Beef Farm Infrastructure Handbook

Animal & Grassland Research and Innovation Programme

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Agriculture and Food Development Authority

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1. Introduction

The guiding principal of good farm infrastructure is that it's safe, and allows for best management practices that are sustainable from an animal welfare, labour efficient, economic and environmental perspective. This handbook is designed to be used as a guide for beef farmers who wish to upgrade their existing farm infrastructure or invest in the establishment of a new farm enterprise.

The handbook covers important areas such as grazing infrastructure, water supply systems, land drainage design and installation and the importance of incorporating biodiversity in the farming system. Grazing infrastructure in relation to roadways, paddock layout and water systems is important in terms of overall herd performance as it can allow more days at grass and therefore greater profitability. The section on land drainage design and installation highlights the importance of carrying out a site and soil test pit investigation prior to installing a drainage system. Finally, biodiversity management is important because it provides both productivity benefits on farm and social and environmental outcomes for the wider community.

In this publication sometimes there are references to commercial suppliers and to products of particular manufacturers. By such reference, it is not intended to indicate that these are the only products, suppliers and materials available; such references are for demonstration purposes only. It is strongly recommended that farmers consult with their advisory officers before using the information provided.

2. Grazing infrastructure

Good grazing infrastructure will allow more days at grass, provide easier management of grass at times of peak growth and make grazing less weather dependent. In a spring-calving suckler herd, one extra day at grass in spring is worth €52/day/40 cows in feed savings. A lot of thought needs to be invested in deciding where to site the farmyard on the farm, how to subdivide the farm into a paddock system and what the optimum layout of roadways should be to make animal movement most efficient. The four key issues to consider are:

1. Adequate access to all grazing areas.
2. Distance that stock are required to walk.
3. Design and layout of roadways. (See roadway design).
4. Farm security and animal disease biosecurity.

2.1 Paddock Layout

Proper subdivision of grazing land into paddocks is essential to be able to successfully manage pastures and achieve desirable rotation intervals. Paddocks must be connected with an efficient roadway system so that the herd can move from one paddock to any other paddock on the farm. An accurate map of the farm is essential.
The ideal paddock system should include:

- The roadways from the farmyard to the paddocks should be wide, smooth and as short a distance as is practical.
- Paddocks to be rectangle to square in shape and wetter paddocks should have longest sides running adjacent to the roadways to avoid poaching in wet weather.
- Alter paddock shape to facilitate stock movement into and out of the paddock i.e. stock move down-hill to exit paddocks.
- Roadways to follow contour where extreme and be wide with gentle sweeping bends.
- Locate roadways on the sunny windy side of a ditch, hedge or tree line.
- Avoid putting roadways directly through springs or swampy ground.
- Main paddock access to be angled to the roadway with at least two access points for each paddock.
- Plan for multiple access points from the roadway for paddocks on wet ground. Have several access points between adjacent paddocks.
- Electrified fences divided into sections with easy to access cut-off switches.
- Number the paddocks with a tag on the gate and on a map of the farm.

Creating paddocks

1. Get a map of the farm with areas for each existing field or paddock.
2. Use farm maps to consider several different ways of laying out the farm and consider the positives and negatives of each one.
3. Decide on the number of paddocks required; have at least six and preferably nine paddocks/grazing divisions for each separate grazing group of cattle.
4. Minimising the number of grazing groups reduces the number of paddocks needed.
5. Determine most suitable road layout to service each paddock.
6. Identify the most appropriate water trough(s) position in each paddock. Where possible, share a trough between paddocks but, more importantly, position the troughs to allow further, possibly temporary, subdivision of paddocks.
7. Allow for multiple entrances. This is useful during temporary subdivisions and allows moving livestock to exit at the end of the paddock irrespective of what direction they are moving on in.
8. Keep paddocks square if possible. Where rectangular, the depth of the paddock should be no more than twice the width.
9. Mark the layout on the ground with marker pegs. Re-consider the layout both from the practicality of construction and operation
   - Are the paddock entrances in dry ground?
   - Are the paddock entrances in the down-hill corner of the paddock?
   - Is the slope of the roadway less than 10%?
   - Will the roadway disrupt normal flow of water down a slope?
10. Re-align the markers on the ground to correct for the issues identified above.
11. Record the final layout on an accurate map and make copies.

Paddock size

Long narrow paddocks results in too much walking over ground to graze the end of the paddocks creating an excessive risk of poaching in difficult grazing conditions. In excessively large paddocks, where grazing takes too long, grass re-growths are affected. This will lead to poorer grass quality and reduced animal performance. Furthermore, using a strip wire to divide the paddock requires extra labour during the main grazing season. If paddocks are too small there will be insufficient grass for one grazing and a requirement for additional water troughs. Grass intake and animal performance will be adversely affected. The maximum depth of a paddock should be 250m from the access roadway reducing to 200m in wet areas more prone to poaching.

Number of grazings per paddock

Normally a 48-hour grazing duration per paddock should be the target. However, in spring and autumn, the allocation may be for 12 or 24 hours to allow paddocks to be fully grazed out when numbers of cattle grazing may be low since not all cattle are at grass. These are also the two periods of the year when grazing conditions are likely to be most challenging and walking over previously grazed areas has to be avoided to minimise soil damage and subsequent regrowths.

For the greater part of the grazing season, 48-hour grazing paddocks/blocks should be the target. Where cattle/cows spend longer than 48 hours in a paddock, emerging regrowth will be eaten, less grass will be available at the next rotation, and overall grass production will be lower.

Calculate paddock size: (48-hour grazing)

Step 1: Minimise the number of grazing groups and, by default, maximise the number of cattle per grazing group. This has the two-fold effect of reducing the number of paddocks needed while keeping the paddocks as large as possible.

Step 2: Establish the number of cattle in the largest grazing group, usually the suckler cows + calves in a suckler herd. This will determine paddock size on the farm.

Step 3: Establish the daily grass demand, e.g. 40 spring calving suckler cows with calves at foot x 17 kg Dry Matter (DM) = 680 kg for 24 hours.

Step 4: Ideal pre-grazing yield is 1,400 kg DM/ha for the main part of the grazing season.

Step 5: A daily grazing 680/1,400 = 0.50 ha for 40 suckler cows/calves in 24 hours.

Step 6: Two days grazing 0.45 x 2 = 1.00 ha for 40 suckler cows in 48 hours.

Step 7: Repeat with each remaining grazing group to determine the ideal paddock size and from that it should be possible to work out how many temporary divisions, if any, are needed in the paddocks established at Steps 2-6 above.

Peak grass growing months April/May/June will normally determine paddock numbers. The essential requirement for an effective paddock system is to have enough paddocks during the peak period of grass growth. More and not less should be the target. A number of commercial 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. Grazings per paddock

Grazing per paddock	Advantages	Disadvantages	Best Practice
12-hour grazing (½ day per paddock)	Good Grass utilisation Protects regrowth and grows more grass Makes grazing more manageable in wet weather Easy to identify surplus/deficit of grass	Most labour intensive Risk of allocating too little area and cattle/cows are underfed Suckler cows and heifers can suffer, especially at breeding time More water troughs required	Only recommended where the operator has excellent grass budgeting skills to allocate correct area for grazing
48-hour grazing (2 days per paddock)	Protects Regrowth Cows/heifersless restricted Cattle more settled due to less movements Easier machinery access due to larger paddock sizes	More difficult to manage in wet periods when grazing conditions are poor More difficult to graze out well when low numbers grazing in early spring or late autumn	Recommended as the option that optimises labour efficiency, grass utilisation and grass production
72+ hour grazing (3+ days per paddock)	Less movement of cattle required Fewer paddocks required	Extremely difficult to manage surplus grass Much more difficult to graze out and to maintain grass quality	Least recommended option

Fixed or Flexible Paddocks

An alternative to a fixed paddock system is to adopt a flexible paddock system whereby large fields that are grazed using temporary wire divisions for all grazings. The area available for grazing and the size of the paddock at any grazing can easily be adjusted throughout the year. Larger paddock size can be given where grass covers are low, smaller paddock size when grass covers are higher. Surplus grass is easily harvested. Key to success is having a least three temporary grazing divisions set up for each grazing group at any given time.

(i) the paddock cattle turned into today,
(ii) the paddock for grazing in two days' time,
(iii) the paddock for grazing in four days' time.

The flexible paddock system entails the use of a farm roadway and permanent post at specific distance along the side of the roadway. Temporary electric fences are used to allocate grass with a backfence used to prevent stock going back to graze the previous area. Multiple access points exist from the roadway to the grazing area. If permanent posts are sited every 25 meters along the roadway it becomes very easy to measure distances.

If we examine the advantages and disadvantages of both paddock systems, farmers should be able to decide which system best suits their own farm and management ability.

