

Section 3

Health and Safety on Dairy Farms

by John McNamara



Introduction

Accidents and illness related to farming are not inevitable and can be prevented through planning and careful work organisation.

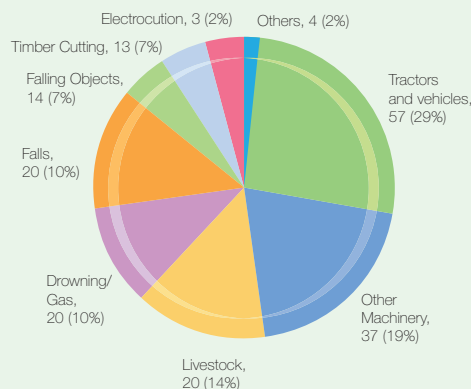
- ① What are the most common serious accidents on dairy farms?
- ② How can dairy farmers protect their health?
- ③ What legal obligations do farmers have?

Health and Safety on Dairy Farms

1 What are the most common serious accidents on dairy farms?

Fatal accidents on Irish farms are linked to:

- Tractors and vehicles (29%) (more than one in four deaths on farms).
- Other machinery (19%) (one in five).
- Livestock (14%) (one in seven).
- Drowning in slurry or water and slurry gassing (10%).
- Falls (10%). • Falling objects or collapse of buildings (7%).
- Timber cutting (7%). • Electrocutation (2%).



Key Fact

Farm machinery causes nearly half of all deaths on farms. Eight key areas account for 95% of farm deaths.(see pie chart). These areas are identifiable and accordingly are preventable.

2 How can dairy farmers protect their health?

There is a belief that farming is a 'healthy occupation' because it is mostly an outdoor occupation. In reality farmers have a poor health profile when compared to other occupations.

How to:

Prevent ill health:

- Have regular health checks (at least once a year);
- Do health promoting activities (physical exercise, diet, weight and alcohol consumption control).
- Manage exposure to sun by wearing sun protection.
- Manage stress (through better work organisation, relaxation etc).

Key Fact

The risk of injury is higher if you suffer from poor health and stress.

Musculo-skeletal disorders (MSDs) are the greatest cause of farmer occupational ill health, with more than half of farmers (56%) affected annually.

The main body parts affected are:

- Back (35%),
- Neck/shoulder (8%),
- Knee (15%),
- Hand-elbow-wrist (8%),
- Hip (12%),
- Ankle/foot (8%)

Over eighty percent (82%) of MSD injuries caused more than 3 work days lost with 24% causing more than 30 days lost. The key preventative approaches are to avoid heavy lifting, over-reaching and twisting one's spine. Tidy farmyards greatly reduce the risk of trips or falls while modern livestock handling facilities reduce the risk of MSD and all injuries. Infections from animals and contaminated material and inhalation of dusts and spores are also potential causes of ill health.

3 What legal obligations do farmers have?

Key Fact

Code of practice risk assessment.

Farmers must, by law, complete and implement a risk assessment. A Farm Safety Code of Practice (including a risk assessment document) has been issued to all farmers by the Health and Safety Authority (<http://www.hsa.ie>). The risk assessment document fulfils the legal requirement to complete a safety statement for farms with three or fewer employees.

A book of Safe System of Work Plans is included in the farm safety code of practice pack. The purpose of this is to provide a quick and easy means of systematically revising your risk assessment regularly.

The risk assessment can also be completed and revised electronically by logging onto: <http://www.farmsafely.com>.

A server at this site stores data and operates the system, and is totally confidential.

Health and safety training.

Teagasc regularly offer half-day courses on how to complete the farm safety risk assessment document.

Section 3

Securing a Land Base

by Brendan Horan



Introduction

Location within the country is generally not a limitation to pasture production. It is clear, however, that on wetter soils the ability to avoid pasture damage and achieve high pasture utilisation will require additional capital investment in grazing infrastructure.

- ① What are the main considerations in securing a land base?
- ② How do I decide whether to rent or lease?
- ③ What are the key risks and how do I manage them?

Securing a Land Base

① What are the main considerations in securing a land base?

Securing a suitable land base demands both diligent research by the farmer and the best professional advice when purchasing/leasing a dairy farm.

Checklist



When purchasing/leasing a dairy farm

Size/shape

- Minimum of 40 hectares with potential for further expansion in future.
- One block, preferably square.
- No public roads crossing the farm.
- Low intensity of ditches is preferable.
- Easy access and useful infrastructure (buildings, road network, drainage) already in place.
- Free-draining soils offer greater trafficability for profitable dairy production over an extended grazing season.

Farming history

- Soil is a complex resource that underpins farm performance.
- What are the major soil types?
- Are there recent soil test analyses for the property?
- What type of farming has taken place?
- What is the fertilizer history of the farm; current soil fertility?
- What is the drainage status of the property?
- Are there areas prone to flooding?

② How do I decide whether to rent or lease?

Advantages of ownership

- Security of tenure - increased certainty for longer term farm business planning.
- Potential for capital appreciation and capital/infrastructure investment to return increased asset value.

Disadvantages of ownership

- Significant upfront cost.
- Potential for stamp duty exposure.
- Capability of dairy enterprise to repay large land purchase commitments is low.
- Places significant debt burden and cash flow restrictions on the farm enterprise.

Advantages of leasing

- Start-up costs are reduced significantly so investment is prioritised to productive areas (stock/infrastructure).
- There is much more land available to lease than to buy.
- Land development investment costs and risks can be shared with the landowners.
- Lease price can be index-linked to the market price of product.
- Significant tax benefits for both tenant and lessor (various rules).

Disadvantages of leasing

- No potential for capital gain through increases in land value.
- Owners are primary beneficiaries of any capital development investments.
- Short-term leases are unstable and add risk to the farm business.
- Leasing requires excellent relationship management with owners.

3 What are the key risks and how do I manage them?

The key risks to consider in securing land for dairying include:

- Do not buy land 'at any cost', the target price guidelines are outlined below and are based on the pasture productivity of the farm.
- Avoid land with a potentially dramatically shortened grazing season e.g. on a peat bog or flood-plain.
- Ensure adequate availability of water.
- Ensure that you can gain access to the land in good time to begin conversion.
- Ensure lands are unrestricted by historical compliance requirements e.g. REPS.
- Ensure longstanding customary access rights by others are not detrimental to the efficient operation of a pasture-based dairy farm.

In addition, the following risks apply to rented/leased lands where maintaining good relations with the land owner is crucial:

- Only work with a reputable land owner who is both profit-focused and open to the adoption of new farming practices.
- Agree on the outline of the planned farming system in advance including a pre-agreed contract of infrastructure investment.

You may consider having a property inspected by a farm management consultant or other professional experienced in property evaluation. Every effort should also be made to talk to local residents about past management practices on the property (e.g. fertilizer use, weed problems, etc.).

Key Performance Indicators



- Farm with potential for growth of 12–15t DM/ha/yr.
- Lease and purchase price decisions should be based on grass growth potential and reasonable estimates for longer term market price of products produced, while capital gains should not be anticipated.
- Lease charges of <€0.40/kg milk solids/yr for more than twelve years.
- Purchase price of €5,000–€35,000 /ha (depending on pasture production capability of 5–18 tonnes DM/ha/yr).





Section 3

Soil Fertility and Nutrient Management

by Stan Lalor, James Humphreys, Mark Plunkett



- ① How do I find out and manage my farm's nutrient status?
- ② How do I use the information supplied by soil analysis?
- ③ How important is lime?
- ④ How much nitrogen should I be using?
- ⑤ How do I get the most from clover?
- ⑥ How much sulphur should I be using?
- ⑦ How much phosphorus and potassium should I be using?
- ⑧ How much fertiliser is in slurry?
- ⑨ How much fertiliser will organic fertilisers replace?
- ⑩ How important is the choice of fertiliser compound?

Soil Fertility and Nutrient Management

Soil fertility management targets

1. Have soil analysis results for the whole farm. Soil tests should be repeated every 3-5 years (four years if applying for a Nitrates Derogation). To spread costs, soil test a portion of the farm every year.
2. Aim to have the whole farm at between pH 6.0 and 6.5 limestone should be spread as recommended. Where soil magnesium (Mg) levels are low, dolomitic limestone (contains Mg) can be used to both increase pH and supply Mg.
3. Manage slurry and soiled water to maximise the fertiliser value.
4. Aim to have all fields in Index 3 for phosphorus (P) and potassium (K). Build up soils in Index 1 and 2. Allow Index 4 soils to fall to Index 3.
5. Apply nutrients in the proper balance. Supply enough of each nutrient without oversupplying individual nutrients. Deciding where slurry should be spread, and choosing the correct compound fertiliser is critical.

1 How do I find out and manage my farm's nutrient status?

Find out the nutrient status of the soils on the farm by taking soil samples for analysis. The soil sample results will provide information on areas of the farm that have low, medium or high fertility. You will need this information to accurately plan fertiliser and slurry applications.

What does soil analysis do?

- A soil test can be used to obtain information on background soil fertility levels.
- Not all of the total nutrients in the soil are available to plant roots for uptake.
- Soil analysis methods are designed to measure and predict the amount of nutrients in the soil that are available to plants.

What nutrients can be tested for?

- Standard soil testing includes soil pH, lime requirement, P and K.
- Additional tests are also available for Mg and micronutrients.
- There is no suitable soil test for nitrogen (N) or sulphur (S).
- Analysis of herbage can provide additional information on the nutrient status of the sward. Herbage analysis is more reliable than soil analysis for S, and for trace elements such as copper, molybdenum and selenium.

How to

Take soil samples

- Soil test results are of little value if the soil sample taken is not representative of the field or area being sampled.
- Divide the farm into fields or areas that can be easily managed separately when applying fertilisers. As a guide, take one sample to represent between two and four hectares. If the area is very uniform a sample may be taken to represent a larger area. For farms with a Nitrates Derogation, the requirement is that the average soil sample area is not greater than five hectares.
- Take separate samples from areas that are different in soil type, previous cropping history, slope, drainage or persistent poor yields.



Key Risks



- Do not sample a field until three to six months after the last application of P and K. Where lime has been applied allow a time lag of up to two years before sampling for soil pH and lime requirements.
- Sampling depth: ensure that soil is sampled to 10cm. Shallower sampling can give inaccurate results, particularly for P. Where permanent pasture is ploughed for reseeded, re-sample the field as soon as possible after ploughing as the soil ploughed up to the surface may have a different nutrient status to the soil ploughed down.
- Avoid sampling under extreme soil conditions e.g. waterlogged or very dry soils. Sample at the same time of the year to aid comparisons of soil sample results.
- When taking a sample, avoid walking in the lines of fertiliser and lime spreading operations on the field.
- Avoid any unusual spots such as old fences, ditches, drinking troughs, dung or urine patches or where fertiliser /manures or lime have been heaped or spilled in the past.

② How do I use the information supplied by soil analysis?

Soil Index

- Nutrient advice is based on a simple soil index system.
- Fields or areas can be categorised on a soil index scale of 1 to 4 for each nutrient (P, K, most micronutrients) based on soil test results.
- The index system is based on the expected response to fertilisers.
- There is no index system for N or S in grassland due to the lack to date of a reliable soil test.

Table 1. Index system for P, K and Mg in grassland soils.

Soil Index	Description	Response to fertilisers	Soil test result range for each Index (mg/L)		
			P	K	Mg
1	Very low	Definite	0–3.0	0–50	0–25
2	Low	Likely	3.1–5.0	51–100	26–50
3	Medium	Unlikely	5.1–8.0	101–150	51–100
4	High	None	≥8.1	≥151	≥101

- Nutrient advice is based on a target of maintaining soils in Index 3. At this index, soils have a bank of available nutrients to deliver nutrients to the grass. The objective is to replace the nutrients that are being removed in products such as silage, milk or meat.
- Index 1 and 2 soils have low nutrient levels, and require additional inputs in order to support grass growth and increase the soil fertility to the target Index 3.
- Soils in Index 4 have high nutrient levels and will support the grass sward without additional fertilisers.

How to

Maintain soil fertility when in Index 3



- The approach to maintaining soil fertility is to replace the nutrients removed in product.
- For example, one kg of P is removed from the farm in approximately 1,000 litres of milk or in 100 kg of animal liveweight.
- Nutrient advice rates are based on replacing the nutrient off-take.

How to

Build soil fertility when in Index 1 and 2



- Additional nutrients above those required to replace nutrients removed in products are required to build soil fertility from low Index 1 and 2 levels up to Index 3.
- The length of time required for soil nutrient levels to increase or decrease will depend on the soil type, but can take a number of years. Therefore, apply additional nutrients for soil build up for a number of years until soil analysis indicates increased fertility.

Soil Fertility and Nutrient Management

3 How important is lime?

Soil pH and lime application

- Acidity in soils is measured by soil pH. Acid soils have low pH (<7) and alkali soils have high pH (>7).
- The optimum pH for productivity, biological activity and nutrient availability in grassland soils is 6.3.
- The pH of acid soils can be increased by applying lime.
- The lime requirement of a soil is determined by soil analysis.
- The lime requirement is calculated as the lime required to increase the soil pH to 6.5.
- Lime does not need to be applied every year. Apply enough lime once every 3-5 years to reach a pH of 6.5. This will maintain the soil pH close to the optimum for a number of years.

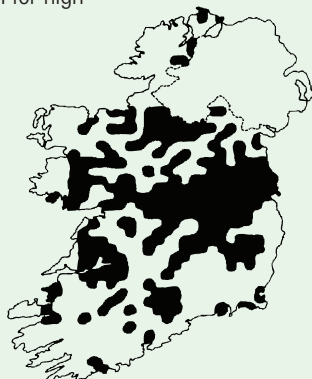
Spreading lime – How much?

- The rate of application is determined by soil analysis. The lime requirement is shown on the analysis report.
- Don't apply more than 7.5t/ha (3t/acre) in a single application.
- Where lime requirements are greater than 7.5t/ha, apply 7.5t/ha initially, and then apply the remainder after two years.
- In soils that are at risk of having high molybdenum (Mo) status (see Figure 1), reduce the lime requirement by 5t/ha to avoid potential problems with copper (Cu) deficiency. (Mo can make Cu unavailable to animals). The optimum soil pH for high Mo soils is 6.2.

Molybdenum

Areas where elevated values have been found

Figure 1. Indicative map showing distribution of potentially high Mo soils in Ireland



Checklist



Lime

Spreading lime – When?

- Lime can be spread all year round.
- Apply to bare swards if possible. Lime should not be applied to swards close to silage harvesting.
- Incorporation of lime into the seed bed is recommended for reseeding.
- Avoid applying urea fertiliser or slurry as nitrogen (N) fertilisers for 3-6 months after lime application, as lime can increase gaseous N losses from urea and slurry.

Spreading lime – How often?

- Conventional ground limestone should be applied as per the lime requirements after soil testing.
- The lime requirement is a once off application, and does not need to be repeated annually.

Spreading lime – Which lime to use?

- Calcium (Ca)-based ground limestone is most common.
- Dolomitic limestone contains both Ca and magnesium (Mg) and is recommended for soils that have low Mg levels.
- Granulated lime products can be applied at lower rates on a 'little and often' basis for soil pH maintenance. The rate applied will depend on the product, but usually lower rates can be used as the material is ground finer than conventional ground limestone and will therefore react faster in the soil. These products offer convenience as they can be applied using standard fertiliser spreaders. However, they are usually more expensive than conventional limestone applied on a 3-5 year cycle, particularly on soils with high lime requirements.



4 How much nitrogen should I be using?

Nitrogen (N) requirements for pasture and silage

- There is no reliable soil test currently available for N. Therefore, there is no soil Index system for N in grassland.
- Recommendations are based on average soil fertility levels.

Table 1. Maximum permissible rates of fertiliser N for grassland in different counties

Rates of fertiliser N are shown as kg/ha (units/acre in brackets)

Stocking rate (kg per ha of organic N)	Carlow Cork	Clare Galway	Donegal Leitrim	Cavan Monaghan
	Dublin	Kerry		
	Kildare	Limerick		
	Kilkenny	Longford		
	Laois	Louth		
	Offaly	Mayo		
	Tipperary	Meath		
	Waterford	Roscommon		
	Wexford	Sligo		
	Wicklow	Westmeath		

≤ 170	205 (166)	202 (164)	200 (162)	197 (160)
171 – 210	280 (227)	277 (224)	274 (222)	270 (219)
211 – 250	248 (201)	244 (198)	241 (195)	237 (192)

- Total N application on the farm and time of application must be compliant with nitrates regulations (Table 1).
- Matching N fertiliser use “to stocking density” or “to stocking rate” on the farm at different times of the year avoids excessive use.
- Applying N fertiliser ‘little and often’ during the growing season gives most efficient response in terms of grass growth.

How to



Calculate stocking rates

For comparison and cross checking with nitrates regulations, it is useful to calculate stocking rate on the grassland area based on organic N excretion per hectare.

