feeding system is the most important determinant of overall feeding value for most herds.

Unless the system can store, handle and utilise the feeds effectively, much of their potential value can be lost through unnecessary wastage or excessive capital or operating costs.

In addition to the many and varied grazing regimes available, a whole host of systems have been developed over the years to deliver individual feeds and feed mixtures to dairy cows.

In simple terms these can be divided into:

- Self/easy-feed silage
- Cut and cart (forage box or block) feeding
- Total mixed ration (TMR) feeding
- Parlour feeding
- Midday feeding
- Out-of-parlour feeding.

Each feeding system has its advantages and limitations, most dairy regimes involving a combination of two or more systems to achieve the best individual farm balance.

As well as assessing the specific attributes of any feeding system, it is important to appreciate that their costs can vary from less than 15p/cow/day to over 95p/cow/day.

Evaluating self/easy-feed silage

Self-feed silage involves cows feeding directly from the forage clamp, usually under the control of a barrier or wire set across the forage face to ensure even feed out.

Easy-feed silage is an adaptation of the system, with silage pulled down from the face and fed behind a barrier set across the clamp, usually employed with taller silage faces.

Key advantages

The main advantage of self and easy-feed silage systems is their simplicity.

No additional machinery is required and the labour input is confined to re-setting the feed barrier or wire and keeping the feeding area clean.

Usually linked with parlour concentrate feeding, such systems are best suited to lower-yielding herds with limited labour and machinery.

Main limitations

As cows can only reach up to a certain height, the depth of silage storage needs to be kept within this or silage above the effective feeding height has to be removed mechanically **(Section 5)**.

The silage face needs to be wide enough to give all cows sufficient access and the feed barrier re-set regularly if dry matter intake is not to be unduly restricted.

Silage storage needs to be conveniently close to the cow accommodation; clamps constructed to ensure slurry and urine flows away from the feed face.

As the clamp face moves back there will be an increased area which will need scraping to reduce dung accumulation.

Fixed cost implications

The capital cost of self-feeding and easy-feeding is generally minimal, being confined to gating and feed barriers or wire. The layout of the unit does, however, need to be carefully planned to ensure good cow movement between silage clamp and cow accommodation and roofed clamps are generally valuable to minimise rainwater adding to slurry volumes.

The systems allow machinery and labour costs to be kept to a minimum, although they are poorly suited to high output regimes.

Evaluating cut and cart feeding

Evolved from the traditional practice of cutting and carting hay or silage from storage to feeding areas or ring feeders, cut and cart feeding involves the provision of forage alone or a simple mixture of feeds along a feed passage, barrier or trough.

This may involve either loose forage fed from a forage box or silage blocks removed using a block cutter.

Key advantages

Cut and cart feeding allows silage clamps and other forage stores to be located away from the main cattle accommodation, enabling them to be simpler and take-up less building space.

In most cases, it also means cattle do not have to move far from their lying areas and reduces the area of yard that needs regular cleaning.

Providing sufficient space is available along the feeding area, the fact that cows do not have to physically pull forage from compacted silage faces enables higher daily dry matter intakes to be achieved than self-feeding.

Other ingredients can also be added to forage boxes as a rough mix.

Main limitations

Because most forage boxes have limited mixing abilities, mixtures of feeds can only really be achieved by layering-in the ingredients.

This is time-consuming and can lead to considerable variations in nutritional value along the feeding area. Block feeding offers even less opportunity for direct supplementation.

Cut and cart feeding consequently offers limited flexibility in the number and types of feeds that can be included and the accuracy with which they can be fed.

Fixed cost implications

A forage box or wagon costs £6,000-£10,000 new (£1,500-£7,000 second hand) and also requires a loader of some description, both of which need to be maintained.

Considerably more labour is needed than self-feed silage, although including a concentrate may save the time required for a separate midday feed.

Block cutters can be considerably more economic to purchase and require relatively little labour since fresh blocks only need to be cut and carted once or twice a week.

Evaluating total mixed ration (TMR) feeding

Using a mixer wagon to feed all or the majority of the diet in a thorough mixture to cows along a feed passage, barrier or trough is a further step-up in complexity and cost from forage box feeding.

In most cases, complete diet feeding (in which no other feeds are fed separately) has given way to more flexible systems involving basal diets topped-up with additional concentrates to individual animals or groups as required.

Key advantages

Thorough mixing of forage and concentrate feeds in a single ration has been shown to maximise dry matter intakes and optimise rumen fermentation by avoiding the swings in pH and microbial activity resulting from the separate feeding of different ration components **(Section 2)**.

TMR also offers the greatest possible flexibility in the number and types of feed ingredients that can be utilised.