Table 2. Advantages and Disadvantages of fixed and flexible paddock systems

Fixed Paddocks	Flexible Paddocks
Advantages	
Suits inexperienced operators	Less expensive to construct
Set daily area	Very flexible
See quantity of grass ahead	Less under or overgrazing
Achieve recommended rotations	Interchange of grazing & silage fields
No regular movement of fences	Easier for machinery to work
Good electric current transmission	No weeds under wire.
	Encourages active grazing management
	Easier to graze when ground conditions are poor
Disadvantages	
Expensive to construct required	Higher level of grassland management ability
Less flexible	Regular assessment of herds' needs
Risk of Under-grazing or over-grazing	Regular assessment of grass covers
Doesn't allow for changing herd size	Regular movement of temporary fence
Fertiliser spreading, topping/cutting & reseeding more difficult	Difficult to manage calves
Less paddock access points	More water troughs required to allow flexibility

Both paddock systems have advantages and disadvantages. The fixed paddock layout can be very rigid resulting in under or over grazing in the set time allowed because there is a quarter of a days grazing too much or too little depending on the growth rate or the changes in herd structure. This is avoided in the Flexible System because the exact quantity of grass can be allocated. But it requires a higher degree of grazing management skills. The farmer will have to be able to assess the daily grass cover, the daily herd requirement and then measure out the area to be allocated. A Flexible System would ensure better utilisation of grass in wet weather and less poaching damage. It would also result in quicker mechanical operations such as topping, cutting, fertiliser spreading, etc. In order to facilitate efficient grazing of silage fields in spring (before

closing) and again the autumn, a narrow roadway (for stock movement) should be constructed down the middle of large fields and flexible paddocks operated at either side. This would ensure no re-growths are grazed.

2.2 Roadways

Without ease of access to paddocks and between paddocks, grass utilisation and stock management are much more difficult to operate to a high level of efficiency. The road layout must allow for good flow movement of cattle between all paddocks and between the paddocks and the yard. A well-designed, carefully built and properly maintained farm roadway system has many benefits, including, faster and easier stock movement and more efficient paddock access.

Assessing roadway condition

Take a quick look at the condition of your farm roadways for defects that may be causing problems. These defects can include, potholes, a roadway that is level or almost level, wheel track depressions, a raised hump

Water trapped on the roadway lodges at low points. Cattle are following tracks due to a less than perfect surface.

of soil under the fence at either side and cattle tracks made between the fence and the roadway or on the roadway.

Problems are caused by; pebbles and loose stones on the surface, a bumpy surface with secure stones, lodged/trapped water on the surface, very dirty section near the farmyard, and a roadway level with or lower than the field. The reasons for these defects are many but may be due to flawed construction methods, unsuitable materials and lack of maintenance. The appearance of the roadway now bears little resemblance to what it looked like when it was initially constructed.

Cattle behavior

Cattle like to walk with their heads down so they can see where to put their front feet. The hind foot is also placed on ground that the animal has seen. When cattle cannot place their feet safely they will slow down. It could be because the roadway surface is poor or because they are being forced to move on from behind. If forced to move on from behind, they become bunched and they lift up their heads and shorten their stride. Now they cannot see where to put their front feet and they lose control of where to place their hind feet. Given time an animal that is left to move along quietly will seldom misplace a foot, even on a poor surface.

Cattle have an average walking speed of 2-3 km per hour (0.6 to 0.8 m per second). On a good farm roadway they can walk at speeds over 4 km per hour (up to 1.2m per second).

There is a social hierarchy and dominance within the herd. Cattle like to stick to their social groups as they walk farm roadways. They don't like too much physical contact with other animals as they walk along. When dominant cattle slow or stop the rest of the herd will do likewise.

Roadway width

The width of roadways depends on the number of animals in the herd. Typical widths of 3 m are suggested for 50-cow suckler herds or similar number of beef cattle with wider roadways needed for bigger herds. A rule of thumb is an extra 0.5m wide for each extra 100 cows in the herd. For ease of machinery access , 4 m wide roadways are advised.

The fence should be positioned about 0.5m (20 inches) from the edge of the roadway. This will allow cattle to utilise the full width of the roadway while at the same time prevent them from walking along the grass margin. A cow track in the grass margin usually means that the fence is too far out and the surface of the roadway is likely to be poor also.

The length of the roadway required will depend on the size and general layout of the farm. On farms with heavy soils a more intensive roadway system makes grazing management easier. The intensity or land area devoted to farm roadways ranges from 1-2% of the grazing area. Most paddock systems aim to have a roadway intensity of between 1.2-1.5% of the grazing area.

The surface needs to be smooth, fine and strong enough to support animals but with a little give in it also. Ideally, the hoofprints from the cattle should be visible across the roadway, but not so much to damage the surface when the weather is wet. Rough surfaces with protruding stones, loose gravel or pebbles (either sharp or round) lying on the surface are a major lameness factor. White line disease and sole ulceration are common causes of lameness. Poor maintenance of roads with little use of top dressing with fine material is known to increase the incidence of lameness. Thus, prevention of lameness at pasture must entail maintaining roads in good condition.

The presence of concrete roadways on farms also increases the incidence of lameness. Therefore, if concrete roads are used, care must be taken to ensure; that the junction between concreted areas and the general roadway network is maintained in good condition, that the concrete is kept free of grit, and run-off from the concrete should be diverted away from the roadway. A kerb or nib wall, close to the end of the concrete where it meets the roadway may be useful. This will force cattle to lift their feet dropping off stones/debris before the entrance. It will also prevent soiled water from the yards running onto the roadway or rainfall run-off from the roadway flowing onto yards. If the kerb is a bit back from the edge of the concrete (about 0.5m), there will be less wear and tear on the roadway where the two meet. Regular brushing/cleaning of the concrete is required.

Roadway Construction

New farm roadways must be laid in good weather when soil conditions are dry. This is primarily to ensure that the roadway material does not mix or get pressed into soft soil. Ideally remove a thin layer of topsoil before placing the roadway material. Topsoil

contains pores, organic matter, is generally weak and is likely to deflect and shear under load. Be careful not to remove too much topsoil as the depth of the roadway will have to be increased to bring the roadway surface above field level. If too much soil is removed the finished roadway may end up being too low. The finished level of the roadway must be above the level of the field, otherwise drainage will be onto the roadway instead of off it.

A wide variety of locally sourced materials may be used as the main road material. If this material is available on the farm, so much the better. However, the cost of using it should be weighed up against the cost of purchased material.

This foundation layer is made up of granular fill material. The usual depth is about 200-300 mm (8-12 inches). The biggest stones should be no bigger than about one third of the thickness of this layer. The intended slope (crossfall) should be formed in the foundation layer. This means that the surface layer will have the same slope and an even thickness.

Generally, 75 or 100 mm (3 or 4 inch) down material is used. This is a graded mixture of different sized stones from 75 or 100mm down to dust. Crushed rubble can also be used.

Compact with a vibrating road roller before the surface layer is spread. Compaction interlocks the material to give a stronger roadway and helps prevent loose stones from mixing with the surface layer.

Geotextile

Consider using a geotextile membrane between the road materials and the soil. A geotextile is a synthetic porous fabric used to separate the foundation layer from the ground underneath. It prevents the stones from becoming mixed with the soil and vica versa. The geotextile keeps the roadway foundation material clean, free-draining and therefore dry and strong. Farm roadways can suffer considerable deformation in use and the role of the geotextile in this situation is to provide physical support, as well as separation.

A geotextile is also highly recommended where soil is heavy or wet. It won't solve drainage problems; therefore any necessary drainage should be tackled beforehand. A geotextile also highly recommended on roadways used for heavy machinery. A geotextile suitable for farm roadways costs about 75 cent per square metre.

Crossfalls

Getting water off the roadway quickly will extend the life of the surface and reduce the cost of maintenance. Potholes will also be less likely to develop. To remove water

quickly from roadways they should slope to one or both sides. A roadway that slopes to one side is easier to construct and machinery runs better on it. However, cattle apparently spread out better on a roadway that slopes to both sides. A crossfall of between 1 in 15 and 1 in 20 is about right. A 4 m (13ft) wide roadway with the fall to one side would have a height difference of from 200-265mm (8-10½ inches), or if the fall is to both sides, the centre would be 100-135mm (4-5½ inches) higher than the sides. Water must not be trapped at the edge of the roadway or in wheel tracks; it must be shed completely and allowed to soak away in the soil or drained along by the side of the roadway and piped out under the roadway at the lowest point.

Roadways on steeply sloping ground can be subjected to a stream of water running the length of a section of roadway during heavy rain. The 1 in 15-20 crossfall should be enough to divert this water away to the sides in many cases. However, where the ground falls considerably along the roadway crossfalls may be insufficient to prevent this scouring, so, low ridges, shallow channels or cut-off drains at intervals across the roadway will divert water before it builds up volume and momentum. Do not allow water to flow off at gaps, gaps are difficult enough to keep right, as it is, without adding to their problems.