- Table 2 provides a template for how to do this for your farm
- Firstly, estimate the average numbers of each type of cattle that your have on the farm over the year (A).
- Then, multiply the number of animals by the organic N excretion per animal per year (B).
- Then, add up the total organic N excreted by all the animals (C).
- Then, divide the total N excretion (C) by the area of grass land on the farm (D) to give the grassland stocking density in kg/ha.
- Other animals (e.g. sheep, horses or dairy cows) also need to be included if they are present on the farm

Table 2. Template for calculating stocking rate on the grassland area on a beef farm

Animal Type	Average no. of animals on the farm per year	Excretion of organic N per animal per year (kg/hd/yr) Total Organic	Total Organic N excretion per year (kg/yr)
	(A)	(B)	(= A x B)
Cow		65	
Animals < 1 yr old		24	
Animals 1-2 yr old		57	
Animals > 2 yr old		65	
Total Organic N Excreted (kg)		(C)	
Total Grassland Area (ha)		(D)	
Stocking rate (kg/ha)		(= C ÷ D)	

Soil Fertility and Nutrient Management

Table 3: N fertiliser advice for grazing

Rates and timing of N fertiliser applications for swards grazed by cattle at various stocking rates. Rates of fertiliser N are shown as kg/ha (units/acre)

Stocking rate (kg/ha organic N)	Jan/ Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total N (u/ac.)
90 (or less)			25 (20)			15 (12)			40 (32)
91-110		15 (12)	30 (24)	15 (12)		15 (12)			75 (60)
111-130		28 (22)	35 (28)	25 (20)		23 (18)			111(89)
131-140		28 (22)	35 (28)	25 (20)		17 (14)	17 (14)		122 (98)
141-150		29 (23)	44 (35)	26 (20)		26 (20)	17 (14)		141 (113)
151-160		29 (23)	44 (35)	35 (28)		35 (28)	26 (20)		168 (134)
161-170		34 (27)	53 (42)	42 (33)		42 (33)	31 (25)		201 (161)
171-180	32 (25)	32 (25)	48 (39)	38 (31)		38 (31)	28 (23)		216 (173)
181-190	31 (25)	41 (32)	54 (43)	37 (30)		37 (30)	37 (30)		237 (190)
191-200	30 (24)	53 (43)	53 (43)	37 (30)	37 (30)	37 (30)	27 (22)		275 (220)
201-210	31 (25)	54 (43)	54 (43)	56 (45)	37 (30)	37 (30)	37 (30)	37 (30)	306 (245)
≥ 210	32 (25)	49 (39)	55 (44)	38 (31)	38 (31)	38 (31)	28 (23)		279

(223)

The rates shown above refer to recommended application of available fertiliser. Chemical fertiliser rates should be calculated by deducting the available N contained in organic fertiliser applications from the rates shown in the table above. Stocking rate is calculated as the total annual nitrogen (kg) excreted by grazing livestock averaged over the net grassland area (grazing and silage area). Stocking rate refers to grassland area only.

Rates shown above refer to grazed swards only, and are not suitable as a guideline value of the N requirement for the entire grassland area. The N requirement for the entire grassland area will depend on the proportions of the area that are grazed, or cut as silage or hay. Lower rates of N should be used where clover is present in the sward. A good clover sward will reduce N requirements. Only fertilize to the stock-carrying capacity of the soil. This often varies within the farm.

Chemical or organic fertilisers cannot be applied during periods when application is prohibited by nitrates regulations. At stocking rates above 210 kg/ha N, N advice is constrained by nitrates regulations.

Table 4. N fertiliser advice for cut swards. Rates of fertiliser N are shown as kg/ha (units/acre in brackets)

Crop	N application rate
Silage: First Cut	125 (100)
Silage: Second or subsequent cuts	100 (80)
Hay	65-80 (52-64)

Rates shown above refer to application of available N. Chemical fertiliser rates should be calculated by deducting the available N contained in organic fertiliser applications from the rates shown in the table above.

If N is applied for early grazing, assume that 20% of this remains available for first cut silage.

An extra 25 kg/ha may be used where necessary for establishment of a good ryegrass sward if pasture is less than 4 years old, provided that the maximum N allowed within the nitrates regulations is complied with.

Where silage fields were grazed rather than cut in the previous year, apply 100 kg/ha for first cut, and 85 kg/ha for second and subsequent cuts. When more than 2 cuts are taken there is a danger that the allowance in the nitrates regulations will be exceeded.

Less N is advised for hay crops when there is a high risk of crop loss due to high rainfall.

Checklist



Controlling N fertiliser costs

1. Apply 28 kg/ha for the first application in spring (mid-January to early March, depending on location and soil type etc.). Urea is more cost-effective than CAN in spring.
2. Replace the first application of N fertiliser by an application of slurry. Aim to apply slurry on two-thirds of the farm in late January, allowing 4-6 weeks between application and the expected date of grazing. Umbilical systems can reduce the machinery compaction when applying slurry. Bandspreading/trailing shoe/injection systems reduce herbage contamination.
3. Apply the second application of N fertiliser four to six weeks after the first, usually some time during March. The third application should roughly coincide with closing up for silage in April. Match N fertiliser applications to stocking rates on the farm at various times of the year.
4. Replace some of the N fertiliser for first-cut silage with slurry in late March. The slurry should be applied at least six weeks before the expected silage harvest date. Allow approximately one week between slurry and N fertiliser application.
5. Make as much silage as possible as first-cut. First, work out how much silage is required. Second, depending on requirements, aim to maximise stocking rate on the grazing area during April and May. This makes as large an area as possible available for first-cut silage. There is a very high response to N fertiliser during April and May. First-cut silage yields will be at least 25% higher than second-cut for lower input costs.
6. Dilute slurry with dirty water to increase the efficiency of utilization of N in the slurry applied to silage stubble after first-cut silage. Dilution should only be carried out where it is a convenient way to manage dirty water and at times of the year outside of the closed period for slurry application. Diluting slurry will increase the cost of application as it will increase the volume of slurry to be spread

7. Avoid making second-cut silage if possible. Having the whole farm available for grazing from June onwards lowers the requirement for N fertiliser.

Apply N fertiliser in line with stocking rate and pasture cover. If pasture cover is above target, lower the amount or increase the interval between applications of N fertiliser. Do not skip applications.

8. Plan to build pasture cover by extending the rotation from late July to mid August. N fertiliser applied in July and August has a greater effect on grass supply in November and in the following spring than applications later in the autumn.
9. Blanket spreading of N fertiliser simplifies record-keeping, and this helps to keep N fertiliser use on the farm under control.
10. White clover has the potential to reduce the amount of N fertiliser used on the majority of grassland farms.

5 How do I get the most from clover?

Over-sowing clover to reduce N costs

- White clover has the ability to manufacture 150 kg/ha of plant available N in the soil.
- Over-sowing is a low-cost method of introducing and maintaining clover in swards.

Checklist



Eight steps for successful over-sowing of clover into permanent grassland

1. Soil fertility: Soil pH should be between 6.0 and 6.5, and soil P and K levels should be at Index 3.
2. Open swards: Over-sowing will only work where there is a reasonably open sward as the clover seed has to come in contact with the soil. Reseeding is a better option for old dense swards or swards heavily infested with weeds.

Soil Fertility and Nutrient Management

3. Weed control: Eliminate docks and other broad-leaved weeds with a suitable herbicide before over-sowing. Once the clover is established, the range of herbicides that can be used is greatly restricted.
4. Sowing date: Moist soil conditions during and after over-sowing are crucial. On heavy wet soils the ideal time is after harvest of first-cut silage in late May or early June. On light drier soils it is better to over-sow earlier in May; after grazing or a harvest of baled silage. Tight grazing before and afterwards is important to ensure success. Over-sowing during the late summer and autumn is not recommended.
5. Sowing rate: Apply clover seed with 0:7:30 or similar fertiliser at a rate of one and a quarter bags per hectare. Apply 5 kg/ha of a mixture of two clover varieties on the recommended list. Pelleted or unpelleted seed can be used with equal success.
6. Broadcasting the mixture: Mix the clover seed with the fertiliser in the field. This will avoid the fertiliser and seed separating out while driving to the field. While pouring in the fertiliser, mix in the seed to ensure an even mixture of fertiliser and seed. Up to five hectares can be done at one time.
7. Post-sowing management: Apply slurry after over-sowing. Apply no N fertiliser for the remainder of the year, as N fertiliser will drive on the grass to the detriment of the clover seedlings. Tight grazing is important. Do not allow covers to get too high (>800 to 1,000kg DM/ha) and graze out to low residuals (<4cm).
8. Over-winter management: Graze tightly before closing up for the winter and do not leave a heavy cover to build up over the winter. Graze tightly again in spring to allow light to penetrate down to the clover stolons. More stolon growth in spring increases the clover content and productivity of swards later in the growing season.

⑥ How much sulphur should I be using?

Sulphur

- Sulphur (S) is an important nutrient for grassland, and is closely associated with N uptake and efficiency.
- There is currently no soil test or soil Index system for S.

- Herbage analysis is the best predictor of S deficiency.
- Lighter soils with low organic matter contents are generally more prone to S deficiency.

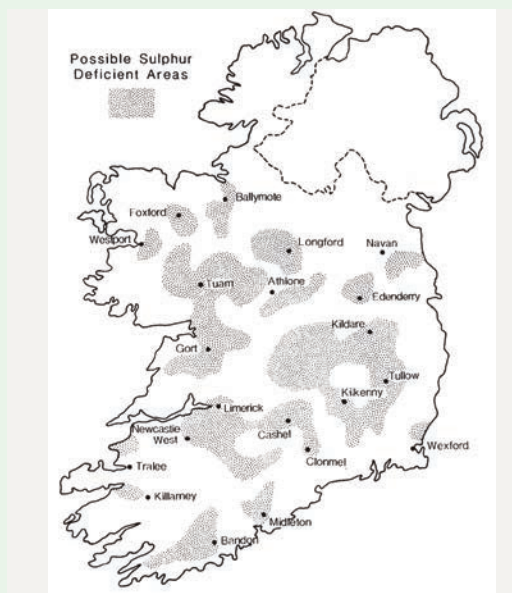


Figure 1. Map of Ireland showing sulphur deficient areas of the country. Shaded areas indicate where response to S fertiliser is more likely

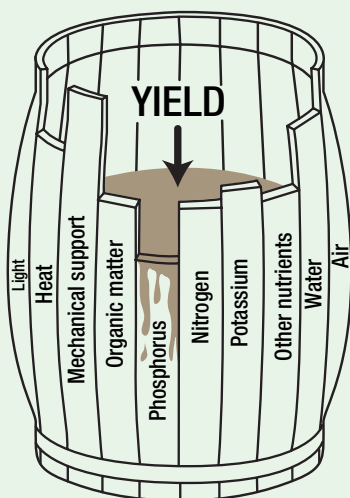
S fertiliser advice

- The response to S fertiliser increases as the rate of N fertiliser increases.
- On S deficient soils, apply 20kg /ha (16 units/acre) per year for grazed swards.
- For silage swards on S deficient soils, apply 20kg /ha (16 units/acre) of S per cut.
- Avoid S application to soils not deficient in S, as excess S may affect the trace element nutrition of plants and animals.
- S can be applied by using any of a number of straight or compound fertilisers that contain S.
- Apply S fertilisers in early spring for grazed and silage swards as recommended

7 How much phosphorus and potassium should I be using?

Phosphorus (P) and potassium (K) requirements for pasture and silage

- P and K can be applied either as a single annual application, or little and often through the year.
- P and K application rates should be based on the soil test and on the usage of the field.
- Requirements for silage are substantially higher than for grazing, particularly for K.
- The target soil Index is Index 3. For Index 3 soils replace the P and K removed in product (milk and meat) or as silage.
- P and K requirements increase with increasing stocking rate and production.
- Index 1 and 2 soils require additional P and K to allow soil levels to increase to Index 3.
- Index 4 soils have sufficient P and K to meet the grass requirements, and should receive no fertiliser until the soil test P and K declines to Index 3.
- Total P application on the farm and time of application must be compliant with nitrates regulations.
- There are no restrictions on K application rates and timings.



Checklist



Sources of Phosphorus (P)

- P in slurry generated by livestock on the farm.
- P in concentrates fed to livestock.
- P in manufactured fertiliser.
- P in any organic manures (e.g. pig and poultry slurry, dairy sludge etc.) imported onto the farm.

A number of steps need to be taken to interpret available P in terms of the amount of fertiliser P that can be applied on the farm:

1. Determine the soil P status through soil testing. This is compulsory on derogation farms. Where there are no soil test results available on non-derogation farms, it is assumed that the soils on the farm are in soil P Index 3.
2. Deduct the P in slurry generated by farm livestock and stored over the winter. Manure applied to soil P index 1 or 2 is reduced to 50% P availability (for example cattle slurry P reduced from 0.8 to 0.4kg P/m³). This 'stored slurry' is a notional quantity based on the statutory requirement for slurry storage on the farm (16, 18, 20 and 22 weeks depending on location). Target organic manure applications to soils with P index 1 or 2 to avail of reduced P availability to 50%.
3. Deduct the P in concentrate feed used on the farm. Discount the first 300kg of concentrate P per 85 kg Org N/ha based on the previous calendar year. The default assumption is that concentrate feed contains 5kg of P per tonne. Alternative values can be used for straight feeds or using feed labels for compound rations. Examples of the quantities of P in concentrate where 0.5, 1.0 and 2.0t of concentrate are fed per ha are presented at the bottom of the table 1 (make adjustment for discounted concentrate P as above).
4. Where reseeding takes place on the farm, an additional 15kg/ha of P may be applied over normal requirements, provided the reseeded area is in Index 1, 2 or 3. No additional P is allowed for reseeding on soils in P Index 4.

Soil Fertility and Nutrient Management

Example:

Take a farm in Zone A stocked between 130 and 170 kg/ha of organic N and where soils are tested in Index 3. No organic manure is imported onto the farm in this example. The amount of fertiliser P that this farmer can apply assuming that no concentrate is being fed on the farm is approximately 13.0kg/ha of P (10.4 units of fertiliser P per acre).

If 1 tonne of concentrate is fed per ha on the farm, deduct the first 600kg (300 per LU) based on the previous year's concentrate usage. The farmer is allowed to apply 11.0 kg/ha (8.8 units/acre) – 13.0 kg minus 2 kg in concentrate. If 2 tonnes of concentrate is fed per ha, this farmer is allowed to apply 6kg/ha (4.8 units/acre).

Where moderate to high levels of concentrate feed is being used, the level of P fertiliser that can be applied will be reduced on the farm. To increase the level of P fertiliser that can be applied on the farm target slurry to P Index 1 and 2 fields first to avail of the 50% reduction in slurry P availability. This will increase the level P fertiliser on the farm. If organic manure is imported onto a farm, the P in this manure is further deducted from the quantity of P allowed under the regulations. Update farm fertiliser plan annually to determine maximum farm P allowances.

Table 1. Approximate rates* of fertiliser P allowed in different parts of the country after deducting P in slurry generated by livestock but before deducting the P in concentrates fed to livestock. Examples of quantities of P in concentrate are at the bottom of the table. Rates of fertiliser P are shown as kg/ha (units/acre in brackets).

Soil P Index	Grassland stocking rate (kg/ha of organic N per year)					
	<85	86 – 130	131 – 170	171 – 210	211 – 250	>250
Zone A						
1	27 (21.6)	32 (25.6)	37 (29.6)	42 (33.6)	47 (37.6)	47 (37.6)
2	17 (13.6)	22 (17.6)	27 (21.6)	32 (25.6)	37 (29.6)	37 (29.6)
3	3 (2.4)	8 (6.4)	13 (10.4)	18 (14.4)	23 (18.4)	23 (18.4)
4	0.0	0.0	0.0	0.0	0.0	0.0
Zone B						
1	26.5 (21.2)	31.5 (25.2)	36.5 (29.2)	41.5 (33.2)	46.5 (37.2)	46.5 (37.2)
2	16.5 (13.2)	21.5 (17.2)	26.5 (21.2)	31.5 (25.2)	36.5 (29.2)	36.5 (29.2)
3	2 (1.6)	7 (5.6)	12 (9.6)	17 (13.6)	22 (17.6)	22 (17.6)
4	0.0	0.0	0.0	0.0	0.0	0.0
Donegal/Leitrim						
1	26 (20.8)	31 (24.8)	36 (28.8)	41 (32.8)	46 (36.8)	46 (36.8)
2	16 (12.8)	21 (16.8)	26 (20.8)	31 (24.8)	36 (28.8)	36 (28.8)
3	1 (0.8)	6 (4.8)	11 (8.8)	16 (12.8)	21 (16.8)	21 (16.8)
4	0.0	0.0	0.0	0.0	0.0	0.0
Cavan/Monaghan						
1	25.5 (20.4)	30.5 (24.4)	35.5 (28.4)	40.5 (32.4)	45.5 (36.4)	45.5 (36.4)
2	15.5 (12.4)	20.5 (16.4)	25.5 (20.4)	30.5 (24.4)	35.5 (28.4)	35.5 (28.4)
3	0 (0)	5 (4)	10 (8)	15 (12)	21 (16.8)	21 (16.8)
4	0.0	0.0	0.0	0.0	0.0	0.0
Concentrate (t/ha)	Amount of P in concentrates fed to livestock (this must be deducted from fertiliser P above)					
0.5	2.5 (2)	2.5 (2)	2.5 (2)	2.5 (2)	2.5 (2)	2.5 (2)
1.0	5 (4)	5 (4)	5 (4)	5 (4)	5 (4)	5 (4)
2.0	10 (8)	10 (8)	10 (8)	10 (8)	10 (8)	10 (8)

*The rates in this table are a rough guideline to permissible rates and are presented for the purposes of example. Rates of P fertilisation that can be used on individual farms must be based on the specific details of each farm.

P and K advice for grazed swards

While the previous table indicates average maximum P limits for the farm, the P requirements within the farm will vary depending on stocking rate and usage for grazing or silage. The following advice must be cross checked against the maximum P allowed for the whole farm.

- Rates shown must be deducted to account for P fed to livestock in concentrate feeds.
- The P and K rates shown can be supplied by either slurry or fertiliser.

Table 6. Simplified P (in Kg/ha) for grazed swards on beef farms. (Rates shown are total P requirements, before deductions for concentrate feeds or organic fertilisers). Rates of fertiliser P are shown as kg/ha (units/acre in brackets)

Soil P Index	Grazed swards Farm stocking rate (kg/ha Org N)			
	< 130	131-170	171-210	>210
1	27 (22)	30 (24)	33 (26)	36 (29)
2	17 (14)	20 (16)	23 (18)	26 (21)
3	7 (6)	10 (8)	13	16 (13)
4	0	0	0	0

Rates shown in the table above are guideline P rates advised for grazed swards. Allowable application rates will vary depending on the farm specific circumstances and the P allowances under the Nitrates Regulations. These rates may need to be adjusted in order that the whole farm does not exceed the limits for P.

Table 7. Simplified K requirements (kg/ha) for grazed swards on beef farms. (Rates shown are total K requirements, before deductions for organic fertilisers). Rates of fertiliser K are shown as kg/ha (units/acre in brackets).