Main limitations

While offering the greatest feed flexibility, mixer wagons represent a very considerable cost and can over-complicate the feeding system, giving more room for error in day-to-day operation.

They can also lead to over-mixing problems if not operated correctly.

Where facilities are insufficient to adequately group cows by stage of lactation and performance, complete diet feeding has been found to pose individual under and over-feeding problems too.

It is important to appreciate that large machinery doesn't always fit easily into old buildings and that mixed rations generally demand more diet formulation skills, greater precision in wagon loading and more sophisticated feed storage facilities than forage box feeding.

Fixed cost implications

A mixer wagon typically costs £15,000-£30,000 (£3,000-£15,000 second hand) and, like a forage box, requires a loader. It also demands secure, weatherproof, bird and rodent-free storage for any other feed ingredients to be used.

In addition to the purchase and maintenance of the wagon, more labour is generally required for feeding than with forage boxes and adequate time needs to be set aside for diet formulation.

Parlour feeders are, of course, not required with complete diet feeding regimes, enabling significant economies to be made in both capital and maintenance costs where these are employed.

Mixing systems

A wide variety of mixer wagons and diet feeders are available with a range of different mixing systems and specifications suited to a range of different farm circumstances.

The main mixing systems are:

- **Vertical auger –** with one or two vertical cone shaped augers that mix by moving feed vertically around the auger and dropping it to the outside of the box. These can chop whole bales of straw, hay or silage quickly and effectively, with the degree of chopping controlled via retractable knives or movable wedges around the side of the tub. They are probably the most versatile type of mixer but tend to cost more.
- **Horizontal auger –** with two or four augers that mix by moving feed up and down the length of the box. These mix very thoroughly and do have knives available as options to allow chopping of feed. However, they do not generally handle whole bales well.

- **Paddle auger –** with a variety of paddle arrangements that mix by tumbling the feed around the box. Machines with straight paddles tend not to mix well from end to end but provided feeds are added to the wagon thoughtfully a good mix can be achieved. Some newer models have split paddles which mix more thoroughly. Knives can be included on the paddles to chop bales but most models do not handle whole bales. There is a tendency for wet silage to form into fist-sized balls rather than mix evenly in some models.

The choice of mixing system will largely depend on how much flexibility is required in forage handling – a vertical auger is likely to be preferable if whole bales are to be used on a regular basis whereas any system will be suitable if the forage is predominantly clamp silage.

It is also worth appreciating that different types of machines discharge at different heights, some with just a slide tray from a high discharge point and others with a height adjustable conveyor from a low discharge point.

Depending on a farm's trough design, discharge height could well be more important in wagon suitability than mixer type.

As mixer wagons are large, cumbersome pieces of equipment, the overall length and turning circle need to be considered as well as the height for building access.

Key considerations in buying a mixer wagon include:

- Method of mixing and discharge
- Height of machine in relation to buildings
- Height of discharge in relation to feeding facilities
- Chopping ability
- Size of machine in relation to herd and group size
- Maintenance cost.

Evaluating parlour feeding

The simplest way of providing accurate daily allocations of concentrates to individual cows is undoubtedly during milking via parlour feeders, although on most units this now tends to be combined with other methods of allocation to better spread concentrate feeding across the day.

Key advantages

Apart from being simple, parlour feeding enables cows to be fed individually with considerable accuracy according to performance or need – especially so when linked to computerised yield recording systems.

For parlours without backing gates, parlour feeding has also been found to be valuable in ensuring a smooth flow of cows into the parlour with minimum labour input. In this respect, it can be particularly important in robotic milking systems.

Main limitations

As most parlour feeders can only accurately allocate pelleted feeds, they confine concentrate feeding to proprietary dairy cakes which tends to mean higher concentrate costs.

Parlour feeding can make it more difficult to get cows out of the parlour and may cause dust.

Feeders need regular calibration to ensure accurate feed allocation and many modern systems cannot easily be bodged to continue operating temporarily in the event of component failures.

Fixed cost implications

While parlour feeders undoubtedly save on labour, they can add considerably to the cost of a parlour and require good maintenance for accurate and reliable functioning.

Evaluating midday feeding

Midday feeding of concentrates in a feed passage or trough was originally introduced as a way of spreading the concentrate ration for higher yielding cows beyond twice daily parlour allocations, which were becoming too large for digestive efficiency.

Key advantages

Midday feeding allows concentrate allocations to be more effectively spread over the day as well as enabling concentrates other than dairy cake to be included in the ration to reduce overall feed costs.

It can be extremely economic because it need not involve sophisticated machinery or equipment – just a bag of cake and a man to spread it along the feed passage in the simplest of systems.