Surface layer

The roadway should be completed with about 50-75 mm (2-3 inches) of a fine material on the surface. If the surface is poor most of the benefits of having a farm roadway are gone. The surface layer needs to be laid evenly and compacted. Spread it out to the slope formed in the foundation layer. Many different types of fine material can be used for the surface layer.

Table 3. Key Specifications

Cross fall/ slope	1:25 one sided slope, 1:15 two sided slope
Construction	Geotextile (optional) 200 – 300 mm hard core plus 50-75 mm fine material
Road slope	Max of 3:1
Fencing	50 cm from edge of road
Approx. cost	€15 – 30 / metre

Costs

A 4.0m wide roadway, with 0.3m depth of material and will need one 25 tonne load to cover a length of 9-10 metres. This assumes a density of about 2 tonnes per m3 for the material used. A similar sized load would cover 45 metres with a 63mm (2½ inch) thick surface layer. The price of road making material, both crushed stone and dust for the surface, is typically €7-10 per tonne plus VAT. As the construction material amounts to over 80% of the overall cost, strict control over the depth and width of the roadway, in line with needs and good construction practice, is essential. Farm roadway costs range between €4 and €7.5 per square metre. Calculate costs in advance and monitor progress. This will avoid surprises and cost overruns. VAT is refundable on new farm roadways but not on repairs.

Repairing an Existing Roadway

Roadways should be repaired as necessary - probably needing some attention every year. Pay particular attention to the most used part of the roadway, especially the first 50-100 metres near yards. This area can get very dirty, worn and low.

Typical areas that require ongoing attention are drainage outlets, water diversion ramps/channels, filling potholes and adding extra surface material to rough areas. Roadways that are in a bad state will need a major repair job to get them right. Remove any grass and clay from the edges and the centre. If the roadway is lower than the level of the field it will have to be raised. If there is no crossfall, one will have to be created.

Generally, 40 or 50 mm (1½ or 2 inch) down granular fill material is used to raise the level. If it has to be raised a lot you may have to use 75mm (3 inch) down. This granular fill should be laid to the falls of the finished surface. Finish off with a suitable surface material and compact.

Tracks/Spur roads

Tracks can be installed as extra roadways, as spur roadways off normal wider roadways or at the end of the main farm roadway. They are generally only suitable for short runs. They are useful for getting access to paddocks in the spring to turn stock out early. Tracks/Spur roads are also valuable in the autumn to extend the grazing season. A depth of about 150mm of material is laid on the surface of the ground. This should be compacted and topped off with a fine surface layer and the surface layer should be compacted also. The width should range between 1.8m and 2.5m, costing €8-€11 per metre run.

Some key points

- Put in multiple gateways to paddocks to reduce gateway wear and tear.
- Do not site water troughs on farm roadways or near paddock gateways.
- Carry out regular roadway repairs. Aim to maintain the surface layer.
- Avoid sharp bends; have swept bends at corners and T-junctions to avoid bottlenecks.
- Remove trees that shade the roadway causing dirty wet surfaces.
- On steep roadways; use ramps or channels to divert water at intervals otherwise flowing water will create tracks and wash away the surface layer.
- Keep pebbles and stones off concrete yards/roadways.
- Allow stock to move along roadways at their own pace to minimise lameness. This also keeps them calm.
- Slow down with farm machinery and keep tractor and heavy machinery use on roadways to a minimum.
- If stock slow down on a farm roadway they do so for a reason.
- Repair potholes in good time and with fine material.

2.3 Fencing

Fencing is an essential element of grassland management. Good fencing is critical for controlled grazing where the farm target is to increase grass yield and maximise the utilisation of grass.

The level of control you require is the most important consideration when erecting a fence. A permanent fence will require different design than a temporary one. Boundary fences may be designed differently than internal divisions.

Materials

The quality of materials will have a major influence on the longevity of the fence. The choice of posts, wire, insulators, gate openings etc. can vary. When erecting a fence use quality materials. These may not always be the cheapest but will be more reliable and require less maintenance in future years.

Strain Posts: These form the backbone of any fence. For most fencers the strainer post should be 20 - 25cm diameter (8-10 inches) and 2.1 - 2.5m (7-8ft) long. This will allow approximately 1.2m (4ft) of the post to be driven into the ground. These posts may be softwoods or hard woods provided they are treated. The distance between straining posts may be up to 200m depending on type and topography of the land.

Intermediate Posts: The ideal post for most fencers would be round posts 10-12cm (4 inches) diameter, 1.7m (5ft 6ins) long. Square posts (7.5 cm X 7.5 cm/3 inches X 3 inches) are also suitable.

Wire: 2.5 (12 gauge) high tensile wire is most suitable for electric fencing. Proper galvanised wire will have a life of 20 -25 years, poor quality wire decays after 7 - 8 years.

Choice of Fence

Single strand electrified fence. This is cheap, easy to erect and very effective against cows and adult cattle. It is most suitable for internal divisions such as paddocks. The height of wire for cows is 90cm (35 inches). Intermediate post spacing should be 14 metres.

Double strand electrified fence: This is suitable for cows, cattle and calves. The height of top strand would be 90 cm with the second strand 37.5 cm (15 inches) lower.

Four/Five strand electrified fence: Cattle, sheep and lambs will be controlled. This fence requires annual maintenance. Grass and weeds underneath the fence must be continually cut or sprayed. The five-strand fence is particularly effective against dogs and foxes. This type fence may be useful where stray dogs are present. The spacing for the five strand from the ground up is 12.5 (5 inches), 15 cm (6 inches), 17.5 cm (7 inches), 20 cm (8 inches) and 22.5 cm (9 inches). Intermediate posts are spaced at 10 metres apart.

Temporary fencing of paddocks is widely practised for strip grazing. Geared reels with wire and white electrified tape are most suitable. There are flexible, light and easily moved.

Key Criteria

Strain Posts

- 20 - 25cm diameter (8-10 inches) and 2.1 - 2.5m (7-8ft) long.
- Approximately 1.2m (4ft) of the post to be driven into the ground.
- May be softwoods or hard woods provided they are treated.
- Distance between posts up to 200m depending on type and topography of the land.

Intermediate Posts

- Round posts 10-12cm (4 inches) diameter, 1.7m (5ft 6ins) long.
- Square posts 7.5 cm X 7.5 cm (3 inches X 3 inches) are also suitable.

Wire

- 12 gauge high tensile wire is most suitable for electric fencing.
- Proper galvanized wire will have a life of 20 -25 years, poor quality wire decays after 7 - 8 years. Wire should comply with one of the Irish or British standards.

Single strand electrified fence

- Contract price approx. €1.50/m, plus VAT for tanalized (pressure treated) posts, (creosote posts add €0.25/m). Contract price includes approx. 40% labour.
- Cheap, easy to erect and very effective against cows and adult cattle.
- Suitable for internal divisions such as paddocks, post spacing about 14 metres.
- Height of wire for cows is 90cm (35 inches).

Double strand electrified fence

- Contract price approx. €1.75/m, plus VAT for tanalized posts.
- Suitable for cows and calves.
- Top strand would be 90 cm high, second strand 37.5 cm (15 inches) lower.

Four/Five strand electrified fence

- Contract price approx. €4.50/m run, plus VAT for tanalized posts.
- This fence requires annual maintenance, not used widely.

Sheep mesh with a single electrified strand

- Contract price approx. €6/m run, plus VAT for tanalized posts.
- Suited to farm boundaries, around farmyards, internal roadways and calf paddock for young calves.
- 80cm (32 inches) sheep mesh is commonly used, topped with a single strand of electrified wire.
- Barbed wire could also be used. Intermediate posts are spread at 7 - 8 metres apart.

2.3.1 Electric Fencers

Power fencing is a means of controlling stock by giving them a sharp but safe shock. It consists of a fencer which transmits electrical current through conductors of wire supported by insulators and posts.

Types of fencers

Battery Operated: Normally used for temporary fencing such as strip grazing and back fencing. Operated by a 6volt battery.

Mains Operated: Permanent power fencing main operated fences are normally used. Normally supplied by ESB supply.

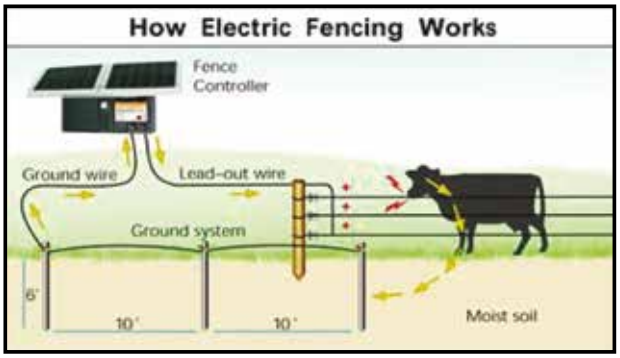
Solar power operated: Obtain energy from the sun and charge a small battery, system mainly suited to out farm where there is no electric power.