Soil K Index	Grazed swards Stocking rate (kg/ha Org N)			
	< 130	131-170	171-210	>210
1	70 (56)	75 (60)	80 (64)	85 (68)
2	40 (32)	45 (36)	50 (40)	55 (44)
3	10 (8)	15 (12)	20 (16)	25 (20)
4	0	0	0	0



P and K advice for silage

- Silage crops remove more P and K from fields than grazing.
- Where swards are being grazed and harvested for silage, use the rates of P and K shown in Table 4, in addition to the grazing requirements.

Table 4. P and K requirements of silage. (Rates shown are total requirements, before deductions for organic fertilisers). Rates of fertiliser P and K are shown as kg/ha (units/acre in brackets).

Soil Index	Cut once		2nd and subsequent cuts	
	P (kg/ha)	K (kg/ha)	P (kg/ha)	K (kg/ha)
1	20 (16)	120 (96)	10 (8)	90 (72)
2	20 (16)	120 (96)	10 (8)	75 (60)
3	20 (16)	120 (96)	10 (8)	60 (48)

Rates of P shown in the table above are guideline P rates advised for silage swards. Allowable application rates will vary depending on the farm specific circumstances and the P allowances under the Nitrates Regulations. These rates may need to be adjusted in order that the whole farm does not exceed the nitrates limits for P.

Soil Fertility and Nutrient Management

8 How much fertiliser is in slurry?

Key fact

Slurry is a fertiliser

Slurry and soiled water produced on the farm can be a valuable source of nutrients for grass. The following guidelines will ensure that soiled water and slurry are used to maximum potential:

1. Where to spread?

- Most of the fertiliser value is due to the P and K content.
- Decide which fields have the highest P and K requirements and spread slurry on these fields.
- This may mean transporting slurry for long distances to outfarms, but this will usually pay for itself through savings in fertiliser costs.

2. When and how to spread.

- The N value of the slurry is affected by timing and method of application.
- N can be lost to the air as ammonia in warm and dry conditions.
- Apply in cool moist weather conditions where possible. Light mist is ideal.
- Application in spring normally gives better results than summer.
- Applying with trailing shoe or bandspreader will improve the N value compared to splashplate.

3. Dilute slurry and soiled water.

- Soiled water and dilute slurries have lower total nutrient contents than undiluted slurry.

Table 9. Fertiliser value of slurries and soiled water. Values are shown as kg/m³ (units per 1,000 gallons in brackets)

Slurry type	Application		Fertiliser value (kg/m ³)		
	Timing	Method	N	P	K
Undiluted slurry	Spring	SP	0.7 (6)	0.6 (5)	3.2 (30)
		BS/TS	1.1 (10)		
	Summer	SP	0.4 (3)		
		BS/TS	0.7 (6)		

Multiply by 9 to convert kg/m³ to units/1,000 gallons

SP = splashplate

TS/BS = trailing shoe or bandspreader

9 How much fertiliser will organic fertilisers replace?

The simplest way to think of the value of organic fertilisers is to consider what they are equivalent to in terms of a 50 kg bag of fertiliser. Values shown are typical average values. Actual nutrient content and availability can vary considerably around these averages. For best results, it is advised to have samples of the material analysed in a laboratory.

Using Organic fertilisers to reduce fertiliser costs

There are a number of organic fertilisers that can be used to replace chemical fertiliser on farms. Where importing organic fertilisers onto the farm, it must be done in compliance with the nitrates regulations regarding spreading times, and the amount of manure that can be imported relative to the farm stocking rate and maximum N and P fertiliser limits. Farms with a nitrates derogation cannot import animal manures.

10 How important is the choice of fertiliser compound?

Nutrient balance

- Applying nutrients in the correct proportion is key to maximising grass production with minimal costs.
- Response to fertilisers is determined by the law of the minimum.
- This means that the limiting nutrient determines yield. For example, additional N is of no benefit if P or K is the limiting factor.
- Therefore, balanced nutrient applications are very important.

How to

Choose a suitable fertiliser compound

- Fertilisers are available in a number of forms.
- Straight N, P or K fertilisers contain only one nutrient, while compound fertilisers (e.g. 18-6-12, 0-10-20, etc) contain a combination of nutrients.
- It is important to apply the fertiliser products that best supply the nutrient requirements in each field.
- A single compound fertiliser will not be suitable in every field.



Section 3

Grazing Infrastructure

by Pat Clarke



Introduction

The design and layout of grazing infrastructure is crucial to overall herd performance as it can allow more days at grass and hence greater profitability. One extra day at grass is worth €270/day/100 cows in spring. In autumn one extra day is worth €150/day/100 cows.

- ① How do I create an efficient paddock system?
- ② How can I create a cost-effective road system?
- ③ What drinking water infrastructure do I need?

Grazing Infrastructure

① How do I create an efficient paddock system?

How to

Set up a paddock system

- Get a map of the farm with areas for each field/paddock.
- Decide on the number of paddocks required; this will depend on whether the paddock will be used for one, two, three or four grazings.
- Determine most suitable road layout to service each paddock.
- Determine most appropriate water trough(s) position in each paddock.
- Allow for multiple entrances into each paddock.
- Ideally keep paddocks square/rectangular, ideally depth: width ratio should be 2:1.

Key risks

Paddock layout

- Long narrow paddocks – too much walking over ground to graze the end of the paddocks can result in excessive risk of poaching.
- Large paddocks – grass regrowths are grazed if over 3-4 grazings per paddock. Using a strip wire to divide the paddock requires extra labour during the main grazing season and it reduces milk solids.
- Small paddocks – insufficient grass for one grazing, extra water troughs are required.
- Farmers expanding should use strip wire until they decide how many cows they will milk.

Alternatives

To a paddock system

Have no set paddock system – use temporary wire for all grazings. The advantage is that the grazing area can be adjusted throughout the year and that surplus grass/silage is more easily harvested.

Other advantages include:

- less expensive to construct
- very flexible
- less under or overgrazing
- interchange of grazing and silage areas
- easier for machinery to work
- no weeds under wire.

A major disadvantage is that it takes time at each grazing change to move the temporary fence. Other disadvantages include:

- higher level of grassland management ability needed
- daily assessment of herd's needs
- daily assessment of grass covers
- difficult to manage calves
- difficult to decide where to site water troughs.

Key facts

- One hectare equals 10,000 square metres (100 metres x 100 metres).
- Rectangular paddocks work best; ideally depth: width ratio should be 2:1, not over 4:1.

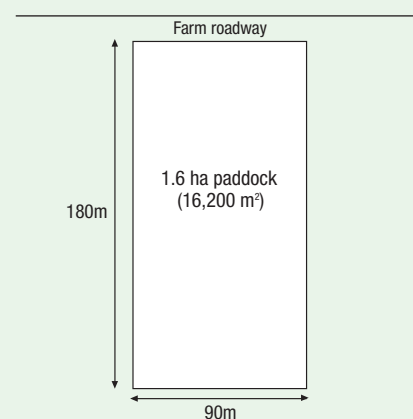


Figure 1: Dimensions of 1.6 ha paddock with depth: width ratio of 2:1. Cows walk less in rectangular paddocks which minimises soil damage in wet weather.

Key target



- Depth of paddock – maximum of 250m from road to end of paddock.
- Wet paddocks – depth of 100-150m from road to end of paddock is optimal.

Number of grazings per paddock

Normally 12 hours (one grazing) is allocated to the herd in spring and autumn. This allows the herd to fully graze out the section during these two critical periods. It is also the period when ground conditions are most challenging and cows should not be allowed to re-walk over ground when conditions are difficult.

For the remainder of the year, allocating grass each day is time-consuming. Therefore paddocks are larger to allow for either two, three or four grazings per paddock, i.e., one to two days. Where cows spend longer than two days in a paddock, re-growth will emerge and will be eaten by cows leading to lower grass growth and production.

How to



Calculate paddock size: (April–June)

Step 1: Establish cow numbers (Plan for long term)

Step 2: Establish daily demand. e.g. 100 cows X 18kg DM
= 1,800kg DM for 24 hours

Step 3: Ideal pre-grazing yield is 1,400kg DM/ha in mid season

Step 4: Two grazing 1,800/1,400
= 1.3ha for 100 cows in 24 hours
To calculate paddock size, divide herd demand by ideal pre-grazing yield.

Step 5: Three grazing 1,800 X 1.5 days/1,400
= 1.9ha for 100 cows in 36 hours

Step 6: The remaining area is normally closed for silage during this period. It could also be divided into similar paddocks.

Peak grass growing months April/May/June will normally determine paddock numbers.

Commercial companies: A number of companies specialise in farm mapping. They use GPS to get exact paddock sizes and will lay out paddock, water and road systems to meet individual requirements.

Table 1. Number of grazings per paddock for mid season

Grazing per paddock	Pros	Cons	Recommendation
1 grazing per paddock	Good grass utilisation Regrowths not affected Better in wet weather Easy to identify surplus/ deficit of grass	Cows could be underfed Heifers tend to suffer More water troughs required	Least Recommended
2-3 grazings per paddock	Regrowths protected Cows less restricted Easier for machinery to travel in bigger paddocks	More difficult to manage in first and last rotation	Most Recommended
4+ Grazings per paddock	Fewer water troughs required Fewer paddocks required Allows for future expansion	Regrowths affected More difficult to graze out Harder to get cows out of larger paddocks	

Grazing Infrastructure

② How can I create a cost-effective road system?

Cows will make up to 600 return journeys from paddocks to the milking parlour each year. Road layout must allow for good cow flow and have a suitable surface for walking speed and hoof welfare. Road layout must allow access to all paddocks.

Construction of roadway

Table 2. Grazing infrastructure

Roadway type	Options
1. All removed	<ul style="list-style-type: none"> • Build up with stone • Consider if a lot of heavy machinery is travelling on roadway • Most expensive option
2. No topsoil removed	<ul style="list-style-type: none"> • Must be prepared during dry weather • Heavy machinery should not travel on this roadway • Geo-textile can be put on top of topsoil followed by stone • More suited for roads far away from farmyard • Less expensive option
3. Invert roadways	<ul style="list-style-type: none"> • Must be prepared in dry weather • All top soil moved to one side • Sub-soil is brought to top and shaped into road • Top-soil put back where subsoil was • Roll with vibrating roller

Key considerations

Is the road to be used for cows only, light machinery or heavy machinery? Heavy machinery could damage a road that is designed for cows only.

Does top-soil need to be removed? A roadway placed on top of wet soil will sink and may result in water pooling on the road. If heavy machinery will use the road then the top-soil may need to be removed.

Is there hard-core available on farm? Stone is the major cost of a road system. A 100m road that is 5m wide will require 100m³ of stone (100 x 5 x 0.2) which is equivalent to 200t of stone (one m³ weighs about 2t). In addition about 25m³ (100 x 5 x .05) of binding material would be required which is equivalent to 50t.



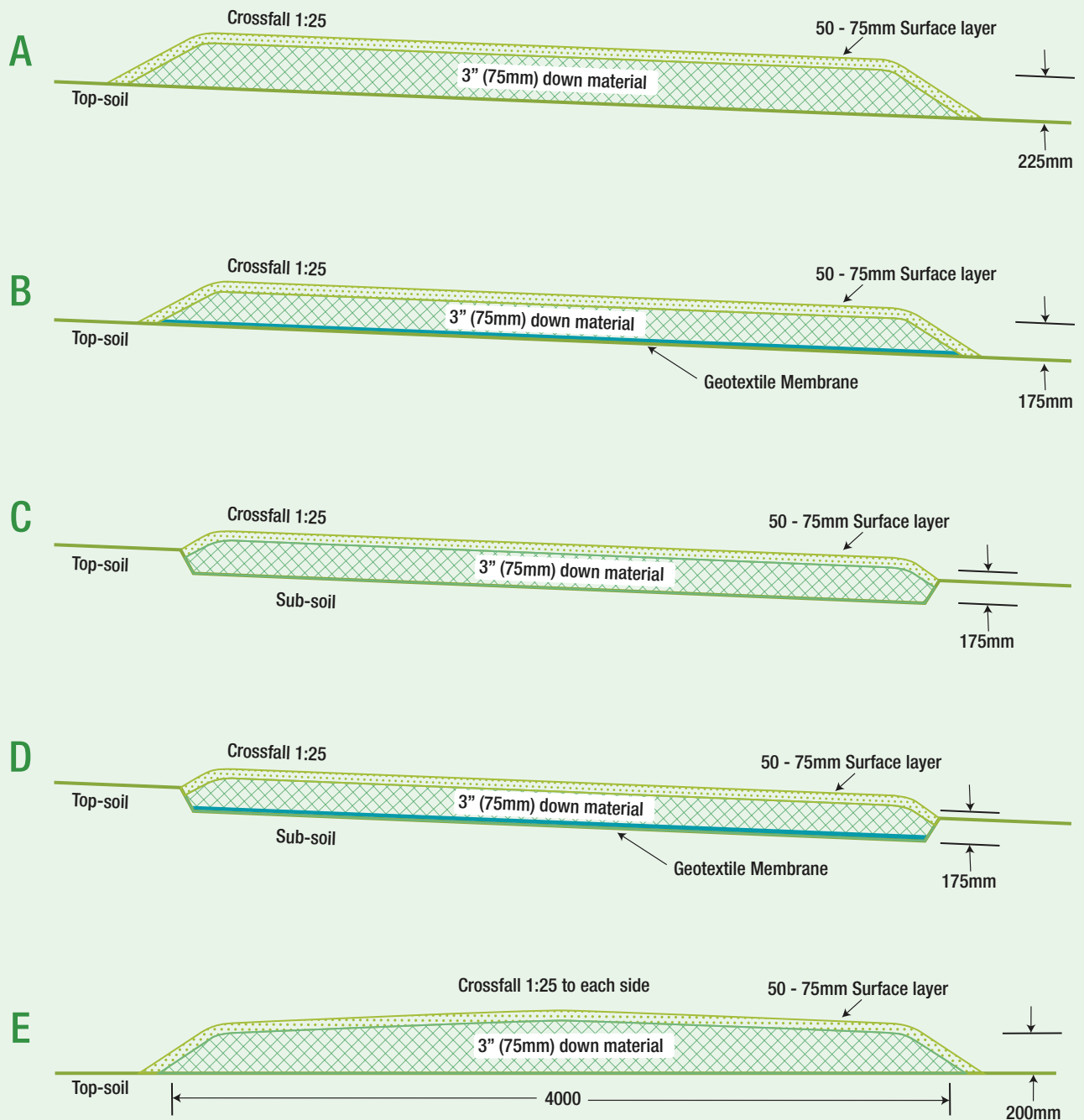
1. Remove top-soil if necessary.
2. Lay base material and shape to give a curved surface that will shed water onto the grassland.
3. Compact with a large vibrating roller to minimum height above the ground level of 100mm at the outer edge and 150 mm in the centre of the roadway.
4. Allow roadway to settle.
5. Cover with 50-75mm of slig/binding material and compact with a large vibrating roller.

Estimated cost of roadway construction (€/m of road, 2016)

Top-soil removal (10cm) (optional)	€4
Hard-core material (20cm)	€15
Fine material (5-7cm)	€5
Hired roller	€1
Total	€25



Farm road profile options



Grazing Infrastructure

Roadways

Key facts



Road width	50 cows - 3m, 100 cows -4m, 250 cows -5.5m add 1 m to the above figures for roadways close to yard
Good camber (slope)	1:25 one-sided slope, 1:15 two-sided slope
Construction	20–25cm hard-core, plus 5-7.5cm fine material
Cow walking speed	2–3km on good road surface
Road slope	max of 3:1
Fencing	45cm from edge of road
Approx. cost/m	€15 – €25/m

How to



Set up a road system

- Get a map of the farm.
- Mark the location of the dry areas, wet area, obstacles to roadways etc.
- Location of the milking parlour.
- Design a system that allows road to reach every paddock on the farm.
- Establish if the road system is for cows only, or for heavy machinery (silage cutting) as well.
- Minimise bends, angles and corners on road to create good cow flow to and from milking parlour.
- Avoid sharp bends, with no bends less than 90°.
- Source local hard-core and binding for the roadway.
- Walk proposed roadway for any issues that do not appear on a farm map, e.g., winter ponds, ESB poles, etc. Adjust if necessary.
- Construct roadways on the southern side of hedgerows.

Key risks



Roadways

- Narrow roads: cows can stop walking due to any obstruction e.g. water, branches, other stock etc. Also cows can push in from the electric fence causing increased lameness.
- Uneven surface: this will reduce cow walking speed (<1.5km/hr) and increase lameness.
- Sharp bends: slow walking and increased lameness due to pushing at bends.
- Water troughs on road: slow walking speed.
- Wrong lay-out relative to paddocks: poor grass utilisation due to excessive walking/poaching of paddocks.

Alternatives



There is no alternative to a good road system. Some farms may use narrow cow tracks rather than completely redesigning the farm roadways. These may be 0.6m to 1.8m wide and usually service long, narrow paddocks. They are not designed for machinery (fertilizer/slurry); these machines enter from the main farm roadway. These tracks must shed water and may need to be raised above ground level, depending on the site.



3 What drinking water infrastructure do I need?

On an average day, a 150 cow herd could drink up to 10,000 litres (65 litres per cow). The water system must be sufficient to deliver this quantity of water to the paddocks. There should also be a reserve in the paddocks, normally nine litres per cow (two gallons) which is equivalent to 1,350 litres for a 150 cow herd.

Water

Key facts

Water intake:	10 litres on cold wet day, 90 - 140 litres on warm sunny day
Drinking speed:	14 litres per minute (3 gallons/min).
Drinking time:	30%-50% water intake within one hour of milking
Trough size:	Allow nine litres (two gallons) per cow, 1,350 litres (300 gallons) for 150 cows
Main waterline:	38-42mm internal diameter for 150 cow herd
Connecting pipe:	20-25mm internal diameter
Ballcock:	Medium pressure
Main pipe layout:	Loop system preferable



How to

Set up a water system



- Decide on main water line loop. Depending on farm layout, two loops may be required.
- Decide on one or two troughs per paddock and their location.
- Map the farm showing farm roadways and paddock layout.
- Identify location of shut-off valve(s).
- Decide on pipe sizes, main water line and connectors to water troughs.
- Ideally water troughs should be located at the centre of the paddock.
- If there are two troughs per paddock - they should be staggered. One in the first half, the other in the second half (see Fig.3).