Main limitations

Although it does allow a better spread of daily concentrates than parlour feeding alone, midday feeding can still result in a relatively large intake of concentrate feed at one go, reducing the efficiency of rumen functioning **(Section 2)**.

It also offers little or no way of ensuring all cows receive the same concentrate allocation, although if there is sufficient external trough space this should not be a major concern.

The extra labour requirement should not be problematic either if a forage box or wagon is already being used.

Fixed cost implications

Apart from the extra labour, midday feeding carries minimal additional fixed cost implications.

Evaluating out-of-parlour feeding

Out-of-parlour feeding systems offer the ultimate in automated concentrate allocation to individual cows on the basis of electronic collar identification.

Key advantages

Out-of-parlour feeders can be programmed to deliver specific allocations of feed to each cow in small amounts through the day, linked to parlour feeding and yield recording in the most sophisticated computerised systems.

Providing there are sufficient feed stations and they are well-sited within the cow accommodation, they can reliably support large herds with highly individual feeding.

Main limitations

Apart from the substantial capital cost, like parlour feeders the main limitation of out-of-parlour feeders is that they tend only to accurately and reliably dispense pellets, so forcing all concentrate feeding to be based on relatively expensive dairy cake.

Insufficient numbers of feeding stations and poor siting of them in narrow access ways can result in some cows failing to take-up their concentrate allocations as a result of obstruction by other animals.

Fixed cost implications

In addition to the feeding stations themselves, out-of-parlour feeding systems require feed storage bins and conveyors to keep them topped-up and electronic collars for all cows that use them.

Once the system is set-up it can offer valuable labour savings over other ways of feeding concentrates outside the parlour.

However, regular monitoring, maintenance and calibration is essential to ensure smooth and accurate continued operation.

Where some feed is already being provided through a forage box or mixer wagon, of course, the labour saving will be less obvious.

Choosing the right feeding system

The most appropriate feeding system for any herd will depend upon a whole host of considerations, including production objectives, output potential, farm layout, labour availability, cow accommodation, feed storage facilities, diet formulation abilities and overall herd management priorities.

Specific considerations may include:

- **High genetic merit cows –** requiring more than two daily concentrate feeds to exploit their potential
- **High constituent value milk –** requiring access to a variety of feed ingredients to optimise milk constituent precursors like starch and digestible fibre
- **Minimal labour availability –** requiring the simplest possible system and/or a single diet for all animals
- **Limited access buildings –** preventing large feeding machines from being used
- **Poor feed storage facilities –** making the use of a variety of feed ingredients difficult
- **Tenancy arrangements –** limiting the opportunity or incentive to invest.

It is worth bearing in mind that those who treat and manage their cows as individuals are unlikely to effectively operate systems which do not offer some way of feeding to yield **(Section 6)**.

Equally, those who treat and manage their cows as a herd are unlikely to find systems involving anything more than marginal feeding to yield of value **(Section 6)**.

With the exception of new dairy units, there will almost certainly be a number of physical and practical constraints to the feeding system employed.

Any significant change in feeding system must be undertaken following a careful examination of all the specific farm, herd and management constraints as well as financial implications.

Feed stocks

Accurate assessments of the stocks of the various bulk feeds available on-farm are vital for well-planned feeding.

Good measurements of quantity as well as quality of forages enable accurate advanced planning of feed purchasing to ensure sufficient supplies are always on hand and secured at the most favourable prices.

Assessing grazed grass stocks

Measuring the amount of grass available for feeding has always been a challenge, not least because it varies widely with season, weather conditions, soil fertility and pasture management.

Fundamental to accurate assessments of grazed grass availability is regular pasture walking throughout the growing season, with levels of field cover estimated either visually or with a rising plate meter.

Linked with effective sward assessment and budgeting this allows grazing availability to be planned ahead of time and adapted in line with changing conditions to make the most of grazed grass over the entire season.

The Grass+ programme provides practical advice on making the most of grass.

For detailed guidance on pasture assessment see Section 3.

Assessing clamped silage stocks

Silage is the single most important winter feed on most dairy farms, yet in the majority of cases it is also the least accurately assessed.

Establishing the amount of silage in any clamp involves:

- Measuring the volume of clamped material (length x width x height)
- Multiplying this by the density of the silage.

Worksheet 1 provides a pro forma for estimating individual silage stocks.

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Measurements of the length and width of silage clamps are simplified by the fact they are generally constructed from a range of standard materials **(Table 3.1)**.