Table 4. Types of fencers

	Mains	Battery	Solar
Installation	**Easy-medium**	**Simple**	**Medium**
Use	Perimeter of farm Temporary fencing	Strip Grazing Strip Grazing	Temporary fencing Temporary fencing on out farm
Key Benefits	Longevity if maintained correctly Suitable for larger areas Greater strength	Easy to install Relatively inexpensive Greatest flexibility and portability	Easy to install Suitable when no power source on farm No re-charging of battery
Caution	Dependant on electricity supply	Risk of theft Battery recharged regularly	Risk of theft Maintenance over winter

How mains works?

Fencer (Energiser) steps up volts to 8,000 to 11,000 volts approximately through a transformer. Each pulse lasts 0.003 of a second. The high voltage electricity is fed to the fence line wire. An earth lead is securely earthed into the ground by means of metal bar. When livestock touch the fence wire, the circuit is then completed giving a shock.



Source: Gallagher Fencing

Checking the Installation

Ensure the connections between fencer and fence are firm and with a good connection. If the wires are passing through a wall you need to make sure that they are properly insulated. If this is not done there is the possibility of power being diverted from the fence into the ground. All installations must be open circuit with the outgoing wire fully insulated to avoid shorts to earth. All joints and connections should be made simply, firmly and above all be very tight, using the correct joiners for the purposes and good quality insulators.

Regular inspection of the line is essential of permanent fences. Weeds and branches touching the line should be removed. Avoid vegetation growth or other items touching

the wire fence as this reduces efficiency and performance, particularly during damp and wet conditions or periods of lush growth.

Earthing System

Without an earthing system for the fencer there would be no shock at the fence line. An earthing system works in much the same way as an aerial does for a radio but instead of collecting airwaves, the earthing system picks up electrons from the ground, which are transmitted with each pulse out along the fence line.

The stronger the fencer the better the earth required. Electrical current passes through soil but does so more easily in moist or mineral soils than would be the case in dry stony soil.

Therefore before deciding how many earth bars are required, take three factors into consideration:

1. The type of soil.
2. High power or low power fencer.
3. The load one can expect on the fence system and the length of fence.

Earthing/Grounding rod

Use the proper type of grounding rod. In most cases, pipe or rebar can be used. The grounding rod needs to be made of galvanized steel and also needs to be at least four feet in length for best results. Using copper rods will diminish the overall effectiveness of the electrical fence system.

In some cases, it may be necessary to add several grounding rods to the grounding system. In fact, the majority of electrical fence systems will actually require at least three grounding rods. These rods should be about 10 feet/3 m apart and should be placed at the start of the fence.

Grounding rods can actually interfere with phone service as well as electrical lines that may be located on the farm. For this reason, it's important to place grounding rods as far away as possible from utilities. This is especially true in relation to phone lines.

Installing the Earthing System

For the exact number of earth bars to be used refer to the manufacturers guide. Having decided on the amount of bars required for the size of your fence, dig a trench 150mm deep from where the first bar is going to be, to where the last one is. Then using 1 m galvanized rod earth bars drive all bars, spaced 3m apart, down until they are flush

with ground level. Connect heavy duty High Tensile Underground Cable from one earth bar to the other until all earth bars are connected in a daisy chain manner not breaking the connection from the first earth bar to the last. Ensure they are securely bonded.

Double insulated cable is UPVC coated 1.6mm/2.6mm mild steel wire. It is highly recommended for permanent electric fence installations to ensure all the energy from your electric fence fencer gets to your electric fence line. This versatile cable is used to also connect your fencer to your earthing system and to carry high voltage power under your gateways.

Checking Earthing System

When the earthing system is installed, it is vital to test it. First you need to simulate heavy vegetation loading on the fence line. Place an iron bar in the ground about 100m out along the fence and lean it against the fence wires. Plug in the fencer and check the voltage reading along the fence line. If it reads 1000 volts or less, a sufficiently heavy load has been put on the fencer. If the voltage is still above this, place more iron bars along the line until the voltage drops to 1000 volts or less. Leaving this load on the line, take a voltage reading on the earthing system. A small reading on the earthing wire is ok as long as it does not exceed 300 volts. If it does exceed 300 volts, the earthing system is not sufficient and you have to install more earth bars.

Visibility and Maintenance of the Earthing System

Visibility of an electric fence is very important too. The animal will remember the shock it received and will respect the fence as a barrier. It is important to monitor the voltage of the fence on a weekly basis to ensure there is sufficient current throughout the fence line.

Lightning Diverter System

It is recommended that all permanent fencers be fitted with a lightning diverter to help protect from lightning damage. It diverts lightning from the fence to the earth to protect the fencer.

Mains Fence- Installation & Operating

1. Please read all installation and operating instructions carefully.
2. Install indoors and out of reach of children.
3. Do not install near combustible material, i.e. hay or straw. As there is a remote possibility that a lightning strike through the earth system could generate a fire risk condition.
4. Any electrode connected shall be separated from the earthing system of any other circuit, and shall not be situated within a distance of 100m of any electrode used for protective earthing.
5. Each fencer must have a separate earthing system.
6. Never fit more than one fencer onto any fence.
7. Every electric fence line and associated controller shall be installed so that it is not liable to come in contact with any power or communication apparatus or wiring, including an overhead power line, telephone, or radio aerial.
8. Any electric fence or portion thereof installed along a public road or as a boundary-line fence shall be identified by signs, clamped to the fence wiring or fastened to posts at suitable intervals.
9. Never place earthing system for electric fence within 10 meter of a household.
10. Never tamper with internal mechanism of fencer as they have the potential to be extremely dangerous.

FARM SAFETY- Health and Safety

Connecting to the Fencer

The cables connecting the fencer to the fence and the fencer to its earth should be special electric-fence run out cable. This is highly insulated with a galvanised steel conductor. Ordinary domestic electric cable is not suitable as it does not have sufficient insulation for the high voltages involved.

The Fence Line

The following guidelines apply to both mains and battery operated electric fences. Try to avoid erecting electric fences closer than 6 metres (20 feet) to overhead power lines. When an electric fence wire has to be taken underneath an overhead line:

DO position it 1-2 meters from the pole and take it at right angles to the overhead line; avoid running it parallel to and under the line. Always mount it on its own supports – never support it on an ESB pole.

DON'T 'twitch' the fence wire when crossing beneath overhead lines, particularly when working it across undulating or sloping ground.

NEVER use barbed wire as a fence line – it is very dangerous – because it could trap a person or an animal.

Where an electric fence is erected near a public road, footpath or right-of-way it should be fitted with a suitable warning notice. For further information: ESB Networks Farm well Farm safely booklet www.esb.ie

What size fencer?

Fencers are mainly advertised in terms of Output Joules and Stored Joules. Don't get these confused, and be aware of which is on the charger. A charger may advertise 30 Joules, but only refer to the stored joules (A fence charger will always store more joules than it outputs). Stored Joules represent the amount of power stored inside your charger. This is ran through an output transformer, which converts the power to a higher voltage. Some of the power is lost during this conversion. Output Joules refer to the actual output of the charger – the power available to shock the animal.

The size of fencer depends on the area to be fenced. Always choose a fencer to match the area. It is better to choose a fencer greater than your requirement rather than less than recommended and expect it to cover more area than advertised.

Table 5. Output Joules required depending on distance, area to be fenced and earthing rods required by a mains fencer.