Key risks



Water pipe too small:	Reduced water pressure at trough.
Trough too small:	Inadequate reserve, bullying at drinking, drop in milk yield
Ballcock too small:	Slow filling of water trough



Inadequate size water tank (no reserve in paddock)

Laying water pipes

- Either by digger or mole plough.
- Lay pipes before roadway construction.
- Mole ploughing (45cm deep) - do a dummy run before inserting the pipes.
- There are a number of companies that can provide this service.

Key performance indicators



- No queuing at water trough.
- Trough always filled after milking.
- No leakage.
- No cow tracks to water trough indicating a long walk to troughs.
- Water system drained over the winter.

Ballcocks

- Size – 12.5mm (half inch) standard, some 20mm available.
- Ballcock pressure: Low – gives flow rate of 42 litres/min.
- Medium: flow rate of 32 litres/min (preferred option).
- High – flow rate of 8 litres/min.

High pressure ball cocks usually have small jet sizes (to minimise leaks) and consequently have lower flow rates.

Grazing Infrastructure

How to

Calculate water flow rate



Assuming a daily demand of 80 litres per cow, almost 50% of which is consumed in a 3-hour period soon after evening milking, means that an hourly flow rate of 13 litres per cow per hour is required (i.e. $80 \times 50\% / 3 = 13$ litres/cow/hour.). Therefore, for a herd of 100 cows the flow rate needs to be about: $100 \text{ cows} \times 13 \text{ litres/hour} = 1,300 \text{ litres/hour}$ or 22 litres per minute.

To check the flow rate on your farm:

- Mark the level of water in a trough.
- Tie up the ballcock and empty, say, 25 litres from the trough.
- Release the ballcock, hold it down and measure the time it takes (in minutes) to refill to the original mark.
- Divide the 25 litres by the time taken to refill, e.g. if it takes a minute to refill then the flow rate is 25 litres per minute.

If the flow rate measured is less than that required for your herd, then your water supply system needs to be improved. Check the flow rate of troughs around the farm.

Water costs

Water

- Deep-well, submersible pump €0.14 per 4,500 litres.
- Mains – €2.50–€6 per 4,500 litres.

Well

- Deep-well pump supplied and installed for €1,500 plus VAT.
- Pump house built in a suitable location for €2,500 plus VAT.
- Estimate for drilling and lining a well, e.g. 75m (250ft) deep, at €33 per metre for drilling and €16 per metre for lining is €3,675 plus VAT.

Water pipes

- Approx cost is €1 per metre of 38mm pipe.

Water troughs

- Approx. cost is €1 per 4.5 litre trough capacity (one gallon), equivalent to €300 for 1,350 litre (300 gallon trough).



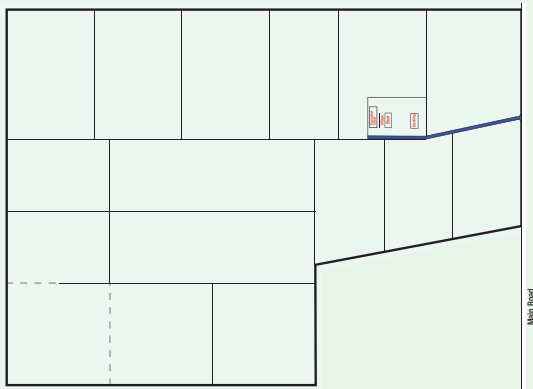


Figure 1. Existing 60ha farm (10 Fields)

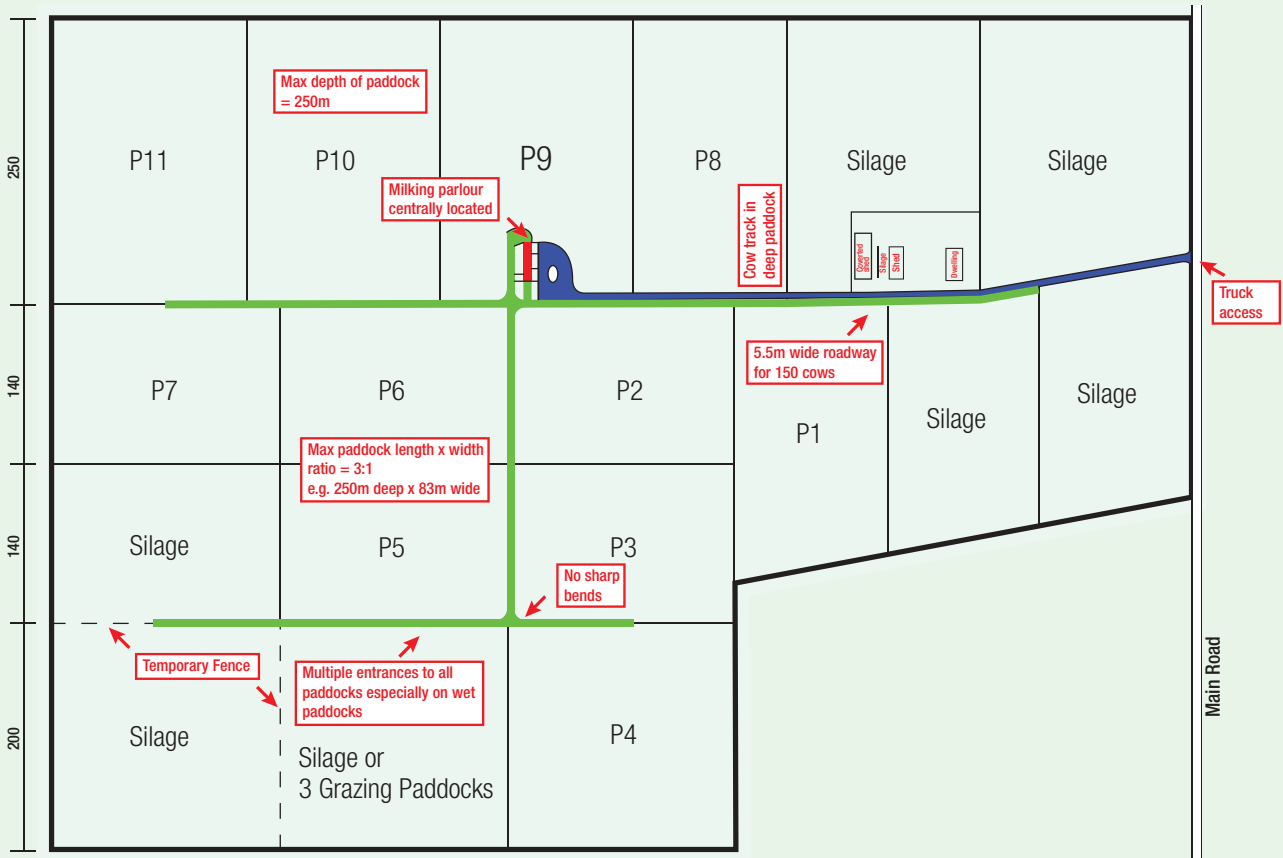


Figure 2. 60ha farm showing farm roadways (green) and grazing paddocks (n=11)

Grazing Infrastructure

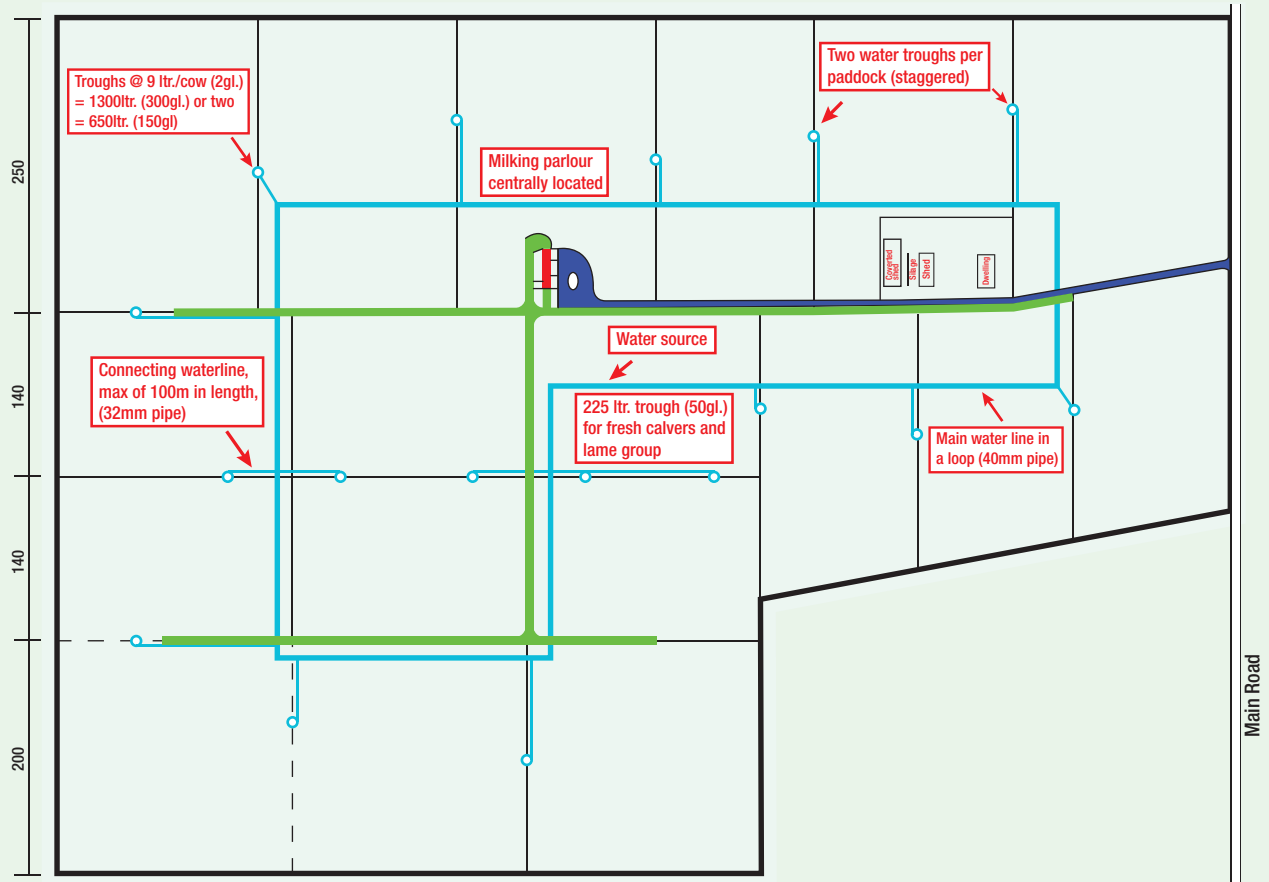


Figure 3. 60ha farm showing farm roadway, paddock design and water system (blue)

Section 3

Milking Facilities

by Tom Ryan, John Donworth



Introduction

Building a new milking parlour is a costly investment with a planned useful lifespan of up to 40 years, or more. Modern milking parlours are complex and labour intensive to construct. Good liaison and co-operation is vital between the farmer and all the various contractors, suppliers and trades involved.

- 1 How do I assess my current milking facility?
- 2 Ideally, where should a milking parlour be located?
- 3 What are the principles of good cow flow?
- 4 How many cows can one operator milk in an hour?
- 5 What type of collecting yard should I consider?
- 6 What size of collecting yard do I need?
- 7 How many units do I need for my herd size?
- 8 Which type of parlour should I choose?
- 9 What are the basic components of a milking machine?
- 10 Where are the specifications available?
- 11 What ancillary equipment is available for a basic milking plant?
- 12 What is the approximate cost of a milking plant?
- 13 What about testing the machine?
- 14 What size bulk tank is required?
- 15 What types of drafting facilities are available?

Milking Facilities

1 How do I assess my current milking facility?

An existing parlour may have potential for expansion but a parlour in poor condition might need to be replaced. The following conditions would give cause for concern.

- Structure and roof are not in good condition.
- A loft with low ceiling makes the parlour dark and unattractive to cows.
- The pit is shallow – forcing the milker to stoop.
- The fall in the pit is not equal to the fall in the milk line.
- Incorrect slopes or dips in milk lines can lead to more mastitis, raised cell count, slow milking, which can cause poor hygiene and rinse water drainage problems.
- The milking machine is more than 20 years old.
- Concrete floors are worn and rails are unsteady or badly designed.
- There is an antiquated (or no) in-parlour feeding system.
- The pump and motor are located in the dairy and the dairy and bulk tank are too small and the compressor out of date or undersized.
- The parlour is too narrow.

2 Ideally, where should a milking parlour be located?

How to

Choose a location for the parlour

- The parlour should be located as close to the grazing area as possible. As cows walk comfortably at about 3km/hr, the closer the parlour is to the grazing area, the better. Corners, junctions and u-turns in and near farmyards, even if designed correctly, can unnecessarily increase the time it takes to bring the cows in for milking.
- A parlour located centrally within the farm minimises walking time and distance for cows. This is particularly important for very large herds. For expanding herds, the parlour is likely to stay near the farmyard, as the cost of moving the parlour to a new location may be prohibitive.

- The access route for the milk lorry should be separate from the cow roadway. This is to minimise cow dung coming into contact with the lorry. In some situations, cows may have to cross the lorry route. The cross-over point should ideally be at a distance from the parlour where it is likely to be less dirty.
- Consider the prevailing wind direction. Ideally, parlour/silage, etc. should be downwind of the dwelling house and upwind of other livestock facilities. Some shelter may be needed to prevent a harsh wind blowing into the milking parlour.
- On sloping ground, build across the slope to minimise excavation and filling. The length of the parlour should be across the slope.

Consult **S103** or **S106** (from DAFM) for distances from diesel storage or any stored contaminant, silage or ensiled material, or a pig or poultry house. Soiled water tanks or slatted tanks should be at least a metre from the edge of the milker's pit (also a key point for expanders).

The choice of collecting yard will generally influence the location and orientation of the parlour. The aim is to have cows entering the collecting yard so that they are lined-up to the parlour entrance and can maintain their social order.

For a rectangular collecting yard, this means that they enter from the rear or the side of the rear so they are facing the parlour entrance. They generally exit from one side of the parlour by doing a u-turn and pass the collecting yard on their way out or do a 90° turn going out to the side. The dairy can be at the front or at the opposite side.

With circular collecting yards, cows generally pass the parlour exit on one side on their way in, move around the circular yard, and exit straight ahead from the front of the parlour. The dairy and plant room must be located at the opposite side to where the cows enter.



3 What are the principles of good cow flow?

How to

Optimise cow flow

- Ensure that cows are lined up towards the parlour entrance and that their social order is not interrupted.
- Cows should be lined up on entering the collecting yard i.e. enter the rear of rectangular yards and enter circular yards from the front of the parlour.
- There should be no steps at entrance or exit.
- There should be no doors at parlour entrance.
- All surfaces should be non-slip.
- There should be good light at the parlour entrance and exit.
- The front of the parlour should be spacious.

4 How many cows can one operator milk in an hour?

Key facts

In an ideal situation, the milker can carry out the complete milking without leaving the pit. The following factors influence the output of a milking parlour:

- cow drafting
- parlour design
- location of the parlour
- skill of the operator
- holding yard design
- milk yield and milking routine
- design of milking equipment
- location of udder wash hoses, teat spray jets, and power hose for occasional washing of cow standings.

Parlour throughput is very important. More units, good design, labour saving devices, labour efficient and safe handling facilities will all pay ongoing dividends.

Parlour throughput hinges on the number of units, good work routine, general design and layout of the parlour and collecting yard, backing gate, absence of obstructions entering and leaving the parlour, entrance and exit gates that can be opened from anywhere in the pit, good light, no stress-causing factors, etc.

Safety is important also. Any facility should be planned and built so that one person can operate it and handle animals in safety. Safety for the user is most important but the importance of safety during construction and subsequent maintenance is also key.

Milking routine

Production levels, design of the milking units, and work routine time (WRT) together decide the eventual performance of a parlour. The work routine time is the time taken to carry out all operations at a milking unit. The work routine practiced on a particular farm is the most important factor in determining the number of cows a milker can milk in an hour. The performance (P) of a parlour in terms of cows milked per man hour may be stated as $P = 60/WRT$ (minutes). A typical work routine time is given in Table 1.

Table 1. Time for different elements of milking routine

Milking routine	Seconds/cow
Cow entry	3.4
Pre-spray and paper dry (estimate)	8.0
Attaching clusters	10.1
Disinfecting teats	1.9
Cow exit	1.9
Washing cow standings	3.9
Miscellaneous	5.0
Work routine time (WRT)	34.2 (0.57 minutes)
Output (cows per operator hour)	105

Milking Facilities

Table 1 shows a breakdown, in seconds per cow, of the various tasks in a typical milking routine. The times were recorded in the Moorepark labour survey. The total is 34.2 seconds, making it possible for one person to milk 105 cows in one hour ($P = 60/0.57$), assuming that the number of units is not the limiting factor. If we omit the pre-spray and paper dry, the WRT is 26.2 seconds (0.4366 minutes), making it theoretically possible for one milker to milk 137 cows in an hour.

5 What type of collecting yard should I consider?

Alternatives

There are two types of collecting yards: circular and rectangular.



Rectangular yards	Circular yards
Easier to build	More complex to build
Can be extended easily	Difficult to enlarge
Promote good cow flow if cows enter from rear	Promotes good cow flow
Important to taper the yard towards dairy entrance	Can support automatic backing gate cleaning system
Can support automatic backing gate cleaning system	Possible to put second herd onto same yard without moving backing gate

6 What size of collecting yard do I need?

How to Size a collecting yard



There are two aspects to consider when sizing a collecting yard:

- 1) the average size of cows in the herd
- 2) future herd size.

- Small cows require 1.2 square metres per cow and large cows require 1.5 square metres per cow.
- Multiply average cow size by the maximum number of cows that need to be in the yard at one time to calculate the total area required.

Other choices to be made include:

- Roofed or unroofed.
- Backing gates – scraper, up and over type and water/electrically driven backing gates for circular yards. It should be possible to control the backing gate from the pit.



7 How many units do I need for my herd size?

Increasing the number of units will reduce overall milking time while increasing individual row time. Individual row time is influenced by pre-milking routine and stage of lactation, which in turn influences cow over-milking.