Table 3.1: Clamped silage dimension guide

Components/material	Typical dimensions
Bays in sheds	15′ (4.5m) or 20′ (6m)
Sleepers	8′6″ (2.6m) long
Plywood sheets	8′ (2.4m) x 4′ (1.2m)
Old concrete silage panels	1 yard (0.9m)
New concrete silage panels	1m or 1.2m

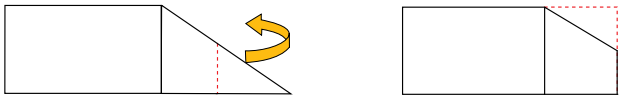
Note: To convert feet to metres divide by 3.3. To convert metres to feet multiply by 3.3

It is important to appreciate that the standard dimensions of sheds are based on their outside measurements, not the internal dimensions needed to accurately assess silage volumes.

Height is usually assessed by measuring down from the top of the clamp wall to the silage surface then subtracting this from the total wall height.

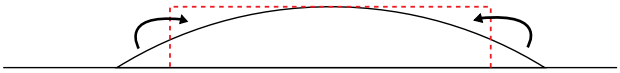
An allowance generally needs to be made for the front ramp – the best way of doing this being to halve the length of the ramp and add it to that of the non-ramped clamp **(Figure 3.1)**.

Figure 3.1: Ramp assessment



Assessing the volume of field, mushroom or Ag-Bag clamps is more difficult given their sloping sides but employing a similar technique to ramp assessments is generally recommended **(Figure 3.2)**.

Figure 3.2: Field clamp assessment



Silage density varies with dry matter, clamp height, degree of consolidation and position in the clamp – deeper material being compressed by the weight of silage above it.

Although accurate density assessments require the weight of material taken from a top-to-bottom clamp core to be related to its volume, a good estimate can be obtained from a standard guide to silage density (Table 3.2).

Table 3.2: Silage density guide (kg/m3)

Silage dry matter (%)	Clamp height (m)			
	2.0	2.5	3.0	4.0
20	780	840	890	950
25	690	730	775	830
30	620	660	690	740
35	570	600	625	670
40+	520	550	570	610

NB: Grass, maize and wholecrop silages are of a similar density for stocks estimation purposes.

The Grass+ programme provides practical advice on making the most of grass.

For detailed guidance on silage stocks assessment see Section 9.

Assessing other feed stocks

As well as size, silage, hay and straw bale weights will vary with crop dry matter, speed of baling, make of baler and shape of bale **(Table 3.3)**.

Table 3.3 Bale weight ready reckoner

Bale type	Typical weight (kg)	Number per tonne
Silage		
Standard round	350-500	2-2.8
Chopped round	350-550	1.8-2.8
Big square (D100)	300-450	2.2-3.3
Hay		
Conventional small	25-30	33-40
Standard round	250-330	3-4
Big square (Heston)	450-550	1.8-2.2
Straw		
Conventional small	18-25	40-52
Standard round	180-250	4-5.5
Big square (Heston)	400-500	2-2.5

The density of other feeds typically varies from around 480kg/m^3 with stockfeed carrots to 700kg/m^3 with barley grain and 1400kg/m^3 with pressed beet pulp **(Table 3.4)**.

The density of moist feeds can vary considerably depending on the degree of consolidation.

Table 3.4 Typical feed densities

Feed	Typical density (kg/m3)
Stock feed vegetables	
Carrots	480
Sugar beet (whole)	556
Potatoes	700
Moist feeds	
Brewers' grains (fresh)	1000
Brewers' grains (ensiled)	1300
Pressed beet pulp	1400
Dry feeds	
Meal	550
Barley grain	700
Wheat grain	770

Monitoring winter feed stocks

Having assessed the stocks of the main bulk feeds available at the start of the winter feeding period, it is essential to monitor their use carefully throughout it to ensure the continued availability of supplies or allow shortfalls to be made-up by judicious feed purchasing in advance.

Additional feed supplies are generally better value for money if purchased out-of-season or, at the very least, not near the end of the winter period when increased demand tends to push up prices (Section 6).

At its simplest level, monitoring can merely involve marking the position of the silage face on the clamp wall at the start of each month with a spray can, enabling a rough assessment to be made of how much longer the clamp will last.

Where a mixer wagon is used, bulk feed consumption can be recorded daily, allowing an accurate assessment of usage against available stocks to be made at the end of each month.

With mushroom clamps or Ag-Bags with no walls it may be necessary to re-assess stocks each month, in which case a computer spreadsheet can be valuable for repeated calculations.

Maintaining a continuous record of silage stocks from regular monitoring throughout the winter is a good discipline and can prove of great value in the future as well as immediate feed planning.

Budgeting winter feed stocks

One of the best ways of assessing the extent to which bulk feeds stocks are sufficient is to prepare a simple budget of herd silage requirements based on likely dry matter intakes **(Example 3.1)**.