Mains Fencers			
Output Joule	**Distance (Km)**	**Area**	**Earthing rods**
0.12	1.5	4	1
1	1.6	10	1
1.10	10	30	2
2.5	11	50	1-2
3.3	15	50	3
4.9	22	75	4
6.1	32	110	4
7	32	100	3
14.8	65	220	6
15	72	200	4
33	145	300	6

Note: This is a guide. Always read and follow manufacturer's guidelines

Battery Fencers

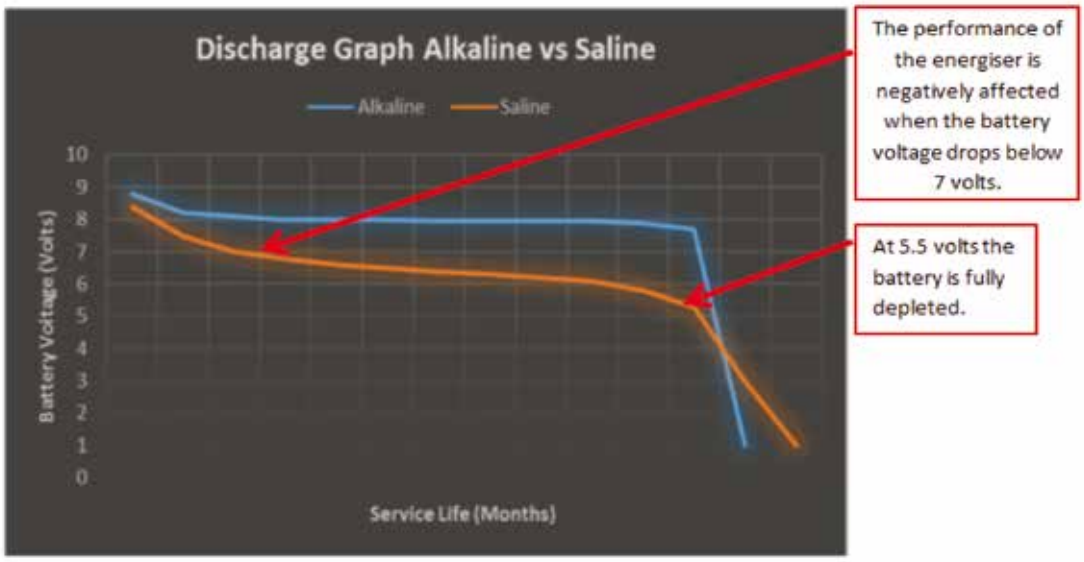
Battery fencers are used for short or temporary fences where portability are flexibility are the main considerations. A Dry Battery is used in many cases. While a Wet 12V Battery allows rechargeable batteries to be used and facilitates a more powerful battery powered fencer.

Understanding Alkaline vs Saline Batteries

There are 2 types of 9 volt dry cell batteries used to provide energy to a battery energiser, these are Alkaline and Saline. Both are air-oxygen batteries therefore they need oxygen to create the chemical reaction which produces the energy. Both are free from of mercury and cadmium and therefore environmentally friendly and should be disposed of at your local WEEE collection centre. However the varying chemical composition of Alkaline and Saline batteries means their performance varies greatly with the Alkaline battery proving to be more efficient.

Advantages of Alkaline Batteries

- The rate of discharge of Alkaline and Saline batteries are very different (see discharge graph below). The tension of an Alkaline battery remains at approx. 8 Volts for the majority of its life whereas the tension of a Saline battery decreases at a pretty even pace over its life from 8.4 Volts to 5.5 Volts. With a decreasing battery tension, the energiser will use more electrical current to maintain the output energy and this will result in accelerated battery discharge.



- The Alkaline batteries function better at lower temperatures due to the fact the electrolyte of Alkaline batteries contains less water than Saline batteries.
- The cathode and anode in an Alkaline battery are much more efficient than that of a Saline battery therefore there is less material used for the same capacity so in turn Alkaline batteries are lighter and smaller than Saline batteries. This results in reduced transport costs and reduced WEEE charges.
- The electrical current increases throughout the life of a Saline battery whereas it remains constant with an Alkaline battery, therefore a Saline battery depletes approx. 20% faster than an Alkaline.

Table 6. Output Joules required depending on distance, area to be fenced and earthing bars required by a battery fencer.

Battery fencers				
Output Joule	**Distance (Km)**	**Area (Acres)**	**Earthing rods**	**Recommended use**
0.2	1.5	4	1	Strip Grazing
0.19	2.25	6	1	Small/Strip Grazing
0.35	4	12	1	Small/medium area
0.43	5	14	1	Medium/Strip Grazing
1	8	25	2	Small/Medium
2	11	40	1-2	Medium/Large

Note: This is a guide. Always read and follow manufacturer's guidelines

Solar powered fencer

Solar electric fences rely on sunlight to power the charger, rather than an A/C outlet or a standard battery. Most solar-powered electric fences are used on out farms or in remote areas where there is no easy access to electricity. Solar electric fences work by sending the animal a shock when it comes in contact with one of the live wires. The solar chargers require batteries, but the batteries last a long time because they are constantly recharged by the sun.

Advantages	**Disadvantages**
Ideal for remote areas	Price
Low maintenance	Not as powerful
Less Labour charging batteries	Dependent on weather
No energy costs	Risk of theft

Maintenance

The solar panel should be cleaned from time to time - a dirty or dusty panel will not operate at peak efficiency. Simply use a soft cloth and water.

The battery requires some maintenance, too, if you want it to last for several years. When the battery is not in use, make sure it is fully charged before it is stored. And during any period when the battery is stored, place it in the sun for three days every three months to recharge.

Installation of Solar fencer

1. Ensure there is adequate access for inspecting frequently.
2. Consider some secure way to install solar fencer to avoid theft.
3. Locate the fencer, panel and battery to an appropriate earth site area away from livestock interference.
4. Try to position the fencer at a central location to minimise the resistance of current flow over the length of the fence.
5. Assemble the panel to be positioned to obtain maximum daily sunlight exposure. Ensure that shadows will not fall on the panel at any time during the year.
6. The panel should always face toward the equator (facing south).

We would like to acknowledge the help of Cheetah Electronics , Forcefield , Gallagher fencing systems for their help compiling this chapter.

Temporary fencing options

Pig tail posts and one reel of polywire- €0.40/m

3 Rows of polywire with pigtail post with 2 attachments - €1.20/m

3 Reels of polywire with white temporary posts- €1-1.50/m

One Reel 3 rows looped polywire with white temporary posts - €1-1.50/m suitable for short distances

Electrified sheep fencing - €1.90/m

Gallagher Smart fence- four strands of wire with integrated plastic post - €2.90/m

2.4 Water system

A good water supply is extremely important for production, health and welfare of livestock. The water supply system must be good enough to supply adequate water needs in the paddocks. On most farms the water system consists of a series of expansions or additions carried out over the years as requirements changed. Only when the system fails to cope, such as during a dry summer, do people realise how marginal their system has become.

Common problems on most farms centre on inadequacies in areas such as, water source, pumping plant, pipe sizes, ballcocks and troughs.

Table 7. Key requirements for water system

Water intake	10 - 15 litres per 100kgs body weight per day
Trough size	Allow 5-7 litres per livestock unit
Ballcock	Medium pressure-gives flow rate of 32 Litres/ min versus 8 Litres/min with high pressure
Main pipe layout	Ring/Loop system preferable

Water Source

A bored well is the most common source on farms. If the well is unable to meet peak demand, the installation of a reservoir of, for example, 9,000 litres (2000 gallons) which can be a pre-cast concrete tank will rectify the situation. The tank can be buried in the ground or placed overground.

A booster pump is then used to pump the water from the reservoir into the water supply system, at whatever flow rate and pressure are necessary. Modern frequency controlled centrifugal pumps will automatically maintain pressure and flow in response to demand. The pump speed will increase when an extra tap or ballcock comes into use and vica versa.

Pumping Plant

Submersible or surface pumps may be used in water supply systems. In general, only submersible pumps should be used to pump from deep wells (boreholes). The running costs of a surface pump, being used to pump from a deep well, can be up to five times higher than for a submersible pump, because some water has to be pumped down into the well to bring water to the surface. Maintenance costs are higher also. Surface pumps can be used for shallow wells where the water can be sucked directly by the

pump. Consider replacing an existing deep well surface pump with a submersible pump.

In deciding on pump size, take into account the depth of the well, the output of the well and the working pressure required to overcome any rise in ground level from the well to the top of the system. Where a new pump replaces a previous unit, the size of the electric cable used to supply the pump must be taken into consideration. Poor standards of installation lead to bad performance and unreliability. Lack of starter switches or wrongly adjusted starters fail to give motors adequate protection. Experienced pump suppliers will be able to help you in planning the system to suit your requirements.

Small Pipe Sizes

This is probably the most common problem with water supply on farms. Even on farms where piping was laid in recent years under-sizing of pipes still occurs. This is illustrated in table 8. Table 8 shows the pressure loss in psi for different pipe bores over a range of flow rates for 100 metres length of water pipe. For example, at a flow rate of 3m3 per hour (50 lit/min or 11gal/min) with a 32mm (1¼ inch) pipe the pressure is reduced by 4.83psi for every 100 metres of pipe. The reason the flow rate reduces is because of friction between the water and the inside surface of the pipe.

Table 8 doesn't take into account the extra pressure required if you are pumping uphill or the pressure gained pumping downhill. Pressure lost due to restrictions at ballcocks and fittings is also extra.

Table 8 doesn't show values for 12.5mm (½ inch) pipes because at any of the flow rates shown the pressure loss would be very high. Where 12.5mm pipes are used on farms the flow rate is reduced to a trickle due to pressure loss.