An operator can handle 14 units where cows are prepared and up to 22 where no preparation takes place. Aim for one unit/7-9 cows i.e. no more than nine rows of cows to be milked. For example: 120 cows ca. 16 units.

Number of Units

- Larger herds (150 cows +) – consider rotary parlour or long herringbone which requires two milking operators.

8 Which type of parlour should I choose?

How to

Choose a milking system



The choice of milking systems should be directly related to the number of cows currently being milked and the herd size envisaged for the future. **Plan to be able to milk an expanded herd in no more than 1 hour 30 mins.** Larger herd sizes will lead to a greater focus on time, working conditions and ergonomics associated with milking. It is important that maximum potential milking performance be achieved from new milking installations and from changes in existing milking parlour size and design.

The particular requirements of the individual dairying enterprise and the cost of labour must dictate the level of automation. The capital, maintenance and running costs of the automated equipment must be carefully considered also. If a high level of automation is installed, it is vital that it is reliable and dependable and can be operated by a person of reasonable skill.

Generally it is better to focus on having adequate milking units at the expense of high levels of automation. It is extremely important that the operator does not have to leave the pit during milking.

Parlour types

Choice of system may come down to personal preference; farmers are advised to visit units with various systems before choosing. Ideally they should personally 'try-out' various systems by actually milking in each design rather than simply observing the parlour.

There are a range of widths and other critical dimensions for the herringbone, the 2' 6" and the side-by-side parlours and these are shown below. These are guidelines only, so consult milking machine manufacturers to get the exact dimensions for their machines.

3 ft. Centre herringbone

Many existing parlours are of this design. The cow is 'side-on' to the milker and clusters are generally applied in front of the cow's legs. There are a number of drawbacks associated with this design.

- Cows take up a lot of space in the parlour.
- Cows can kick off the clusters.
- Herringbone (3') – 915 mm centres.
- Cows are at 30° angle to milker.
- The longer pit increases walking time (less labour efficient).
- Cluster attachment is in front of hind leg.
- Troughs (concrete) are difficult to install accurately. Steel troughs are better.
- Measures 5' 3" to 6' 6" from wall to edge of pit.

Milking Facilities

There are two options:

- Zig-zag mangers with a straight rump rail. The width of the cow standing is typically 1.9m (6' 3") from wall to edge of pit. (1.7m approx for smaller cows).
- Adjustable breast rail with a zig-zag rump rail. This option allows the operator to adjust the breast rail as the cow gets heavier in calf and it keeps the number of cows equal to the number of clusters. It also helps when cows are lighter at the start of lactation. It also helps with the alignment of cluster removers. The width of the cow standing should be 2.1m or more for this design.

Design factors for 2' 6" parlours

- 2' 6" – 762 mm centres.
- Cows are at 50° angle to milker.
- As it is a shorter pit, there is less walking.
- Clusters are applied between back legs – less kicking off of clusters.
- Alignment of swing arms/clusters is important.
- Zig-zag concrete or steel troughs or straight breast rail and zig-zag rump rail.
- Generally no need for bailing/cow restraint.
- Easier to fit into existing shed (if wide enough).
- 1.9m (6' 3") from wall to edge of pit.
- Good cow flow.

Side-by-side - 2' 2" to 2' 4" parlour

Cows are almost at right angles to the edge of the pit and this system is often used with sequential baling systems. Clusters are applied between the cow's rear legs.

Design factors for side by side parlours:

- Cows at 660mm, 685mm or 710mm centres (2' 2", 2' 3", or 2' 4").
- Cows are at 85°–90° angle to pit.
- Provides good udder presentation – clusters are applied between back legs – easy to reach from pit.
- Shorter pit – less walking.
- Cows will need to be trained initially – good cow control.
- Designed to work with a manual/sequential bailing system.
- Results in good cow flow.
- Measures about 2.4m (8ft) from wall to edge of pit.



Other parlour types

Double-up

In this situation there is a cluster for each cow space. There will be a milk line on each side of the parlour. This type of parlour is rare in Ireland but may have a role where existing facilities have restricted space for expansion. Generally in Ireland, it is put in as a midi line rather than a low line. Cluster removers are a requirement with this type of machine.

Rotary

These systems should be considered where herd size exceeds 250 cows. Size can vary from 40 to 100 units. One operator can manage a very large number of units so capacity is high. Cows enter and exit one at a time rather than in groups as with other systems. It is impossible to expand once the system is in place. However, rotaries have the potential to milk several hundred cows by extending the milking time.

Main points to consider

- Six revolutions per hour, i.e. 360 cows per hour for a 60-point.
- Plan on the basis that each revolution takes approximately 10 minutes.
- 300–400 cows needs a 50–60 point rotary.
- Shed size would need to be 24m by 24m (80'x80') for a 60-point with extra space for the dairy, washroom, plant room and office at the end or the side.



- A big handling area is needed for the big numbers because more cows may have to be drafted and the farmer/vet can also deal with cows as they come off the table in single file or in groups after milking.
- The collecting yard can be a rectangular yard moving cows towards a race. The race funnels them into single file.
- Safety: no animal handling tasks should be performed on cows on the platform, whether moving or stationary – it's too dangerous. Access to the centre of rotary via a tunnel under the turntable. This is a requirement for safety and fire regulations.
- The most popular rotary is probably a side by side type with the cows' heads facing towards the centre.
- The platform is either a floating concrete type or it is mounted on tapered (cambered) rollers. The floating type may be unstable, easy to drive but difficult to stop – dangerous and awkward.

The roller type is sturdy with a concrete standing for the cows. It is easy to stop and the tapered rollers are not affected by friction wear due to the inner and outer circumference.
- Good natural and artificial light is needed in the building.
- Allowance must be made for the different levels, the collecting yard and platform, the tunnel and the level at which the milker works at, to facilitate cluster attachment and minimise repetitive strain injury. Use soft mats or an adjustable standing for the milker.
- Cow flow rate: each cow passes the milker every ten seconds. Therefore, it will take 4,000 seconds to milk 400 cows. It will take one hour and seven minutes to milk them in a 60-point and one hour and twenty minutes to milk them in a 50-point.

Robotic or Automated Milking Systems (AMS)

One cow is milked at a time in a single stall AMS and milking is conducted over 22 hours each day. One robot can cater for approximately 70 cows. Cows volunteer for milking by walking from the cow accommodation or paddock to the AMS unit. The majority of the work for the operator becomes cow and data management rather than physical work.

9 What are the basic components of a milking machine?

- | | | |
|---------------|--------------------|-----------------|
| • Vacuum pump | • Breather line | • Milk pump |
| • Milk line | • Vacuum regulator | • Sanitary trap |
| • Wash line | • Gauge | • Receiver jar |
| • Air line | • Cluster | • Test points |
| • Pulsation | • Liner | • Milk filter |

10 Where are the specifications available?

- International and Irish Milk Quality Co-operative Society (IMQCS) standards exist and are the basis for new milking machine installations. IMQCS was set up in 1989 to ensure that Irish milking machine installation and testing standards are at least equal to International Standards Organisation (ISO) standards. Teagasc, ICOS, milking machine manufacturers and the milking technicians were closely involved in implementing the new revision of ISO standards, which were introduced in 2008. They have published a guide to the ISO standards entitled "Teagasc/IMQCS Recommendations for the installation and testing of milking machines" to help those designing, manufacturing, installing, servicing and testing milking machines in Ireland. This publication can be downloaded from www.milkquality.ie.

Other useful sources of information are:

- Milk quality handbook available on www.milkquality.ie.
- Department of Agriculture, Food and the Marine specifications for milking parlours, **S106** and **S103**.
- Standard drawings and plans of milking parlours available from Teagasc B&T dairy advisors.

Milking Facilities

11 What ancillary equipment is available for a basic milking plant?

- Automatic cluster removers (ACRs)
- Bailing systems
- Automatic cow identification
- Automatic drafting
- Automatic milking machine wash systems
- Air purge systems
- Swing-over arms
- Low level wash
- Diversion line
- Cluster flushing system
- Feeding systems
- Electronic milk metres
- Auto entrance and exit gates

Automatic cluster removers

While cluster removers are often considered unnecessary, they offer great flexibility in large, two-milker parlours. ACRs ensure that clusters are removed consistently when cows are milked. Swing-over arms are usually required for correct operation. If planning to install cluster removers at a later date, swing-over arms should be installed at the start, making the fitting of cluster removers easier in the future.

Correct ACR operation requires good cow positioning in the parlour. They should be calibrated and maintained so that they shut off the vacuum before detaching the cluster and only detach the cluster when the cow is fully milked.

ACRs are recommended in parlours where one operator is expected to handle more than 14 units. They are generally not needed for less than 12 units and are very desirable at 16 units or more.

Bailing systems

Bailing systems allow cows to be located conveniently for proper operation of ACRs. The main advantage with bailing systems is that cows are controlled and positioned better for easy and safer cluster attachment and removal.

Automatic cow identification (Auto ID)

Auto ID allows full control and monitoring of each individual cow in the herd. It is used to monitor, feed and automate day-to-day cow management tasks on the farm. It operates in conjunction with such equipment as in-parlour and out-of-parlour feeders, and electronic milk metres. It can also be used to control drafting gates and weighing devices.

Automatic drafting

Where automatic drafting is available, cows can be diverted automatically in up to three different directions, according to management needs, with little effort. Cows can be accurately sorted and normal cow flows are not disrupted.

Automatic drafting provides gentle cow treatment and maximum cow flow away from the parlour. Semi-automatic drafting systems are available also. One such system uses a tail transponder. The tail transponder is attached to the tail of the cow to be drafted.

Automated milking machine wash systems

Automatic wash systems reduce wash-up time as well as ensuring safe and accurate addition of cleaning chemicals to wash water. Many farmers do not measure the exact amount of cleaning chemicals used in the wash trough for circulation or for plant rinsing. Automatic wash systems should eliminate this problem. Automatic wash systems should only be considered for larger parlours and should be serviced and calibrated annually. If you change your detergent steriliser product, you may need to recalibrate the autowasher. As with any wash system, the size of wash troughs must correspond with the number of units.

Key risks



- They can run out of detergent or detergent can crystallise and block the pumps.
- Automatic milking machine wash systems need an air purge system to function correctly.

Air purge systems

Air purge units remove residual milk after milking and residual water after washing from the milk delivery line. The milk delivery line is located between the milk pump(s) and the bulk tank. Using an air purge system eliminates the risk of inadvertently adding water to milk. It also saves time by not having to wait for milk and water to come through before and after milking and washing.

Swing arms

They should be located in the centre of the pit and above the head height of the milker. They help to eliminate clutter in the centre of the pit. They prevent clusters getting dirty and swinging free across the pit when detached. They also support the rams for cluster removers and the long milk tubes.

Wash-line

The trend now is to install a low level wash-line below the standing cow. This means that there are no jetter tubes hanging down in the pit. This improves the labour efficiency.

Diversion line

- Diverts waste milk (high SCC, antibiotic milk) for disposal, or milk for calf feeding.
- Improves labour efficiency, particularly in spring.
- The disadvantage is the initial cost and extra washing and maintenance costs.
- Other options – T-piece at plate cooler.

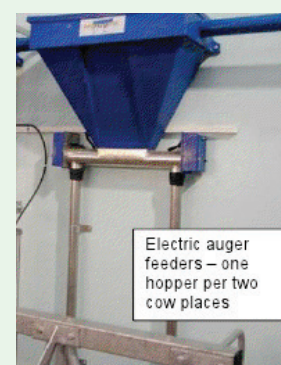
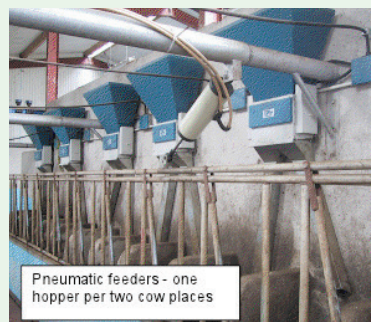
Cluster flushing systems

- Cluster flushing systems eliminate the need for cluster dipping or pre-spraying teats. They work by back-flushing the long milk tube and cluster with water and food grade disinfectant, e.g. peracetic acid.
- Some systems can also post-teat dip cows.
- Disadvantages of the system are the installation and subsequent maintenance and running costs. The perceived risk is that water and or disinfectant solution could contaminate the milk, especially if maintenance is neglected.
- It shouldn't be seen as a substitute for good hygiene and milking practices.

Feeding systems

Why install a feeding system?

- Saves time and improves labour efficiency.
- Eliminates drudgery by making the job of feeding easy.
- Systems available can feed individually, in batches, or be pre-programmed to feed automatically.
- Performance related feeding to yield, body weight and stage of lactation is possible.
- There can be a tendency to overfeed because it is so easy to do.
- It is necessary to calibrate feeders to ensure accuracy of feeding.
- Dust-free designs are desirable.
- The more units you have, the more beneficial they are.
- Consider the location of the meal bin and installation of the flexi-augers when designing the parlour.



Milking Facilities

12 What is the approximate cost of a milking plant?

How to

Minimise milking machine costs:



- Milking machine costs vary widely from about €2,000 to €8,500 (per unit 2016) depending on the specification. Just €1,700 per unit would be a very basic machine, without feeders and possibly with some pre-owned parts. €8,500 per unit would supply a state of the art machine with swing arms, automatic front and rear gates, diversionline, automatic cluster removers (ACRs), electronic milk metres, electronic feeders, auto-identification, auto-washer, electronic drafting, etc.

- A price range of €3,500 to €5,000 per unit would include in-parlour meal feeders and a reasonable level of automation, such as swing arms, ACR's, diversion line and front and rear automatic gates. Discuss the various options with your agent before you get a written, itemised, quotation.
- The cost of some other items of equipment to take into account or consider are; a bulk tank, milk filter, plate cooler, waterheater(s), wash troughs, hand washing facilities, wash down system, backing gate, generator, air compressor, etc.

Table 1. Typical costs of ancillary equipment

Items		Estimates (2016)
Air-operated gates - back	each	2,500
Air-operated gates - front	each	2,500
Augers	each	3,500 - 4,000
Auto ID	each	8,000 - 8,500
Automatic washer	each	4,500
Cluster removers	per unit	750
Compressor	each	-
Drafting	each	5,000 - 11,000
Dump line	per unit	550 - 600
Electronic milk metres	per unit	800 - 1,300
Generator	each	-
Feed mangers - all galvanised	each	270
Feed mangers - Stainless steel pan	each	400
Meal bin	each	2,500 - 3,000
Meal feeders	per unit	1,000
Milk pump - centrifugal (incl. in plant price)	each	1,300 - 1,500
Milk pump - variable speed centrifugal	each	1,500 extra
Plate cooler	each	1,500 - 2,500
Recording Jars	per unit	600
Manual individual bailing	per unit	250
Manual individual bailing compressed air rams	extra	1,700
Sequential bailing	per unit	800 - 900
Stainless steel droppers	per unit	85
Swing arms - depending on switches, etc.	per unit	200 - 250
Teat sprayer - in pit	each	600 - 1,000
Wash trough	each	500 - 800

13 What about testing the machine?

- Have your milking machine serviced and tested by an IMQCS registered milking machine technician at least once per year. A register of trained milking machine technicians is available on www.milkquality.ie.
- If a mastitis problem needs to be investigated, it is important to test twice; once before servicing and again after servicing. This will identify existing faults and confirm that such faults have been corrected after servicing.



Checklist

Milking machine maintenance

- Regulator filters should be cleaned regularly.
- Inspect all rubberware for wear and cracks regularly.
- Check vacuum pump oil regularly and oil drop rate.
- Check that claw air bleed holes are free daily.
- Liners should be changed every 2,000 cow milkings. Only liners suitable for the shells should be used. Under-milking due to worn liners can contribute to increases in cell count.
- Check vacuum gauge at milking time to ensure correct vacuum level is being maintained.
- Check that air is hissing through the regulator during normal milking.
- Check drain valves at low points on airlines.

14 What size bulk tank is required?

To calculate the capacity of the bulk tank you require, you need to know how many milkings you need to store at peak. It is five milkings for every two day (E2D) collection and seven for every three day (E3D) collection. Other factors are the number of cows, now and in five years' time, and the yield per cow e.g. 30 litres/day at peak (6.5 gallons/day).

Example: Herd Size: 100

Bulk tank capacity for E2D: $100 \times 30 \times 2.5 = 7,500$ litres (1,652 gallons)

Bulk tank capacity for E3D: $100 \times 30 \times 3.5 = 10,500$ litres (2,313 gallons)

Get a detailed written quotation stating: model of tank, rated capacity, make, model and HP of condensing unit(s), details of automatic washer, details of new pre-cooling system or modifications to existing system, rough sketch of where tank and any ancillary equipment fits into dairy, and clarification of who does what if any building work, plumbing, electrical or modifications to milking machine are required.

How to

Buy a second hand tank:

- Tanks have a lifespan of at least 20 years and many tanks are still in good condition after over 30 years of operation.
- Ice-bank tanks repolished and fitted with new copper coil evaporators are like new. However, some direct expansion tanks over 20 years old may not be able to withstand pressure developed by modern refrigerants.
- If buying a second-hand tank: buy from a reputable dealer, check the age of tank, and get a reputable refrigeration engineer/serviceman to examine the condition of the tank.
- If the tank is over 7/8 years old, install a new condensing unit and always get a reputable refrigeration engineer/serviceman to move the tank and ancillary equipment.



Key risks

Choosing the wrong size bulk tank



- The dairy must be big enough for the tank.
- The dairy should have at least 0.6m (two feet) spare around the bulk tank on three sides and 0.9m (three ft) on the fourth side beside the wash troughs. This allows room for working at the wash trough, cleaning the outside of the tank and maintenance.

Milking Facilities

Key risks



Budget creep.

If you do not have a definite budget for your parlour there is a risk of spending more than you intended.