Example 3.1: Dairy herd silage requirements

	Stock numbers	Dry matter intake (kg/ head/day)*	Total silage (kg DM/day)	Feeding days **	Total (tonnes)
	A	**B**	**C = A x B**	**D**	**C x D ÷ 1000**
Cows in milk	118	12	1416	182	258
Dry cows	25	9	225	182	41
Heifers 1-2 years	60	8	480	196	94
Heifers 0-1 years	55	4	220	196	43
Silage DM intake					436
Safety margin – assume 10%					43.6
Silage DM required E					480
Silage DM % F					25
Silage fresh weight required = E ÷ F x 100					**1920**

**Typical silage DM intakes are set out in Table 3.5*
***Assumes October to March feeding period for cows and October to mid-April for Heifers.*

Table 3.5: Typical silage DM intakes

	Dry matter intake (kg/ head/day) Average	Dry matter intake (kg/ head/day) Range
Milking cows *	12	10-15
Dry cows	9	8-10
Heifers (1-2 years)	8	7-10
Heifers (0-1 years)	4	2-6

** Animal size, yield level and required growth rate should be taken into account in determining actual intakes, assuming ad-lib access and normal concentrate supplementation.*
N.B. Higher DM intakes are achieved when mixed forages are fed. When grass and maize silage are fed together, for instance, milking cow intakes of up to 13-15kg DM/day should be assumed. Forage DM intakes will also tend to be higher with higher quality silages.

Worksheet 2 provides a pro forma for assessing individual farm silage requirements.

Less silage will, of course, be required if dairy cows are turned out earlier in the spring and grazed later into the autumn.

Once overall silage requirements have been established, these need to be compared with an estimate of silage availability **(Section 5)** to identify likely shortfalls or surpluses.

The accuracy of feed budgeting will further depend on the extent to which losses of forage stocks in storage are accounted for.

The Grass+ programme provides practical advice on making the most of grass.

For detailed guidance on silage budgeting see Section 8.

Sampling feeds

Monitoring the quality of the forage available is at least as important to effective feeding planning as monitoring its quantity.

Knowing the dry matter of the forage, in particular, will enable usage to be more accurately planned on the basis of anticipated intakes, while a good assessment of the available nutrients it contains will ensure the most effective balancing with other feed ingredients in the ration **(Section 7)**.

Silage sampling

Samples of silage taken with a corer prior to opening a clamp provide essential advance information on its feeding value (Section 4).

As the cored sample provided for analysis may be only one millionth of the total weight of silage in the clamp it is vital to ensure it is as representative as possible.

Silage samples should, consequently, be taken from the full depth of the clamp, with several taken along a diagonal line across it.

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Because blunt corers will squeeze moisture out of the sample, accurate dry matter analyses depend on keeping corers sharp – they should slice through silage like a hot knife through butter.

Samples taken from the silage face or big bales on opening are also valuable in assessing nutritive value.

In the case of silage faces it is important to take silage from the full width of the clamp and from all layers in proportion to their presence, ideally from around 6" behind the exposed face.

Samples should not be taken from spoiled areas that are unlikely to be fed to stock.

With wholecrop or maize silages it is also important to ensure a representative balance of grain with leaf and stem.

Mixing the bulk samples together in the same way as diet sampling allows a representative sub-sample to be sent for laboratory analysis.

Diet sampling

While it may be valuable to check the analysis of a diet rather than the ingredients by sampling a mixed ration, this is not generally recommended as reliable sampling is difficult.

The following process will ensure the greatest mixed ration sampling accuracy:

- Take a shovelful of the diet from several points along the feed face
- Mix these together and split into four quarters
- Discard the two opposite quarters and remix the rest
- Continue quartering and remixing until the sample is small enough for despatch.

The same quartering technique must be used for sampling blends or premixes.

Sample identification

Because most laboratories use Near Infrared Reflectance (NIR) scanning to produce a light spectrum which is automatically compared to reference samples to predict the analysis, it is important that the right reference samples are employed in each case.

As well as providing a detailed reference which identifies the sample from others for farm use, a description of the type of silage should always be included on the sample bag – grass, wholecrop, maize, etc. – to guard against the inadvertent use of the wrong reference data.

Factsheet 2 summarises the common terms used in feed analyses.

Feed storage and presentation

While careful attention to detail in storage can limit wasted silage to 1-2% of total stocks, wastage levels of over 20% are common where clamp management is poor.

Most of this wastage results from poor fermentation and preservation due to insufficient exclusion of air which can be prevented by good silage management practice **(Section 5)**.