Table 8. Pressure loss in psi for different pipe sizes at various flow rates for 100 metres length of water pipe

Pipe bore (mm)	**Flow rate m³ per hour (litres per minute)**				
	1 (17)	**2 (33)**	**3 (50)**	**4 (67)**	**5 (83)**
20	14.20				
25	3.27	11.50			
32	0.64	2.27	4.83	7.60	11.65
38	0.34	1.21	2.49	4.05	6.25
50	0.11	0.38	0.88	1.34	2.06

With regard to pipe size it's the change in cross-sectional area in relation to its bore (diameter) that's important. It's hard to imagine that a 20mm (3/4 inch) pipe has approximately twice the cross-sectional area of 12.5mm (1/2 inch) pipe. Similarly, a 25mm (1 inch) pipe has four times the cross-sectional area of 12.5mm (1/2 inch) pipe, although it's only twice the bore.

The pressure loss is also affected by the pipe length. The pressure loss and the resultant reduced flow rate are directly proportional to the length of the pipe, i.e. if you double the length of the pipe you double the pressure loss. You can use table 8 to judge how much pumping pressure is lost with various pipe sizes and flow rates, while taking the pipe length into account.

The net effect of pressure loss is reduced flow rates. Increasing system pressure to maintain flow rate is not a good solution. It would be extremely energy inefficient and give rise to damaging levels of pressure. The answer is to use the right pipe size.

Ring system

If you are installing a new main line, incorporate the existing line as well if it's in good condition and not too difficult to do. This is worthwhile where pressure is low or the main line is long and the end of the new line and the existing line are not too far apart. Connecting up the ends of two main lines (of the same size) to form a ring main will almost double the flow rate.

Laying pipes

If you are using a mole plough to lay the pipe, do it in stages, using a digger to make holes at intervals where connections are going to be made. Try to get the pipe down to a depth of 450mm or more. Tractors with double-acting rams on the arms can add enough weight to the mole plough to get the depth. Do a "dummy run" first before feeding in the pipe and allow the pipe time to recover from the stretching before making connections.

Ballcock Problems

Very often the ballcocks are the weak link in an otherwise satisfactory water supply system. Ballcocks are frequently over restrictive, even on systems where the pipe sizes are adequate. A high pressure 12.5mm ballcock in the drinking trough is not capable of allowing an adequate flow rate, which is in most situations about 16 to 22 litres per minute (3.5 to 5gal/min).

In general, standard ballcocks are described by their size and pressure. Ballcocks can have high, medium or low pressure jets. The high, medium and low pressure refers to the pressure the ballcock can withstand without leaking when the trough is full.

High, medium and low pressure jets

The high-pressure jet has the smallest hole and the low-pressure jet the biggest.

The high pressure jet in a standard ½ ballcock is only 1/8 of an inch in diameter whereas the medium jet is ¼ of an inch in diameter. Other ballcocks are available that have openings of ½ inch or greater.

In most systems medium pressure ballcocks will provide an adequate flow rate (see table 7). In practice, most standard ballcocks are sold with high pressure jets in them, which is one reason why so many farms have flow rate problems.

High or medium pressure jets will fit into all 12.5mm ballcocks (see photo 2). The low pressure jet will not fit up against the gasket in standard 12.5mm ballcocks. If you want the option of using a low-pressure jet get the 12.5mm ballcock that can take any size of jet. It has a bigger plunger and a bigger gasket (photo 3).

Two standard ½ inch ballcocks, one showing a shorter float arm. High and medium pressure jets can be used with this type of ballcock.

This is a bulkier version of the ½ inch ballcock, in which fits the low pressure jet as well. Note the bigger seating gasket for the jet inside.

Using a longer float arm or a larger float can solve the problem of leaking ballcocks by increasing the force on the gasket with the extra leverage. Longer float arms are available or they can be lengthened by braising on a piece.

Ballcock jets should be checked from time to time to see that they are free flowing because they can become encrusted with lime scale or partially blocked with dirt.

Table 9. Flow rate l/min (gal/min) with a standard 12.5mm (½ inch) ballcock and a system pressure of 3.6 bar (52psi) for different jet sizes

	12.5mm (½") Ballcock		
Jet type	Low pressure	Medium pressure	High Pressure
Jet size mm (inch)	10mm (3/8")	6mm (1/4")	3mm (1/8")
Flow Rate l/min (gal/min)	42 (9.25)	32 (7)	8 (1.75)

Table 9 shows the effect of using different jet sizes on flow rate. We put the three different jets in turn into the same standard 12.5mm ballcock at a trough in a paddock. The system pressure at the trough with no water flowing was 3.6 bar (52psi). The most striking finding is the massive increase in flow rate between the high and medium pressure jets, going from 8 to 32 litres per minute. Table 10 shows the combine effect of pressure and Ballcock jet size on flowrate. Note that quadrupling the static pressure will double the flow rate while quadrupling the jet size will increase flow rate by a factor of 16.

Table 10. Flow rate (gal/min) through ballcock at varying static pressure and ballcock jet size

Static Pressure (P.S.I.)	**Ballcock Jet Size**			
	1/8"	**¼"**	**3/8"**	**½"**
0.5	0.20	0.82	1.84	3.28
1.0	0.29	1.16	2.61	4.65
2.0	0.41	1.65	3.69	6.57
4.0	0.58	2.33	5.22	9.29
7.0	0.77	3.08	6.90	12.30
10.0	0.92	3.69	8.27	14.70
15.0	1.13	4.52	10.10	18.00
20.0	1.31	5.22	11.70	20.80
25.0	1.46	5.82	13.00	23.20
30.0	1.60	6.40	14.30	25.50
35.0	1.73	6.90	15.50	27.50
40.0	1.85	7.38	16.50	29.50

Note: The pressure is at the ballcock and NOT at the pump.

Water Troughs

Cattle will drink 10 - 15 litres of water per 100kgs body weight per day. Adult cattle can drink at the rate of 14 litres a minute from a trough. Peak water intake generally coincides with peak grazing periods. Water flow rates must be capable of supplying these peaks of demand.

Carefully consider trough location; stock don't like to walk more than about 250 metres to get a drink. Locate water troughs away from paddock gateways and farm roadways. This will shorten the walk to water, prevent bottlenecks, and reduce the wear and tear at gateways.

Check water troughs regularly to ensure that ballcocks are working properly and that there are no leaks; a leak at a water trough is a real disaster.

Flow rate should be considered before trough size in ensuring adequate supply. However, large troughs provide more drinking space and can compensate a bit for poor flow rate at peak drinking time. The main advantage of big troughs is they give more space for drinking. Each cow drinking at a trough needs 450mm of space measured along the trough rim. For large herds it may be necessary to install a second trough in the paddock. Siting troughs underneath a paddock wire fence will more than halve drinking space. Young stock and timid cows may also get bullied if adequate drinking space is not available.

The area around the trough should be able to take a lot of traffic i.e. a similar surface to a farm roadway and ideally have good drainage.

This is a typical 0.5m3 (110 gallon) rectangular water trough. It is located on a high point in the field with a good surface around the trough. The length of the rim of the trough all around is 4.8m (16ft.).

Leaks

Troughs can overflow and pipes can leak. Leaks can make a mess and add considerably to water bills. Overflowing troughs and leaking pipes frequently go unnoticed. A leak in a metered supply downstream of the meter may lead to massive water bills. Leaks in a private supply are costly also because electric motors are very expensive to run, if running continuously. Use quality fittings and install isolation valves on pipelines to isolate different sections of the paddock water supply. Isolate all the sections during the housing period.

Top-fill 500 gallon water trough servicing adjacent paddocks

Portable water troughs

It may be necessary to use portable water troughs in some situations e.g. strip grazing. To provide a portable trough use frost-proof gate valves and good quality non-restrictive quick-couplers. Connection points should ideally be away from fixed troughs because they can be damaged and some valve types can be opened by stock, causing leaks.

Key points

- Daily drinking water requirements vary but typically amount to 10-15 litres per 100kgs body weight.
- Weight gain and animal health are affected by inadequate water supply.
- Many water systems are inadequate especially if poorly maintained.
- Allow 450mm (18 inches) drinking space per cow so that close to 10% of your herd to drink at the same time.
- Main pipelines should be at least 25 or 32mm and 38 or 50mm for larger herds.
- Use 12.5mm medium pressure standard ballcocks or newer bigger types; avoid high pressure ballcocks.
- Correct siting of water troughs is important.

3. Reseeding

3.1 Why reseed?

Productive grassland farms must have perennial ryegrass dominated swards. Recent research shows that old permanent pasture produces, on average, 3 t DM/ha/year less than perennial ryegrass dominated swards. Old permanent pasture is up to 25 per cent less responsive to available nutrients such as nitrogen than perennial ryegrass dominated swards. Reseeding is a highly cost effective investment. With regular reseeding the grass growth capacity of the farm can be increased substantially; and the annual return on investment is large.

Many farmers do not recognise the economic loss of underperforming paddocks. Low producing paddocks are grazing paddocks which are grazed on average 4 - 6 occasions/year. PastureBaseIreland shows that there is large variation in the grass growing capacity both within and between farms in Ireland. To improve overall farm grass production this variation needs to be reduced.