How to



Minimise construction costs:

- Plan what you want to do, get planning permission, get several quotations and prepare cost estimates. It is vitally important to know what costs you are letting yourself in for, when you go about building a new parlour or want to extend/renovate an existing one.
- Divide the costs into those associated with building the parlour/dairy; the milking machine; and the bulk tank. Allow for future expansion and the possibility of adding more automation.
- Construction costs: To build a 14 unit milking parlour, dairy, plant room, unroofed collecting yard with slatted tank and unroofed drafting area with a small crush costs about €5,000 per unit (2011 prices). Building an 18 unit parlour, to the same specification would cost about €4,300 per unit.
- When comparing one quotation with another ensure you are comparing like-with-like.
- The more automated and elaborate the milking installation is, the more servicing will be required. Increased maintenance costs will be a factor here. It is wise to enquire about these costs in advance.
- Aids for reducing the cost of the development are the VAT refund, the capital allowances and interest relief against income tax. Get an investment health check from your Teagasc adviser.

15 What drafting facilities are available?

Large herds will have bigger milking parlours; therefore the milker will be full-time in the pit. Identifying cows in heat and drafting them for insemination must be operated from the milker's pit.

There are three options:

- manual drafting
- automatic drafting
- automated herd detection and drafting.

Manual drafting requires the operator to pull a rope attached to a swing gate that diverts the cow in heat into a separate pen. It can operate successfully with side exit parlours and front exit parlours, especially for small herds. With large herds, and 16-20 unit parlours, it is more difficult, especially with side exit parlours.

For details on measurements and manual drafting options, check the Teagasc booklet "Cow Collecting Yards and Drafting Facilities." This is available from your Teagasc adviser.



Manual drafting from milking pit works well in front of parlour

With automated drafting, the cows are separated outside the milking parlour. Each cow has a transponder that the auto-drafter identifies. The milker can programme the auto-drafter from the pit or an office to separate out the cows. The transponder (ear tag/neckband) is also used for other management issues, e.g., milk recording, etc.

A simple auto-drafting system is also available where a transponder is attached to the tail of a cow in the parlour. As she passes through the drafting facility, the cow is separated. The tail transponder is then removed and can be used again at the next milking.

New technology is looking at automatic heat detection and associated drafting thus removing this task from the milker. Cows are fitted with neckbands or pedometers which give each cow automated ID. These record cow movements relative to the herd average. Cows in heat, which are much more active, can be identified and drafted automatically. Approximate cost is €2,500–€3,000 for software and €90–€100/cow for the collar/pedometer.

Can an expensive auto-drafting system be justified?

- It is designed for large herds/parlours.
- It saves time in the parlour relative to manual drafting.
- It can be used where there is no room for a manual drafting system.

Checklist

The benefits of good drafting facilities



- The milker can stay in the pit and continue with the milking with minimal or no disruption when drafting (separating a cow from the herd). Disruption to milking extends milking time, reduces time at grass and may lead to overmilking.
- Good facilities greatly reduce the risk of getting injured when separating out cows as they exit the parlour.
- Farmers with a good system can safely draft out cows at their ease and are inclined to continue using AI for much longer.
- Automatic drafting allows cows to be drafted without the milker having to see the drafting taking place e.g. parallel to the parlour.
- Automatic drafting is also valuable for parlour locations which do not allow sufficient space for drafting to take place close to the exit. The drafting unit can be located anywhere suitable on the exit route.

- The holding pen for drafted animals should be at least large enough to hold 10% of the herd.
- Leave room for one complete row of cows before the auto-drafter and the parlour exit.

Entrance/exit gates

Entrance/exit gates that can be operated from anywhere in the pit are essential. There are a number of types available. They are either spring-loaded, opened and closed by a pneumatic or vacuum-operated ram or manually controlled rope and pulley.

Washdown systems

An effective washdown system is essential and should contain multi-stage centrifugal pump systems. You need a pipe going around the parlour with convenient outlets at various locations. A flow rate of 180 litre/min (40 gals/min) at (4 bar 60 psi) is recommended.

Soiled water collection

Soiled water consists of machine washings, bulk tank washings and washings from the cow standings. If the collecting yard is scraped into a tank the scrapings are regarded as slurry. Any rainfall collected from the scraped yard is regarded as soiled water.

If you don't scrape the yard, then what runs off it is regarded as slurry. This makes it difficult to size soiled water tanks in collecting yards. Under the Nitrates Directive soiled water is defined as having a dry matter less than 1% and a biological oxygen demand (BOD) less than 2,500. A ten-day storage capacity must be provided during the closed period. The tank in the collecting yard should be big enough to make washing efficient and avoid the need for frequent emptying.

Dairy and plant room design

- Size – according to bulk tank size (allow for future expansion).
- Leave enough space around tank.
- Ceiling - no common air space.
- Vermin proof.
- Double wash trough.

Milking Facilities

Plant room

- Houses motor, pump, and other equipment.
- Separate room with a separate entrance from outside or from milking premises.
- Adequate floor area - for installation and maintenance.
- Electrical distribution - accessible.
- Ceiling desirable – noise reduction is important.
- Condensing unit may be in the plant room – but preferably outside.
- Ice builders should be located in the plant room.
- Exhaust – noise, fumes, cleanliness. Exhaust vent pipe should direct fumes away from the building.

Construction recommendations – milking premises

- Adequate eave height allows room for equipment and prevents excessively warm parlour in summer.
- Good natural and artificial light is essential.
- Avoid steps at entrance and exit.
- Avoid channels and trapped gullies.
- Bonding.
- Good floor and wall finishes.
- Drainage, levels and falls – S106.
 - Cow standings, pit, dairy, yard washings, roofs.
 - 1:60 to 1:70 along standings.
 - 1:40 across standings and in pit.
 - Pit drainage to external pump sump.



Section 3



Maximising Energy Efficiency

by John Upton



Introduction

The high and rising cost of energy makes energy efficiency a top priority.

- ① What is the best single way to reduce energy costs?
- ② How do I optimise water heating?
- ③ How do I optimise milk cooling?
- ④ What role can variable speed vacuum pumps play?
- ⑤ How can I optimise lighting on the farm?
- ⑥ What renewable energy options are available?

Maximising Energy Efficiency

① What is the best single way to reduce energy costs?

Key point

Night rate electricity v day rate electricity

Night rate is charged at €0.08 per kWh, day rate is charged at €0.16 per kWh. Use night rate electricity as much as possible. Night rate hours are from 11 p.m. to 8 a.m. during winter time and midnight to 9 a.m. for summer time.

Where appliances are required to operate during night rate hours, e.g. electrical water heaters, digital time clocks with battery back-up should be used.

Key risk

Analogue timers without battery back-up will become out-of-synchronisation in power failures

② How do I optimise water heating?

Water heating

An adequate and reliable supply of hot water is an essential element in the production of high quality milk on any dairy farm. Every farmer should have their water tested for hardness. A water softener should be installed in areas of hard water.

Key risks

Inadequate supplies of hot water at required temperatures can lead to rapid increases in bacterial contamination and subsequent reductions in milk quality.

Build up of limescale in water heating systems will shorten life and increase running costs.

Checklist

Water heating

- All hot water pipes and hot water storage tanks should be heavily insulated.
- Electrical water heating systems should be operated on night rate electricity only.
- Oil-fired water heating systems can provide large volumes of hot water very quickly.

- Oil-fired heating systems should be considered if daily usage of hot water exceeds 300 litres.
- Generally, a minimum hot water requirement is nine litres of 80°C water per milking unit for each hot wash cycle, plus a reserve for bulk tank washing.
- The bulk tank will require at least 1% of the volume of the tank of hot water for washing.

Heat recovery

Heat recovery systems transfer energy from the bulk tank cooling system's refrigerant to water in a storage tank, raising the water temperature.

Supplementary heating of heat recovery water using electricity or oil is always required to achieve the desired temperature of 80°C. The heat recovery tank should be used as a buffer tank only. A second tank to heat the water to 80 degrees is always required.

The heat recovery tank should pre-feed the final temperature water tank.

Electrical elements or oil burners should not be connected to a heat recovery tank.

Installing HR is a specialised job and should only be done by a registered refrigeration technician with experience of heat recovery. Incorrect installation will stress the compressors and drive higher power consumption as well as decreasing compressor life.

A guarantee should be sought for all heat recovery installations.

Modifying an old milk cooling system to include heat recovery involves changing to new 404A refrigerant which is expensive and is not recommended. When installed by a qualified refrigeration engineer as part of a new cooling system, upgrading is much safer.

③ How do I optimise milk cooling?

Milk cooling

Refrigerating milk on the farm has two main aims, to inhibit bacterial growth by extending storage on the farm and to minimise milk transport cost. Cooling milk immediately after milking is vital to maintaining high milk quality standards.

How to

Ensure effective cooling



The goal of pre-cooling is to bring the milk temperature as close as possible to that of the water entering the plate cooler.

Effective pre-cooling in a plate heat exchanger can reduce milk cooling costs by 50%. Variable speed milk pumps smooth the flow of milk through the plate cooler resulting in better milk pre-cooling.

Achieve a milk:water flow ratio of at least 1:2. Unrestricted water flow from the well or mains supply through the plate cooler through large diameter pipes is needed to achieve this goal.

Control the water flow through the plate cooler with a solenoid valve so that water is not being pumped unnecessarily when milk is not flowing through the plates.

Adding extra plates to existing plate coolers will have only a moderate effect on the performance of the plate cooler. Increasing the water flow through the plate cooler will have a much more dramatic effect. Variable speed milk pumps are recommended to control the flow of milk through the plate cooler. Ensure a good air flow to and from the bulk tank condensing unit (radiator).

Heavily insulate all refrigerant gas piping.

Key risks



Anything that restricts the supply of fresh air and/or causes the recirculation of warm air will increase running costs and reduce compressor life.

It is very common to see condensing units on farms that are damaged, partially blocked and recirculating warm air.

Alternatives



“Direct expansion” (DX). DX cooling systems are the most efficient in terms of kWhs consumed per litre of milked cooled. However they must operate predominantly on “day rate” electricity. Freezing of small volumes of milk in large DX tanks is a common problem in the ‘shoulders’ of the year. “Instant” cooling is where the milk cooling is completed external to the storage tank and then pumped into storage.

Chilled water from an ice builder is used to cool milk rapidly in a dual phase plate heat exchanger. This cooling system is less efficient in terms of kWhs consumed per litre of milk cooled, however ice bank builders can generate enough ice at night to meet the entire milk cooling demand the next day. This system takes advantage of significantly cheaper night rate electricity.

4 What role can variable speed vacuum pumps play?

Variable speed drive (VSD) vacuum pumps

Variable speed drive vacuum pump motors can save over 60% of the energy used by the vacuum pumps. The VSD can adjust the rate of air removal from the milking system by changing the speed of the vacuum pump motor to match the rate air is admitted to the system at a given vacuum level. All of the energy used to move air through the conventional vacuum regulator is saved.

5 How can I optimise lighting on the farm?

How to

Optimise lighting on dairy farms



Moisture resistant double fluorescents or high bay metal halide lamps are the most common types of lighting used on Irish dairy farms. Similar size dairies using metal halide lights can use over three times as much electricity on lighting as farms using fluorescent type lights.

Key risks



Some modern fluorescent tube fittings tend to interfere with milking parlours’ automatic cow identification systems, reducing the effective distance from the cow’s ear tag to the antenna.

The reason for this is the use of high frequency switching ballasts within the light fittings themselves. These ballasts give out high frequency nuisance signals which interfere with the automatic identification antenna.

Key points



Switch start or magnetic ballast fluorescent tubes (double five foot T8 58W switch start) fluorescent tubes are still commercially available and where automatic identification systems are installed, these lights are the best option.

Maximising Energy Efficiency

Where automatic cow identification is not installed, T5 high efficiency fluorescent tubes (double five foot 58w T5) are the best option. Low pressure sodium (LPS) lights are the most efficient solution for lighting external areas where colour perception is not a priority.

⑥ What renewable energy options are available?

Renewable energy

Renewable energy refers to energy that occurs naturally and repeatedly in the environment. Therefore, it does not release any net greenhouse gases into the atmosphere.

Using renewable energy sources can offer a range of benefits:

- lower energy bills
- energy price stability
- security of supply
- 'green' credentials
- possibility of selling electricity back to the grid.

Renewable energy can be generated using various technologies and at various scales.

Electricity generation:

Alternatives



Wind power

Wind turbines are used to produce electricity. Small-scale roof-mounted turbines rarely offer solid payback periods. Larger mast-mounted turbines require detailed site surveys as site location is critical to turbine performance and planning permission may be required. Utilising the power generated is difficult on dairy farms due to the load profile; grid connection is essential. Payback periods realised will be dictated by the export tariff.

Solar electricity (photovoltaics)

Panels or cells convert sunlight into electricity. They are attached to the outside of buildings – requiring a structural survey and possibly planning permission. As with wind power, utilising the power generated is difficult on dairy farms due to the load profile; grid connection is essential. Payback periods realised will be dictated by the export tariff.

Small-scale hydro-electric power

An immersed turbine uses flowing water to produce electricity. This technology is highly site-specific. It requires a nearby body of water that is flowing and has a drop in level that can be exploited.

Solar water heating

Uses energy from the sun to heat water up to 55–65°C. Systems should be roof-mounted and ideally integrated into your current hot-water system. Solar thermal systems could meet 40–50% of the water heating demand on a dairy farm. A supplementary heating source will always be required to achieve the desired 80°C for plant washing.

Air-source heat pumps

These pumps are a way of converting low-level heat, occurring naturally in the air, into high-grade heat. Systems must be attached to the outside of buildings. Air-source heat pumps are not completely 'renewable' as they require electricity to drive their pumps or compressors. A supplementary heating source will always be required to achieve the desired 80°C for plant washing.

Payback periods on renewable technologies can vary considerably with farm size and initial capital costs. Generally, the larger the farm the more cost-effective renewable technologies become. Rising energy costs will make these technologies more attractive year on year. New technologies to reduce dairy farm electricity consumption are being identified and evaluated on an ongoing basis as part of the larger energy research programme in Teagasc.

Section 3

Winter Facilities

by Pat Clarke



Introduction

Choice of winter facilities is key, particularly for expanders or new entrants to dairying.

- ① How much should winter accommodation cost?
- ② What are the advantages/disadvantages of each system?
- ③ How can I ensure animals have adequate feed space?
- ④ What slurry facilities do I need?

Winter Facilities

① How much should winter accommodation cost?

There are many different combinations of winter accommodation and slurry storage facilities that can be used at farm level. Each has their own merits, but there are some basic considerations before choosing a system.

Factors to consider include:

- initial capital cost
- availability and cost of capital
- annual running costs
- annual labour input
- potential to increase capacity.

Table 1: The effect of winter accommodation system on construction costs, operating & annualised housing costs for a 16-week winter. (Estimates 2016)

	Conventional cubicle shed	Out-wintering pad/Earth-lined store
Slurry storage requirement (m ³ /cow/year)	5.3	7.8
Total housing/slurry storage cost (€/cow)	1,600-1,800	700
Depreciation & interest (€/cow/year)	160	70
Bedding & slurry spreading (€/cow/year)	20	85

Winter facilities drawings: Contact your local Teagasc office for a copy of the different winter facility options (up to 30 different designs available).

Always ensure you are applying for grants to which you are entitled.



② What are the advantages/disadvantages of each system?

Table 2. Advantages and disadvantages of different types of winter accommodation.

	Advantages	Disadvantages
Cubicle shed	<ul style="list-style-type: none"> • Low maintenance • Independent of weather for cows and farmer • Suitable for lactating cows, e.g. liquid herds, autumn, late spring 	<ul style="list-style-type: none"> • High initial cost • Repayments subject to interest rate changes where capital is borrowed • Inflexible, as size of cubicles determines animal use • Design may not allow for expansion
Straw-bedded shed	<ul style="list-style-type: none"> • Flexible shed for livestock • Shed can be used for other purposes 	<ul style="list-style-type: none"> • Annual straw cost • High labour requirement • High machinery cost • Dungstead required where sheds are cleaned out during winter closed period • Low number of animals per m² of shed
Out-wintering pad	<ul style="list-style-type: none"> • Low initial capital cost • Flexible • Animals outdoors – improved animal performance when managed correctly 	<ul style="list-style-type: none"> • Annual cost of woodchips • Cost of spreading woodchips, plus effluent • Not suitable for lactating cows over a long period • Less suitable on marginal land • Farmer exposed to weather for management activities
Winter crops, e.g. kale/rape	<ul style="list-style-type: none"> • No capital cost • Animals outdoors • No machinery running costs 	<ul style="list-style-type: none"> • Slurry storage facility required (by law) • Weather dependent, e.g. heavy frost • High level of management required • Good yield of crops required
Saved grass	<ul style="list-style-type: none"> • No capital costs • Less machinery required 	<ul style="list-style-type: none"> • Slurry storage facility required (by law) • Large land area required e.g. 0.5-1.0 ha per cow
Outdoor Cubicles	<ul style="list-style-type: none"> • No shed cost at construction • Easy to expand cubicle numbers • Animals are outdoors • Low maintenance 	<ul style="list-style-type: none"> • Less suitable in high rainfall areas • Increased volumes of soiled water to collect • Farmer exposed



Winter Facilities

Cubicle shed

Construction of a cubicle shed for cows is a major project requiring significant design and financial planning before construction begins. Cubicle shed plus slurry storage could cost between €1,500 and €2,000 per cow place, which is approximately €260,000 for 150 cow places.

Considerations when designing a cubicle house include:

- number of cubicles (i.e. cows to be housed)
- potential to expand in future
- number of rows of cubicles
- location of feeding passage and feed space per cow
- water supply to shed
- access from shed to paddocks and milking parlour.

Table 3: Features and dimensions of cow cubicles

Cubicle width (centre to centre)	1.15m +/- 0.025
Total length (rows towards wall)	2.3 – 2.6m
Total length (rows head to head and single rows with no front wall)	2.21 – 2.45m
Brisket board/pillow from rear kerb (if fitted)	1.75m +/- 0.05m
Neck rail from rear kerb, (measured horizontally)	1.70m +/- 0.05m
Height of neck rail	1.15m +/- 0.05
Cubicle bed slope	5% +/- 1%
Bedding height above the passageway floor	0.2 – 0.25m

Refer to DAFM specifications **S101** for full details for construction of a cubicle shed for cows.