Effective clamp management to minimise silage losses can save up to £5,000/year or 0.35p/litre for a 200 cow unit with silage valued at £15/ tonne.

Higher dry matter silages are especially vulnerable to wastage due to more restricted fermentations and greater permeability to air – especially if consolidation is less than ideal.

Big bale silages have the additional disadvantages of a relatively high ratio of surface area to volume, a thin covering of wrap which can easily be damaged and considerable attraction to both rodents and birds.

Good hygiene and management is equally important in the farm storage of other feeds (Section 6).

However, adequate the stocks or high the nutritive value of the main feeds, making the most of them fundamentally depends on ensuring cows the greatest possible access.

While the demands of milking and day-to-day cubicle management mean 24-hour feed access is clearly impossible, the best systems ensure feed is available to every cow for 20-22 hours each day.

Failure to provide sufficient access – either because cows are shut away from the feed in the collecting yard, for bedding or scraping or because the feed area is too small to allow the bulk of cows to feed at the same time – can seriously reduce daily feed intakes.

Wherever access is restricted for whatever reason, the smallest, most timid or least mobile animals in the herd – primarily the heifers – will suffer the most.

For the best feed availability it is important to gear access to the 'unluckiest animal' in the herd – the one that spends the longest in the collecting yard, lies down rather than feeding when she returns to the yard through tiredness and finds it difficult to get to the feed area through over-crowding or ill-health.

Where it is proving difficult to ensure even the 'unluckiest cow' in the herd has 20 hours of feed access a day management changes should be considered.

These changes may include reducing the group size in the collecting yard at any time or allowing some groups of cows to remain in their accommodation while other groups are being milked.

Assessing feeding facilities

With the exception of self-feed silage systems and simple ring feeders, the choice of bulk feeding facilities is essentially between troughs or barriers **(Table 3.6)**.

Table 3.6: Key feeding facility considerations

Consideration	Barrier	Trough
Cost	Relatively cheap to construct	Relatively expensive to construct
Capacity	No limit to quantity that can be put out at each feeding	Over-filling leads to wastage so troughs must be big enough
Management	Feed will need to be pushed-up to barrier 2-3 times/day	No attention needed to feed once put out
Cleaning	Easy to clear away uneaten feed	Uneaten feed usually needs to be removed by hand

Feed barrier design

The main function of a feed barrier is to allow cows easy access to their ration while prevent them soiling it.

Barriers can vary in complexity and cost from a simple tensioned wire rope over a short stud wall right up to a galvanised fence incorporating self-locking yolks.

Important factors to consider in feed barrier design include:

- The danger of small cows or heifers getting through the barrier
- The risk of slurry or urine running under the barrier and contaminating the feed
- The ease with which feed can be dispensed and refusals cleared away
- Other uses to which the barrier can be put – such as restraining cows for AI or PD.

In all cases the feed area should be 6" (0.15m) above the cow standing area in order to put the least pressure on the front feet and reduce ulceration risk.

Cows' necks should be checked for hair loss or swellings indicating rubbing on barrier top rails and, if detected, rails should be raised or moved so off-set to the lower wall.

Feed trough design

Troughs need to be large enough to hold the entire feed allocation for a day but small enough for cows to reach all the feed.

Important dimensions to consider in feed trough design include:

- A maximum width of 2'6" (0.75m) for feeding from one side only
- A maximum width of 4'6" (1.35m) if feeding from both sides
- A base 6" (0.15m) above the cow standing area
- A wall a maximum 20" (0.5m) above base of trough
- A top rail or wire rope 3-4' (1-1.2m) above ground in most cases.

Ensuring sufficient feed space

Herd behaviour means that sufficient feed trough or barrier space needs to be provided to allow the bulk of cows in a group to feed at the same time if access is not to be unduly limited.

Rule of thumb

A feed space of 30" (0.75m) per cow needs to be provided if all animals are to have sufficient access simultaneously.

A full space allowance will be essential wherever:

- Cows are to be fed a ration for only a limited period (midday concentrates)
- Selection is possible (with ingredients such as potatoes, carrots or fodder beet)
- Access time is significantly less than 20 hours/cow/day.

Where mixed diets are being fed with an access time approaching 20 hours/cow/day, feed space can safely be reduced to 18" (0.45m) per cow without compromising individual intakes.

Safeguarding feed palatability

While cows must always have sufficient feed in front of them, to ensure the highest possible daily intakes they should never be forced to consume silage-based feeds that are stale or significantly spoiled by having spent too much time exposed to the air.

To achieve the best balance of feed access and palatability:

- Spoiled or mouldy materials should never be fed
- Feed should never be allowed to accumulate for longer than two days
- Uneaten feed should be removed daily if heating up, every second day if not
- Daily feed allowances should be based on a maximum of 5% wastage.