Objectives of reseeding are to create swards that:

(1) Increase the overall productivity of the farm,
- Increase the carrying capacity (stocking rate).
- Allow higher animal output.
- Increase grass quality.

(2) Are more responsive to fertiliser.

(3) Increase grass utilisation.

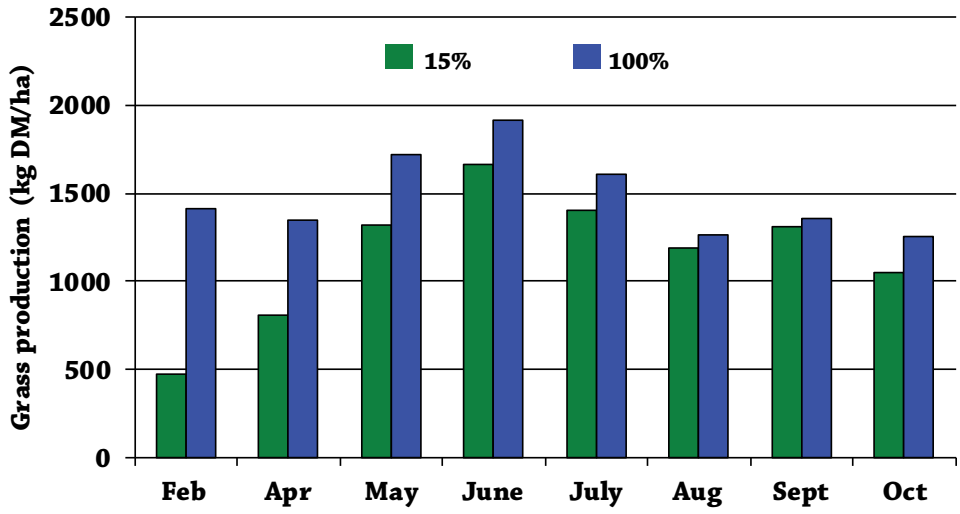
(4) Allow white clover/perennial ryegrass pastures to establish.

Old permanent pasture

Newly reseeded pasture

Reseeded swards are more productive

Perennial ryegrass is a high quality feed. The figure below shows the grass production across the grazing season of a sward containing 15% perennial ryegrass compared to a sward containing 100 per cent perennial ryegrass. The swards with 100 per cent perennial ryegrass grew 2.7 t DM/ha more than the 15 per cent perennial ryegrass sward. Most of the difference in grass production between the two swards occurs in the spring period, up to mid-May. Swards that have poor grass production in spring will not support early spring grazing. It is recommended that pastures with less than 40 per cent perennial ryegrass should be reseeded.



Grass production per month (February to October) in a sward containing 15% perennial ryegrass and 100% perennial ryegrass.

3.2 Timing of reseeding

Most reseeding in Ireland takes place in autumn. This may make sense from a feed budget perspective but it does have some negative consequences. Soil conditions deteriorate as autumn progresses – lower soil temperatures can reduce seed germination, and variable weather conditions reduce the chances of grazing the new sward. The opportunity to apply a post-emergence spray in autumn is also reduced as ground conditions are often unsuitable for machinery. Pest damage can also be a problem in the autumn.

Spring reseeding offers farmers huge opportunities to be flexible when reseeding. Swards reseeded in spring will have similar, or even greater, total herbage production in the year of reseeding as will an old permanent pasture. Establishing white clover in a spring reseed is more reliable than in autumn due to the stability of soil temperatures in late spring. Post emergence spraying for weed control is usually very successful with spring reseeding due to favourable weather conditions in summer.

Whether reseeding in spring or autumn, it generally takes a sward around 11 months to fully establish, so good grazing management in that early growth phase is very important.

Turnaround time

The target turnaround time in which to get a reseed back into production should be 60 days. Generally farmers are slow to reseed pastures because they view that paddocks

are out of production for too long. The time that the sward is out of production can be minimised by cultivating 7-10 days after spraying off the old grass – a major failing at farm level is to wait too long after spray off. Prevailing weather conditions will influence this decision, but the objective must be to minimise the non-productive period and weather conditions in spring are generally more stable and predictable than in autumn.

What is important about timing in Spring and Autumn?

- Spray off the old sward. If there are perennial weeds such as docks and ragwort use a glyphosate spray.
- Begin cultivation 7-10 days after spray off.
- Ensure a low level of thrash in the pre-cultivation sward, particularly for minimum cultivation techniques (graze tight or top or mow tightly). Trash will be buried if ploughing.
- Target a short turnaround time - <60 days.
- Use a post emergence spray early (5-6 weeks post sowing/at the seedling stage of weeds).
- Ensure a firm seed bed, irrespective of reseeding method used.
- Roll to ensure seed to soil contact, even if rolling isn't possible at sowing, roll before first grazing – otherwise loose plants will get pulled at grazing.
- Monitor for pest attacks, especially in wet autumns (slugs, leatherjackets, frit fly and rabbits are the main threats).

3.3 Soil fertility - need soil index 3 for P and K

Reseeding can improve the productivity of a sward; however, for it to have maximum effect soil fertility must be correct. Getting soil fertility right is crucial if perennial ryegrass is to establish well and persist after reseeding. Soil testing provides information on the soil fertility status of a field or paddock. Once soil test results are available, appropriate applications of P, K and lime can be made to ensure adequate soil fertility for perennial ryegrass germination, establishment and production.

Getting soil fertility right

- Soil test for P, K and lime requirements (pH) before reseeding.
- Soil test in the autumn before planned reseeding,
  - Make sure to test to an adequate soil depth – 10 cm.
- The target soil pH is 6.3 for mineral soils and pH 5.5 for peat soils,
  - Do not apply more than 7.5 t lime/ha (3 t/ac) in a single application.
- P and K must be brought up to soil Index 3.
- N is essential for good grass establishment and growth,
  - Apply 40 – 75 kg N/ha (20 – 60 units N/ac) when reseeding.
- After ploughing permanent pasture for reseeding, paddocks should be soil tested again the following year to ensure that the fertility of the soil brought to the surface by ploughing is correct for grass growth.

Phosphorus and potassium

Phosphorus (P) is essential for root development. It is immobile in the soil, and if the young seedling roots are to get adequate P, there must be an abundance of this element dispersed in the soil. Table 11 shows the P and K requirements when reseeding grassland at the different P and K index levels.

Table 11. P and K rates required for pasture establishment

Soil P Index	Soil P range (Morgan's mg/l)	P application rate (kg/ha)
1	0.0-3.0	60
2	3.1-5.0	40
3	5.1-8.0	30
4	>8.0	0
Soil K Index	**Soil K ranges (mg/l)**	**K application rate (kg/ha)**
1	0-50	110
2	51-100	75
3	101-150	50
4	> 150	30

An additional 15 kg P/ha is permitted in addition to normal allowances on reseeded grassland on index 1, 2 and 3 soils. These advice rates must be checked against total annual P allowances on the farm under Nitrates rules.

The value of slurry

Slurry is a good option to maintain soil nutrient status. With the increased cost of compounds (P and K) slurry should be used when reseeding to replace some of the P and K fertiliser. At soil Index 3, 3-4,000 gals/acre of slurry is sufficient to supply required P and K nutrients.

3.4 Cultivation techniques

How paddocks are prepared for reseeding depends on soil type, amount of underlying stone and machine/contractor availability. There are many different cultivation and sowing methods available. All methods, when completed correctly, are equally effective.

Key points

- Soil test
- Spray off old sward – a contact spray can be used if there are no perennial weeds; glyphosate should be used if perennial weeds such as docks and ragwort are present.
- Graze sward tightly or mow to minimise surface trash.
- Apply lime.
- Choose a cultivation method that suits your farm.
- Apply fertiliser.
- Firm fine seedbed with good seed/soil contact is essential.
- Roll after sowing.

Table 12. Considerations around different cultivation techniques

	Do's	**Do not's**
Ploughing	Shallow plough. Develop a fine, firm and level seedbed	Plough too deep (>15 cm). Cloddy, loose seedbed
Discing	Graze tight. 2-3 passes in angled directions. Apply lime	Forward speed too fast - rough, uneven seedbed
One-pass	Graze tight, apply lime. Slow forward speed at cultivation	Forward speed too fast – rough, patchy seedbed
Direct drill	Graze tight, apply lime and slug pellets. Wait for moist ground conditions (slight cut in ground)	'Trashy' seedbed - no seed/ soil contact. Use when ground is dry and hard

Ploughing

- Avoid ploughing too deep (>15 cm) as this can bury the top layer of soil (the most fertile soil).
- Use land leveller until an even seedbed is generated.
- Aim to develop a fine, firm and level seedbed.
- If seedbed is cloddy and loose, grass seed (and especially white clover seed) will be buried too deep and will not germinate.
- Plough/Spread Lime/Land Level/Spread Fertiliser/One pass with Seed/Roll.