Figures 1 and 2 show the plan and cross-section of a typical shed with 126 cubicle places.



Outdoor cubicles

This system of wintering cows is an option in low rainfall areas with long grazing seasons. Compared to conventional cubicle housing, the cost of the shed is avoided, but there is increased storage for the rainwater collected during the winter period.

There is an option to roof the cubicles at a later date. Compared to out-wintering pads, they are much cheaper to maintain and have the same advantage in that cows are accustomed to weather conditions for grazing after calving.

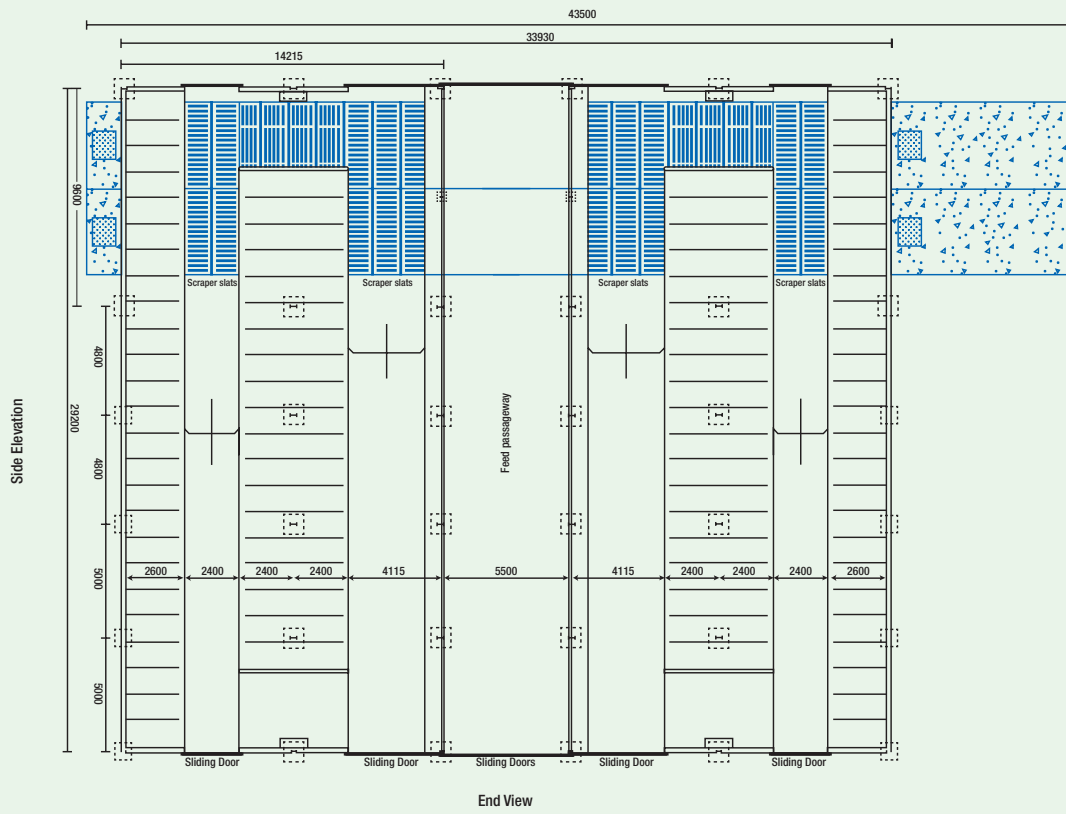


Figure 1: Plan of cubicle house with 126 cow places.

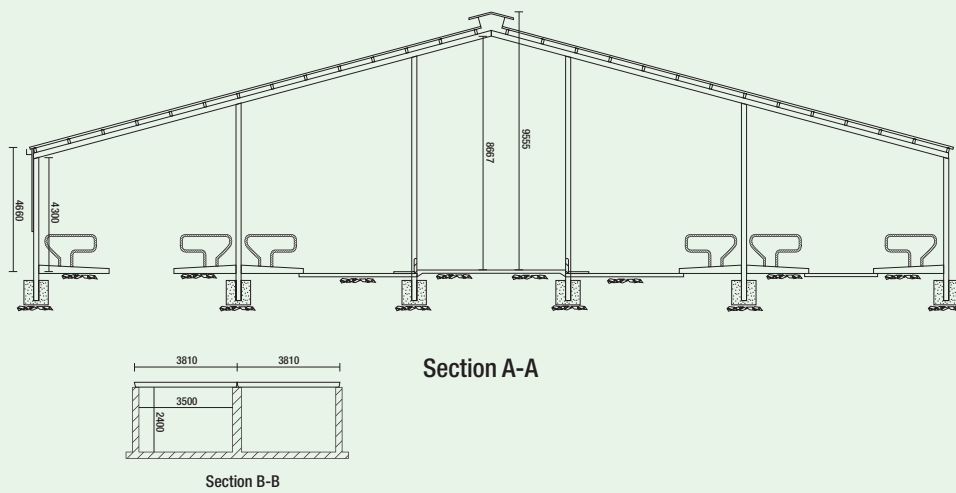


Figure 2: Plan of cubicle house with 126 cow places.

Winter Facilities

Alternatives



Cubicle kennels

Cubicle kennels are an alternative to a full cubicle shed. In this design, only the cubicles are roofed, the passages and feed area are unroofed. This reduces the cost of construction. Slurry is scraped from the passages and feed area to an external slurry storage facility.

Out-wintering pads

Out-wintering pads (OWP) are a new development in Ireland. Pads are bedded with woodchip and the drainage system underneath removes urine and rainwater. The cow feed area can be located on the pad or off the pad. Some slurry is removed from the feed area (by scraper), with the remainder incorporated into the woodchip.

Key facts



Out-wintering pad

Space allowance	12m ² lying area/cow
Storage required	All slurry from cows plus rainwater on OWP
Rainfall level	As specified under nitrates rules
Drainage	Ridges and drainage pipes leading to storage facility
Ridges	3m apart and 150mm high
Drainage stone	300mm above drainage pipe
Woodchip height	200mm above drainage stone



How to

Calculate the area for an OWP

E.g. For a 150 cow herd	
Pad area required (150 cows x 12m ² per cow)	= 1,800m ²
Feed area required for silage only (150 cows x 300mm/cow)	= 45m
Pad area (1,800 divided by 45)	= 45m x 40m
Feed standing area (concrete)	= 3m
Overall pad area	= 45m x 43m

Woodchips: Woodchips will compact by about 30% when spread on a pad. Therefore a 1,800m² pad will require 360m³ of compacted woodchip, which is equivalent to 514m³ fresh woodchip. The approximate bulk density for sawmill by product is 400kg/m³ and 250kg/m³ for recycled timber

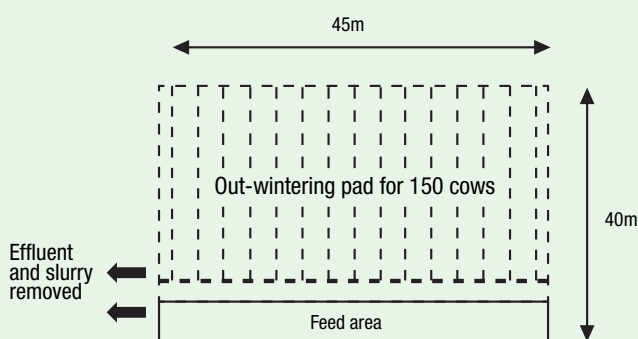


Figure 3: Layout of out-wintering pad for 150 cows with feed space of 300mm per cow

Earth-lined or geo-membrane lined

A site assessor, approved by the local authority, will inspect the site, and carry out a site analysis and characterisation prior to construction. Following site assessment, a decision can be made whether an earth-lined or geo-membrane liner is required. There are minimum accepted criteria that determine whether the site is suitable to be earth-lined, e.g. clay content, sub-soil thickness, sub-soil suitability, water-table height, etc. There are four steps to site assessment:

- (A) collation of background information
- (B) visual assessment
- (C) trial holes and site tests
- (D) decision-process and preparation of recommendations.

Check DAFM specifications for details of on-site assessment.

- **S132** Minimum Specification for Out-wintering Pads - Feb 2007
- Guidance Document for Out-wintering Pads
- **S132A** Accepted Contractors for Geo-membrane Lined

Figure 4 (overleaf) shows the cross section area of an out-wintering pad that requires a geomembrane liner. Figure 5 shows an earth lined pad where the clay content of the subsoil is at least 10%. The depth of compacted sub soil layer will depend on the clay content of the soil.

Winter Facilities

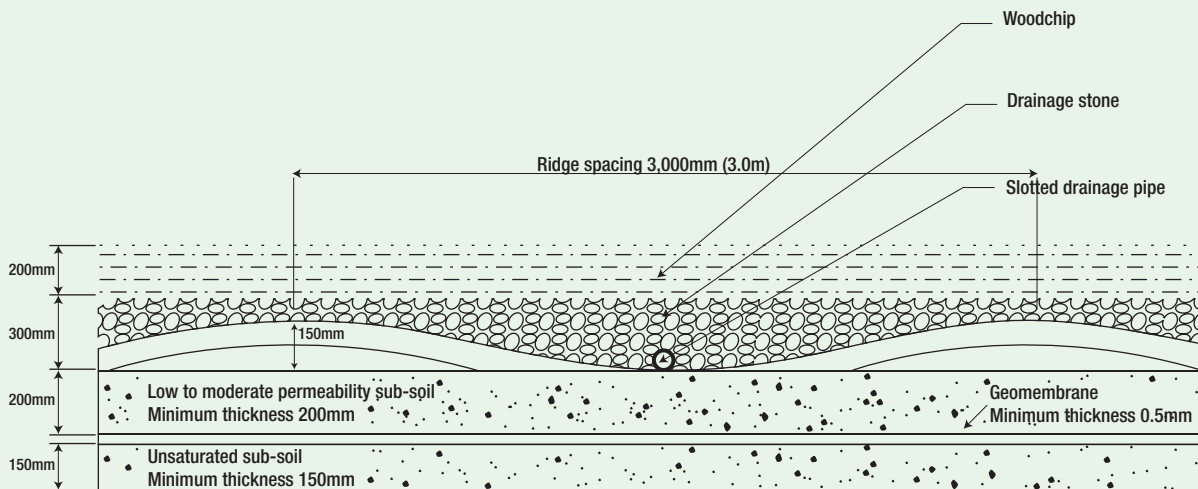


Figure 4: Cross section of out-wintering pad showing geo-membrane liner (from DAFM specifications)

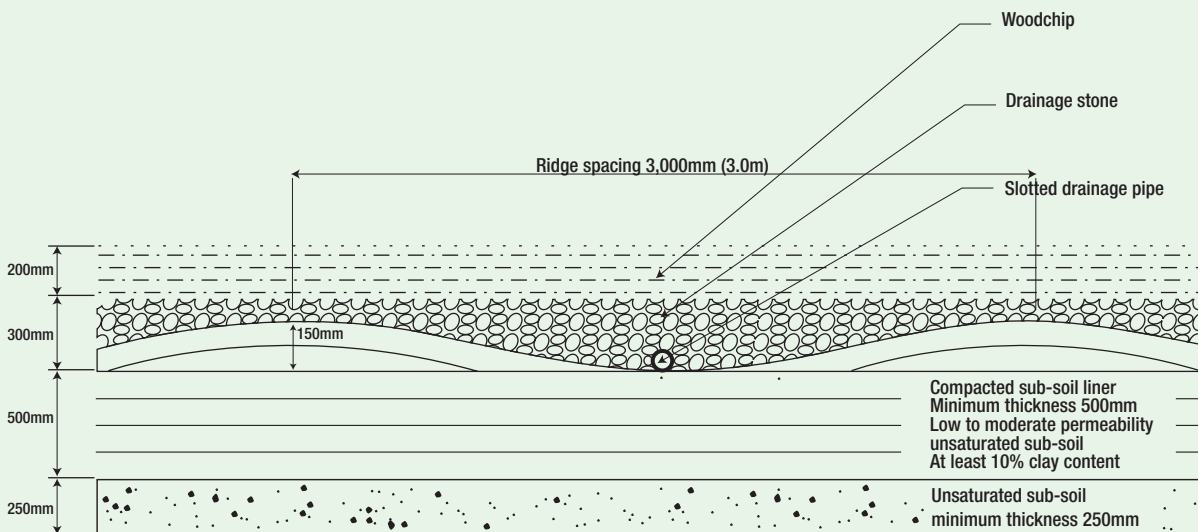


Figure 5: Cross section of out-wintering pad showing compacted earth liner (from DAFM specifications)

On-pad feeding/off-pad feeding

There is an option to place silage on top of the pad and allow the cows to self-feed. In this case the space allowance is 20m²/cow on the pad. This includes the silage pit. The silage pit should be filled from outside the pad, to prevent damage to the drainage system by machinery.

The pit should be a maximum of 1.8m high to allow cows to fully eat the pit face without having to feed out the silage. For 150 cows this would require a pad size of approx. 3,000m², i.e. 50m x 60m.

Grazing crops over the winter

Grazing feeds *in situ* reduces the cost of feed per cow over the winter. Also, there is no requirement for wintering facilities but full slurry storage is required (under legislation) for all dairy cows on the farm. Options include swede, kale, fodder beet, rape, turnips and winter grazing of grass.

Successful over-wintering on crops requires:

- high crop yields
- suitable soil type for growing crops
- suitable soils for grazing
- grassland management that allows cows go to grass full-time after calving
- alternative forage supply during difficult weather, e.g. wet conditions, frost
- back-up forage if crops fail, e.g. due to heavy frost.

The land area required will depend on the yield potential of the crop and the sowing date. See Table 4 for potential carrying capacity of the different crops.

Table 4: Potential grazing capacity of crops during a 100-day winter

	Fodder Beet	Kale	Swede	Rape	Deferred grass
Yield (t DM/ha)	18	10	12	4.2	2.8
Utilisation (%)	70	70	70	70	60
Energy (NE/kg DM)	1.12	1.05	1.12	1.03	0.85
Supplement required as baled silage (kg DM/day)	3	3	3	3	0
No. of cows wintered per hectare for 100-day winter	29	15	19	6	2
Hectares required for 150 cow herd (100-day winter)	5.2	10	8	25	75

Straw-bedded shed (no dungstead)

The cost of straw makes this system extremely expensive. In addition, there is increased labour with bedding, mucking out and spreading of the farmyard manure generated. Approximately 55kg of straw per cow is required each week to absorb all urine. This is equivalent to four small square bales of straw.

Manure pit and dungstead

Bedding material for calving and calf rearing cannot be stored on grassland over the winter closed period. Effluent must be collected where this material is removed from sheds over the winter. Refer to DAFM specification for manure pits and dungsteads for construction details.

- S108 Manure Pits and Dungsteads

③ How can I ensure animals have adequate feed space?

Feed barriers

- There are two main methods, easy feed and self-feed.

Easy feed

Barrier design is crucial. Cows must have a good reach with neck-rail, stub wall and feed passage height giving cows maximum reach without impacting on animal posture. Similarly, space per cow must be sufficient for the feeding system so that no bullying, lameness or health issues are caused by the feed barrier. For head space, there are two recommendations:

(a) Silage fed ad-lib - 300mm/cow

(b) Meal feeding - 600mm/cow

An increasing number of farms are feeding supplements at feed barriers, e.g. no feeders in parlour, feeding high quality baled silage in spring/autumn. In these scenarios, it is essential that adequate feed space is available for the herd.



Winter Facilities

Key facts

Feed barriers

Head-rail height from cow standing area (adjustable):	1,175mm
Stub wall height from cow standing area:	550mm
Feed passage height above cow standing area:	125mm
Concrete apron to slat in cow area:	600mm
Head-rail location on stanchion:	on feed passage side
Silage feed space per animal:	300mm
Meal feed space per animal:	600mm
Stub wall thickness:	100mm

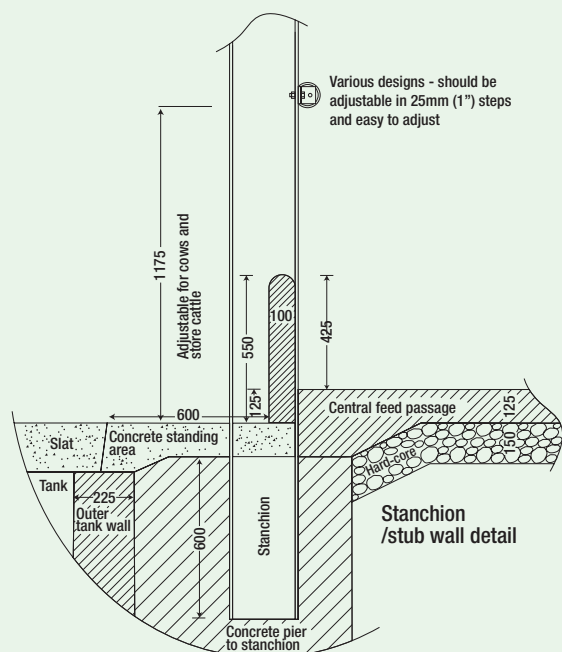


Figure 6: Typical stub wall and feed barrier.

Self-feed

Self-feed systems are operated by electrical wire where cows can eat above and below the electrical wire. This wire must be flexible. Pit height should be a maximum of 1.8m high.



4 What slurry facilities do I need?

Slurry storage

Slurry produced during winter is a major resource. Recycling this slurry to the grassland area is an essential part of nutrient planning on dairy farms and reduces the amount of P and K fertiliser needed. Similarly, slurry can be used to replace N fertiliser, especially when applied early in the grazing season.

Legislation defines minimum slurry storage capacities required on dairy farms. These range from 16 to 22 weeks, depending on the zone a farm is located in. Similarly there are minimum closed periods when slurry cannot be spread. These range from 12 to 16 weeks.