Regular cleaning out of feed areas makes the task less onerous and uneaten feed removed daily is still suitable for beef cattle or youngstock.

With careful allocation and management, the amount of unused feed that needs to be cleared away should be minimal.

Ensuring effective feed mixing

While mixer wagons are a convenient way of providing a thoroughly mixed ration, they are not necessary to provide effective mixed rations in all cases and can cause over-mixing problems if not used correctly.

Provided the ration mix is well-formulated it is not essential for cows to have an identical mix of ingredients in each mouthful.

Indeed, appreciating that ration palatability may be improved by some degree of selection, some top herds avoid mixer wagons so cows can select their own balance of forages.

Such sorting of rations can cause problems where they contain a relatively high proportion of the daily concentrates but where much of the concentrate ration is fed in some other way, mixing of the basal ration does not need to be as thorough.

Over-mixing of feed is recognised as being a more serious problem than under-mixing in many cases.

It can destroy the physical characteristics of the dietary fibre (creating so-called hairy silage) causing it to sink rapidly in the rumen rather than becoming incorporated in the surface mat **(Section 2)**.

In turn, this can reduce cudding and allow the rumen pH to fall to a level which reduces overall diet and fibre digestibility.

Fore-end loader bucket mixing of feed ingredients is proving accurate enough to deliver yields of over 10,000 litres on some farms where partial mixed rations are fed.

For the most effective mixing of TMR rations:

- Load dry concentrates first followed by forages which need chopping and finally forages which require no additional processing
- Mix for the minimum time required to achieve a diet with no lumps of individual feeds
- Avoid visible shredding of forages
- Do not leave the mixer running if other tasks need attending to while feeding.

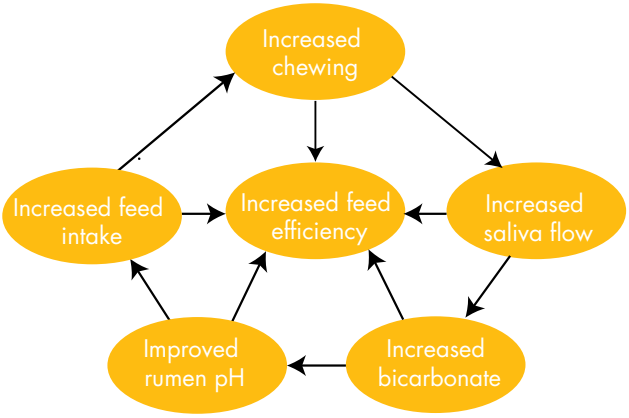
Optimising forage chop length

More powerful forage harvesters have allowed forages to be chopped increasingly finely in an effort to improve clamp consolidation.

Many farms could be in danger of pushing chop lengths too low, with maize silage in particular chopped down to 6mm being linked to digestive problems in some cases.

Forage chop length has a direct effect on the chewing time of a diet – longer chopped materials stimulating greater chewing **(Figure 3.3)**.

Figure 3.3: Chewing interactions



Longer chopped forages also significantly improve the fibre mat at the top of the rumen for greater intakes, more effective carbohydrate utilisation and better digestive health **(Section 2)**.

While the rumen operates most efficiently at a pH of between 6.0 and 6.5, most high yielding UK diets depress this to below 6.0 for much of the day and quite often to 5.5 for part of it.

These lower pH's slow down the fibre-digesting microbes to the extent that Sub-Acute Rumen Acidosis (SARA) can occur, causing a shift in metabolic pathways which has been linked with an increased incidence of displaced abomasums and laminitis as well as decreased digestive efficiency.

Short chopped maize silage is often associated with increased problems from displaced abomasums.

Factsheet 1 provides practical guidance on metabolic disorders.

A worldwide review of silage chop length and its metabolic effects has shown a direct relationship between chewing time and butterfats.

While the evidence of many trials is contradictory, with chop length now easily adjustable from 6mm up to 44mm in modern forage harvesters, a number of general guidelines can be established.

For maize silage:

- Avoid chopping to below 15mm for all diets
- If the diet starch content is over 20% and its breakdown rate is likely to be fast (where rolled cereals are included), there is probably no advantage in a chop length of more than 22mm
- If the diet starch content is over 20% and its breakdown is likely to be slow (with wet crimped grain, caustic or urea treated wheat), a chop length over 30mm is likely to improve rumen conditions
- Ensure the grain processor is set to damage each grain.

For grass silage:

- With dry matters of up to 30%, the longer the chop the better (up to 40mm)
- On drier silages the chop can be reduced to 25mm to achieve an effective consolidation
- With dry matters of over 40% it is safer to make baled silage or haylage as wastage at feed-out can be high
- Ensure a chop length of 25-40mm for self-feeding.

Since longer chopped forage will be harder to consolidate in the clamp, it is advisable to invest the diesel saved by working the forager less hard in increased clamp rolling.

Consolidation will be improved by:

- Filling the clamp in long thin layers rather than with a steep wedge
- Keeping tractors moving on top of the silage all the time
- Reducing the chop length for the final 0.5m of silage in the pit.

Chop length testing

To check if the current diet is likely to form an adequate fibre mat in the rumen, drop a representative sample into a clear tub or bucket of water. While much of the material will settle to the bottom, around 15-20% should float.

To confirm the rumen is actually working well and chewing behaviour is correct, wash a sample of dung through an ordinary garden sieve. The dung should contain no particles larger than a 5p coin **(Figure 3.4)**.

Figure 3.4: Dung sieving

A high proportion of undigested grain and numerous large particles in the dung indicates less than ideal rumen functioning.

D.

Feed conversion efficiency (FCE)

A crude measure of how much of the total feed going into the cow is coming out as milk can be made by dividing daily milk production by daily feed dry matter intake.

$$\text{Feed conversion efficiency (litres/kg DM)} = \frac{\text{milk produced (litres)}}{\text{feed consumed (kg DM)}}$$

While gathering data on total feed consumption can be difficult for cows at grass, it is far easier for herds on winter rations – especially where good records are kept.

It is important to appreciate that all feeds used for the dairy herd, including dry cows, must be included in FCE estimates but not any youngstock feed.

Evidence from 90 UK herds monitored as part of a Keenan study indicates a wide range in the efficiency with which feed is converted into milk and a marked difference in margin per litre as a result **(Figure 3.5)**.

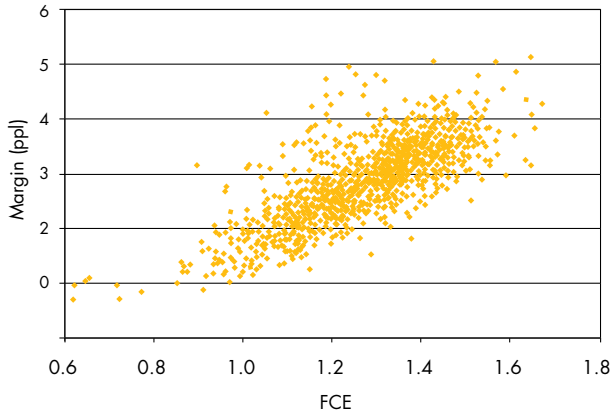
Feed conversion efficiency improves with increasing diet energy content and milk output since the proportion of the overall energy supply required for maintenance decreases.

For this reason high yielding herds on high concentrate inputs tend to have higher feed efficiencies.

It is interesting to note, though, that higher feed efficiencies are not always associated with higher margins, many herds achieve high margins with relatively average efficiencies.

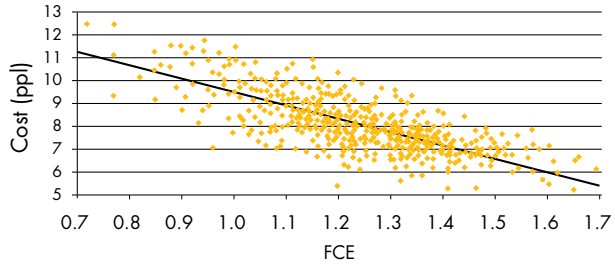
In the same way, while feed costs generally fall as feed efficiency increases, even at an FCE of 1.2 feed costs have been found to vary from 6p/litre to almost 10p/litre **(Figure 3.6)**.

Figure 3.5: Feed conversion efficiency and dairy margins



Source: Prof David Colman; Richard Keenan SAB (Scientific Advisory Board) Advance & Thrive publication; Feb 2007.

Figure 3.6: Feed conversion efficiency and feed cost



Source: Prof David Colman; Richard Keenan SAB (Scientific Advisory Board) Advance & Thrive publication; Feb 2007.

Improving feed conversion efficiency

Improving feed conversion efficiency from 1.2 litres/kg DM to 1.3 litres/kg DM can increase the milk production of an 8000 litre cow by 8.5% or reduce the amount of feed needed to support this yield by over 1kg DM per day.

Factors to consider when improving feed conversion efficiency include:

- Forage energy content
- Feed chop length
- Forage intake
- Feed access space
- Feed access time
- Rumen conditions (avoiding sub-clinical acidosis)
- Concentrate type
- Concentrate level
- Length of dry period
- Cow genetic potential.