Key facts

Slurry storage

Slurry produced per week:

Dairy cow	0.33m ³
0-1-year-old cattle	0.08m ³
1-2-year-old cattle	0.15m ³

Winter slurry storage required per cow by law

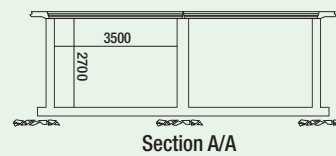
16-week zone:	5.28m ³
18-week zone:	5.94m ³
20-week zone:	6.6m ³
22-week zone:	7.26m ³



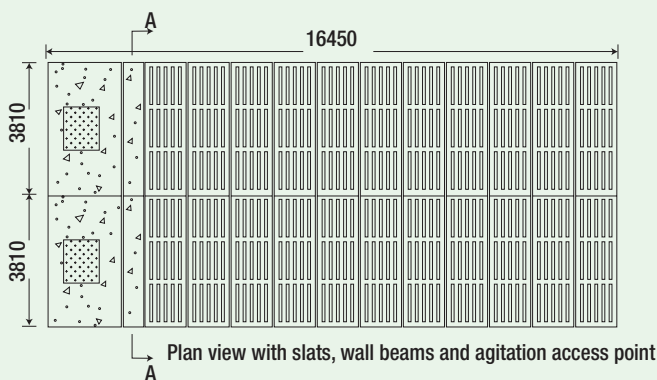
	Advantages	Disadvantages
Slatted tank	<ul style="list-style-type: none"> • Low labour requirement • Low maintenance • No running costs • Where all passages are slatted – eliminates requirement for scrapers 	<ul style="list-style-type: none"> • Expensive to construct • Difficult to increase capacity/expand tanks
Steel tank	<ul style="list-style-type: none"> • Cheaper to construct • Can increase capacity by adding extra height • Can locate outside farmyard to allow for extra expansion within farmyard 	<ul style="list-style-type: none"> • Slurry must be pumped into tank • Slurry collecting system required, i.e. scrapers/slurry channel • Rainwater is collected
Lagoon (earth lined or geo membrane lined)	<ul style="list-style-type: none"> • Cheap to construct • Some sites suited to earth-lined lagoon • Slurry is dilute – more efficient use of N fraction in spring 	<ul style="list-style-type: none"> • Collects rainwater, extra volume to be spread • Slurry collecting system required i.e. scrapers/slurry channel • Some local authorities don't allow earth lined lagoons

Slatted tanks

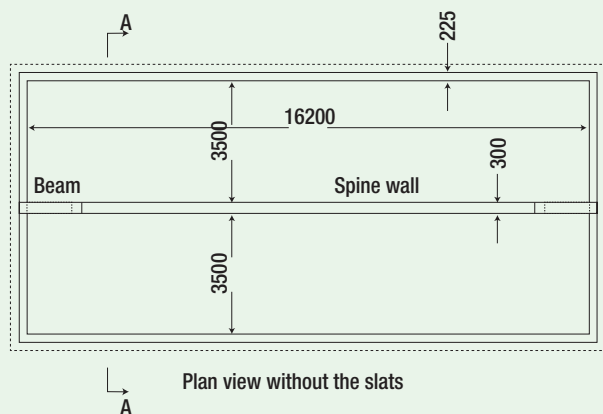
Figure 7 shows the typical slatted tank design. Internal width is 3.5m with a 3.81m (12'6") slat on top. The spine wall is 300mm to support the two slats with outer wall 225mm. Net capacity of the tank is the internal length (16.2m) by the internal width (3.5m) by the net height. A freeboard allowance of 200mm is taken from internal tank height to get the net height. Therefore the slurry capacity of each tank is 16.2m x 3.5m x 2.5m which is 141.75m³.



Section A/A



Plan view with slats, wall beams and agitation access point



Plan view without the slats

Figure 7: Cross-section of standard double slatted tank with 4.1 metre slat

Winter Facilities

How to

Calculate slurry tank size



Slurry produced – 150 cows x 0.33m³/week x 18 weeks = 891m³

Slatted tank – 2.7 m deep (net depth 2.5m), 3.81m (12'6") slat (3.5m internal width)

Capacity per metre of tank = 2.5m deep x 3.5m internal = 8.75m³ per metre length of tank

Required tank length - 891 divided by 8.75 = 102m

This tank will usually be in sections e.g. four tanks each 25 metres long or alternatively tank size could be wider i.e. 4.4m, 5.0m etc. increasing the capacity and therefore reducing the total length of tank required.

Refer to DAFM specifications for construction of slatted tanks

- **S123** Bovine Livestock Units and Reinforced Tanks - March 2006.

Collecting rainwater

Outdoor collection facilities e.g. overground steel tanks, lagoons must also collect rainfall and therefore require additional capacity for rain storage over the winter period. There is also a freeboard requirement of 300mm with outdoor storage facilities.

Table 5: Average net rainfall during the specified storage period.

County	Millimetres per week	County	Millimetres per week
Carlow	24	Longford	23
Cavan	27	Louth	20
Clare	32	Mayo	40
Cork	37	Meath	19
Donegal	38	Monaghan	23
Dublin	17	Offaly	20
Galway	34	Roscommon	26
Kerry	45	Sligo	32
Kildare	18	Tipperary	27
Kilkenny	23	Waterford	31
Laois	22	Westmeath	21
Leitrim	33	Wexford	25
Limerick	26	Wicklow	33

Where the rainfall level is 32mm per week and the winter period is 18 weeks then a total of 576mm of rainwater will fall during this period. Outdoor storage must allow for this rainfall. Also 300mm freeboard must be included in tank capacity.

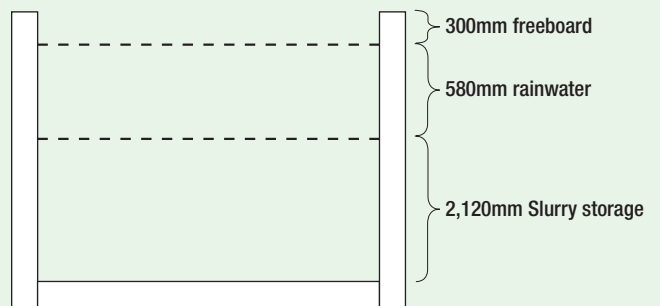


Figure 8: Outdoor tank 3.0m high showing freeboard, rainwater and slurry storage for 18-week zone with 32mm rain per week (not to scale)

Overground circular tank

Overground tanks (steel and concrete) are available in a range of sizes. Normally their height is two rings, but some have the option to increase height by one ring and therefore increase the capacity.

The capacity of a circular tank is pi (3.14) multiplied by the radius squared by the height. But remember that freeboard and rainfall must also be allowed for. For example, the net capacity for a tank that is 3.0m high, radius of 10m, rainfall of 32mm per week and storage requirement of 18 weeks is pi (3.14) x radius squared (10 x 10) x net height (3-(0.3+0.58)) = 666m³.

Refer to DAFM specifications for full details of construction of overground slurry stores.

- **S122** Minimum Specification for Proprietary Over-Ground Circular Slurry/Effluent Stores - Feb 2006.
- **S122A** Accepted Contractors for Proprietary Over-Ground Circular Slurry/Effluent Stores - March 2009.

Lagoons



Lagoons are cheap to construct and can accommodate large volumes of effluent. As for out-wintering pads, the proposed site must be assessed to determine whether an earth or geo-membrane liner is suitable. In calculating the slurry capacity of a lagoon, multiply the average height (excluding freeboard and rainwater) by the average width by the average depth. For example, in Figure 9 the capacity is 2.4m x 15m x 15m which is 540m³ (120,000 gallons) (1m³ = 220 gallons)

Key facts

Earth-lined lagoon (ELL)

Maximum liquid depth	3.0m
Minimum freeboard depth	0.75m
Minimum ground level to top of banks	0.6m
Maximum inner bank slope	33°
Maximum outer bank slope	33°
Minimum width of top of bank	3.0m

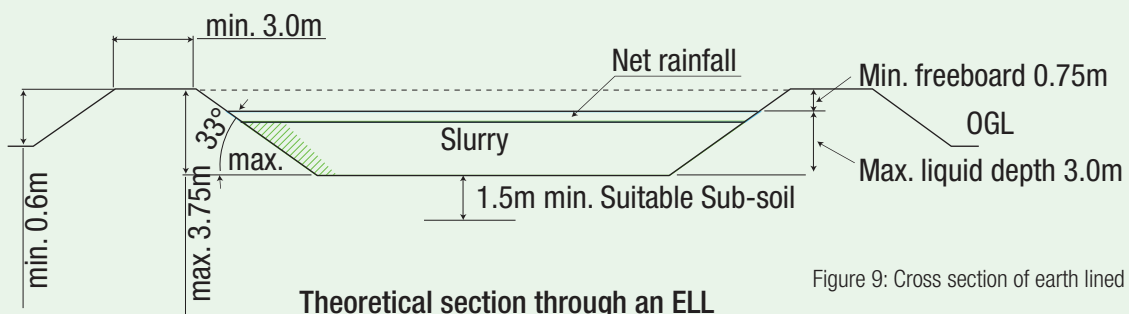


Figure 9: Cross section of earth lined lagoon

Lagoons and out-wintering pads (OWP)

Where out-wintering pads are linked to a lagoon the capacity of the lagoon must be sufficient to hold:

- effluent produced from the pad
 - slurry from the cows
 - proportion of rainfall on the pad
- Rainfall on the lagoon.

How to

Calculate effluent produced from an out-wintering pad



The formula is:

$$E = (P \times R) + (N \times V) - (P \times 0.013)$$

where:

E = effluent produced, (m³ per wk)

P = pad area, (m²)

R = net rainfall on the pad, (m per wk)

N = no. of animals on the pad,

V = excreta produced per animal per week (m³ per wk).

e.g. 150 cows for 18 weeks with 32mm rainfall per week

$$= (1,800 \times 0.032) + (150 \times 0.33) - (1,800 \times 0.013)$$

$$= 83.7\text{m}^3 \text{ per week}$$

$$= 1,507\text{m}^3 \text{ for 18-week winter}$$

Winter Facilities

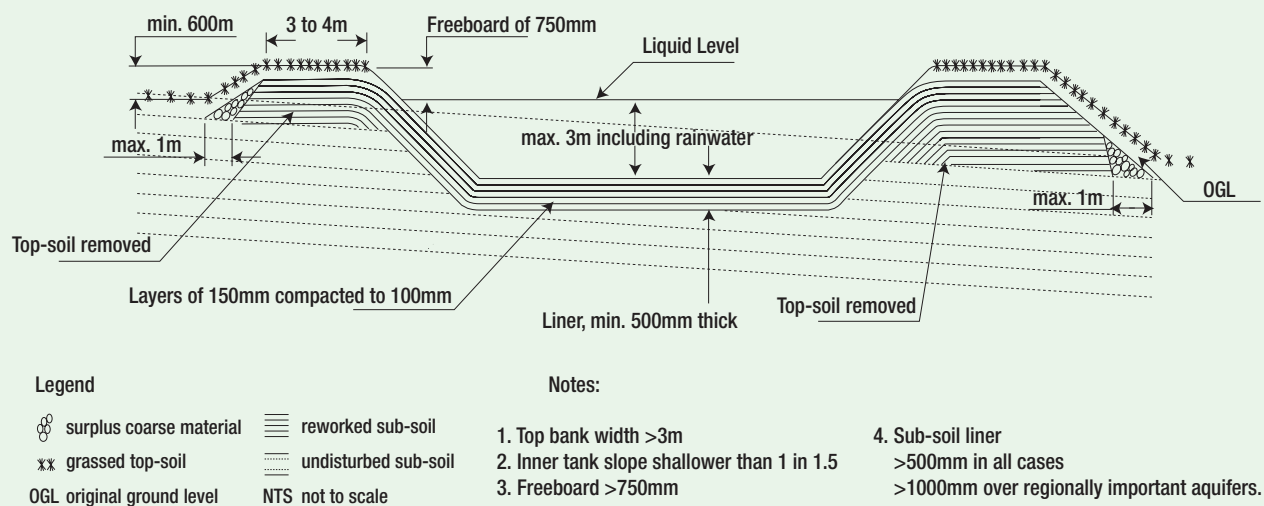


Figure 10: Cross-section of earth-lined lagoon

Refer to DAFM specifications for construction of lagoons

S126 Minimum Specification for Geomembrane-lined Slurry/Effluent Stores, and Ancillary Works - Nov 2002

S126A Accepted Contractors for Geomembrane Lined Slurry/Effluent Stores - June 2010

S131 Minimum Specification for Earth-Lined Slurry/Effluent Stores - Oct 2005

Earth lined lagoons and out-wintering pads are not permitted in some local authority areas due to the nature of the sub-soil. Check before proceeding.



Section 3

Dairy Farming on Heavy Soils

by James O'Loughlin, John Maher



Introduction

More than one-third of milk production in Ireland is carried out on heavy soils.

- ① Why is farming on heavy soils difficult?
- ② What are the basic principles of dairying on heavy soils?
- ③ What are the challenges in dairy farming on heavy soils?

Dairy Farming on Heavy Soils

① Why is farming on heavy soils difficult?

The problem of these soils is low permeability i.e. water is slow to pass down through the soil profile. This makes grass utilisation difficult as treading of cows' feet damages pasture. Land is more easily compacted when soil is wet and drainage is further impaired. Often these soils occur in locations with high rainfall.

② What are the basic principles of dairying on heavy soils?

The basic principles of spring calving milk production are not any different than for other soils and involve:

- compact calving
- maximising milk production from grazed grass.

③ What are the challenges in dairy farming on heavy soils?

1. Calving date

Turn-out to grass is normally later on heavy soils, so the start of calving should also be later. Compactness of calving is more critical on heavy soils as the grazing season is shorter.

2. Farm infrastructure

To maximise grass utilisation on heavy soils it is critical to have:

- good farm roadways.
- a well laid-out paddock system.
- multiple water access points.

Ground conditions are often marginal on farms with heavy soils. It is inevitable some damage will be done; therefore it is essential that when animals come off a damaged area, they do not go in there again until the next rotation. This cannot be done without an adequate farm roadway system; easy to operate paddock system with multiple access/exit points and easy access to water for cows. Cow paths or spur roadways should be considered.

3. Adequate winter feed

Heavy farms have longer winter feeding requirements. The growing season will be shorter and often a higher peak growth rate occurs. This must be harnessed to maximise the amount of quality silage harvested. Making round bale silage is very useful to keep grass supply under control and provide quality short-term feed in times of deficits and/or poor grazing conditions. There should be a greater emphasis on quality silage, as cows will end and begin lactation on some silage.

4. Winter housing and slurry storage

Longer winters mean more slurry storage. Most farmers who farm on heavy soil farms have adequate slurry storage and housing for the existing herd. However with expansion will come demands for additional slurry storage and housing.

5. Ryegrass content

Levels of ryegrass are quite low on a lot of heavy farms. There are challenges in reseeding as the 'window' to reseed is much shorter on heavy land. Nonetheless it is essential that ryegrass is established to maximise grass production. Late heading diploid varieties are the most suitable.

6. Grazing management practices

Severe damage to pasture must be avoided at all costs. Grazing management practices (e.g. grazing from the back of the paddock, spur roadways) that will limit damage to pasture must be considered. In addition, giving cows access to grass for a limited time only (on/off grazing for 1-3 hours) will help. If damage to pasture is severe despite using these techniques, then animals should be housed.

7. Drainage

There are opportunities to improve grass production and utilisation through drainage. It is costly and needs to be part of an overall business plan. Before drainage is undertaken, the basics must be right. Watercourses must be opened and cleaned, existing drains examined and repaired, etc.

Section 3

Mechanisation

by Dermot Forristal



Introduction

The key challenge for dairy farmers is to establish the right balance of machinery ownership and use of contractors.

- ① What are the key issues to consider in relation to a mobile/motorised machinery strategy on a dairy farm?
- ② What is the best approach for tackling mechanisation?
- ③ What size of machine should I purchase?

Mechanisation

① What are the key issues to consider in relation to a mobile/motorised machinery strategy on a dairy farm?

The farmer should consider whether owned machines or alternatives such as contractors should be used.

If machines are to be bought: the type and ownership strategy of the machine should be worked out in advance.

There are many factors which influence these decisions. The decision to use a contractor supplied service instead of buying machines typically depends on:

- contractor costs v ownership costs (depending on scale)
- availability of contractor service
- quality and timeliness of contractor service
- availability of labour and consequently value of labour supplied by contractor
- impact of adoption of contractor use on utilisation of existing machinery (e.g. tractors).

It should be remembered **when a contractor is chosen, the quality of the service must still be monitored and managed by the farmer.**

Where ownership is chosen, decisions about the size and type of machine to be purchased and in particular the replacement age of the machine and whether the machine is purchased new or second-hand, must be made. These will be influenced hugely by scale, but also by factors such as the availability of labour and supporting machines (e.g. a suitable tractor), but also the ability of the farmer to maintain machines inexpensively. It is worth noting however that mechanisation supply is just one element of farm management and it should not distract the farmer from the key management activities which influence farm profitability.

② What is the best approach for tackling mechanisation?

For each machinery operation, the costs and benefits of alternative supply options should be considered. All aspects outlined here should be considered but emphasis on calculating cost and benefits is important. Individual operations should not be considered in isolation, as there is frequently a need to match implement size to tractor availability.

For example if a 70kW tractor is sufficient for fertilizer spreading, feeding and most operations on a farm, it would be uneconomic to purchase a 10,000 litre slurry tanker that would require the purchase of a larger tractor for this operation alone. Alternatives would be to continue to use a smaller tanker or hire in a contractor for this service.

For most farms, there will be a mix, ownership for some operations, and contractor use for others. Typically the contractor supplied services will be those which can be supplied in a short time and which benefit most from the economies of scale (e.g. silage harvesting).

③ What size of machine should I purchase?

This is a complex question. Generally machine size is related to the working capacity required which is in turn dependent on the time available to do the work. Over-capacity brings little production benefit and can be expensive, although long replacement life strategies and/or the use of second-hand machines can reduce the additional costs of some over-capacity.

Tractor size needs to be broadly matched with the main implements it works with. The tendency to pursue the mechanisation choices of larger farms should be avoided unless expansion is imminent. If a 150 cow unit uses a 100kW tractor, matching loader and grab, 18m³ diet feeder and 9,000 litre slurry tanker; then should not a 75 cow unit be able to operate with machines of half the working capacity? Plan carefully, with cost and timeliness as key determinants of machine capacity.

Please see appendix at end of manual on zero grazing.