Discing and One-pass

- Aim for 2/3 passes of the disc harrow in angled directions to break the sod and turn up enough soil to form a seedbed.
- Forward speed must not be excessive as it can lead to rough, uneven seedbeds.
- Disc (2-3 passes)/Spread Lime and Fertiliser/One pass with Seed/Roll.

Use a heavy discharrow to do the primary cultivation followed by a final pass with a power harrow that can also be fitted with a seed box to till and sow with a 'Onepass'.

One-pass

- The slower the forward speed of the machine the better in terms of finish.
- Often left rough and patchy due to operators moving too fast across fields.
- ***Spread Lime/One pass (twice) with Seed (on second run)/ Spread Fertiliser between one pass runs (if possible)/Roll.***

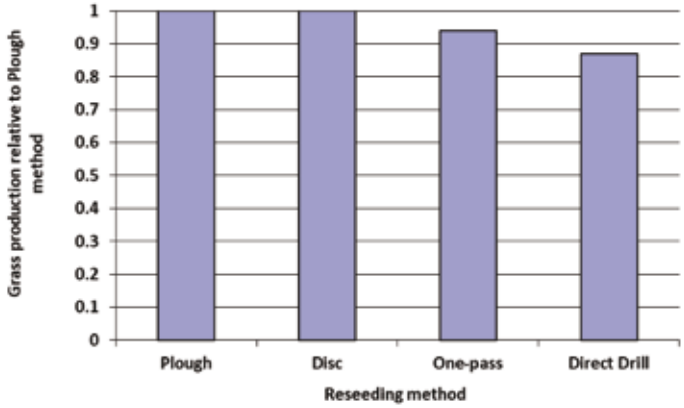
Use shallow surface cultivation with a rotary power harrow to produce a seed bed with seed sown using an air seeder attached to the power harrow.

Direct Drill

- Difficult environment for seeds to establish in as there is no cultivation of the soil.
- A slight 'cut' in the ground will allow more seed/soil contact.
- Results can be variable.
- Not suitable on dry, hard ground.
- Need to use slug pellets.
- Spread Lime + Fertiliser/Direct drill.

Effect of reseeding method on grass production

The effect of reseeding method has been investigated at Moorepark. The figure below shows that, when compared on a proportionate basis to ploughing set at 1.0, the disc method was equal in terms of grass production, with the one-pass method slightly behind at 0.94 and the direct drill method at 0.87.



A comparison of reseeding methods in terms of grass production potential.

3.5 Variety choice

Key traits

Use the Teagasc Pasture Profit Index and DAFM Recommended List to identify suitable varieties. The Recommended List evaluates varieties across years and sites and is the only evidence available of the potential performance of grass cultivars in Ireland.

The key traits in a seasonal grass based production system are:

- High quality.
- High seasonal production.
- Good persistency score.

When the decision to reseed is made, the next major decision is selecting the most appropriate grass variety or varieties. The first thing to consider is the primary target use of the field. Is it predominantly grazing or is it generally used as a silage paddock? How much tetraploid should be used? A balance between quality, dry matter productivity and sward density is generally what must be achieved.

Table 13. Differences between diploid and tetraploid varieties

Tetraploid varieties	Diploid varieties
Tall upright growth habit	Prostrate growth habit
Create more 'open' sward	Create a denser sward with less "open" spaces
Higher digestibility value	Generally lower digestibility and yield

Combining diploids and tetraploids in a mixture will create a dense, high quality sward – ensure you select varieties which express high performance in the key traits. Increasing the proportion of diploids on heavier soils is recommended to create better ground cover.

Key points when formulating a grass mixture

- Decide what the end use is – grazing or silage – formulate based on this.
- Focus on the key traits, increase the proportion of the varieties with the key traits.
- Minimum of 3 kg of an individual variety.
- There should be no more than three to four variety in a grass mix.
- Sow 35 kg/ha (14 kg/ac) of seed.
- Less than 7 days range in heading date between varieties.

Grazing specific mixtures

- Varieties exhibiting high seasonal PPI values.
- Varieties with high quality sub index values.
- Use 35-50 per cent tetraploid varieties in mixtures on dry soils.
- Use 15-20 per cent of highly persistent tetraploids on heavy soils.
- Small/Medium leaf white clovers for dairy cows/cattle, small leaf white clovers for sheep.

Silage specific mixtures, e.g. 2-cut system

- Varieties which have high silage sub index values.
- 40% tetraploid (less on heavy soils).
- Ensure proximity of heading dates.
- Avoid low silage sub index diploids and poorly persistent tetraploids.

Choosing the right white clover cultivar

White clover is used in grazed grassland. White clover cultivars are categorised by leaf size.

Small leaf white clover

- Lower yielding.
- More persistent.
- Tolerant of tight grazing, e.g. sheep grazing.

Medium leaf white clover

- Intermediate for yield and persistency.
- Suitable for cattle grazing.

Large leaf white clover

- Higher yielding.
- Aggressive and can dominate a sward.

Small leaf white clovers are recommended for sheep grazing and medium leaf white clovers for dairy or beef cattle grazing.

In general to establish a sward with >25% white clover, which is the level required for an animal production benefit, 4 kg white clover seed/ha (1.5 kg/ac) should be included in the seed mix.

Alternatives to perennial ryegrass

Hybrid and Italian ryegrasses are an alternative to perennial ryegrass but are more suited to silage systems. Both are less persistent and have lower mid-season digestibility than perennial ryegrass, but have a higher annual yield. Hybrid and Italian ryegrasses have a shorter lifespan than perennial ryegrass, generally 2 to 4 years.

3.6 Management of Reseeded Swards

It takes about 11 months for a new sward to establish and settle down; therefore the management of the reseed in this period is important.

Table 14. Management of New Reseeds

	Do's	**Do not's**
First 8 weeks	Spray weeds before grazing Graze when grass is at 2-3 leaf stage Nitrogen and P & K Slug pellets (if required)	Graze at high cover (>1200 kg DM/ha) Do not harvest for silage
Second grazing onwards	Graze at 1,200 - 1,600 kg DM/ha (6-8 cm) Re-spray weeds if necessary	Allow high covers to develop Graze in really dry or wet conditions
Autumn	Keep grazing at 1,200 - 1,600 kg DM/ha Graze off well before first winter (<4 cm) Light slurry application	Overgraze or poach Apply excessive slurry
Second year	Ensure the new sward receives adequate nitrogen Monitor soil P and K status	Overgraze or poach

Graze the new reseed as soon as the plants do not pull out of the ground, approximately 1000 – 1200 kg DM/ha. It is especially important that autumn reseeds are grazed before the first winter.

The first grazing does not have to be completed by the main grazing herd, calves or young stock may be a better option, particularly during poor grazing conditions.

All the benefits of reseeding can be lost after sowing due to:

- Poor soil fertility - poor establishment and tillering.
- Grazing at high grass covers or cutting for silage – tiller/plant death.
- Weed infestation (especially docks) – loss of ground cover.
- Pest attack (frit fly, leatherjackets and slugs) – tiller/plant death.
- Poaching – don't damage new reseeds.

Tillering

- Tillering is the production of new grass plants by the main grass plant established from the seed.
- The process of grass tillering is critical for successful sward establishment.
- Tillering helps reduce the space available for weeds.
- To encourage tillering:
  - Apply 40 kg N/ha 3-4 weeks after sowing.
  - Graze the reseed when it is about 6-7 cm high.
  - Continue to graze the reseed in the first year of production.
  - Avoid cutting the new reseed for silage in the first year (if possible).

3.7 Weed Control

- Weeds in new reseeds are best controlled when the grass is at the 2-3 leaf stage
- Docks and chickweed are the two most critical weeds to control in reseeds.
- High populations of other weeds such as fat hen, charlock, redshank, mayweed can cause problems (see Herbicide Guide).
- It is essential to control docks and chickweed at the seedling stage and this is achieved by applying a herbicide before the first grazing.
- To achieve the best lifetime control of docks in a sward, eradicating the dock at seedling stage in a reseed is the best opportunity.
- Herbicide choice for dock control will depend on the presence of white clover in the reseed (see Herbicide Guide).
- Chickweed can be a problem particularly where regular grazing is not expected to take place (silage fields), therefore herbicide choice is important.
- You should consult your local adviser or merchant representative for correct herbicide choice.
- Remember to keep the prescribed cross-compliance records and follow the instructions on the product label.
- Pesticide users must comply with the regulations as outlined in the Sustainable Use Directive (SUD).

Herbicides in New Leys

Table 15. Herbicide Guide

Weed Problem	Trade Name	Clover Safe	Pack Size	Rate/Ha	Comment
Docks and most other less important weeds	Underclear etc.	YES	10 L	7 L/ha	Controls moderate levels of docks, thistles, chickweed, etc. and most annual weeds.
	Legumex DB Undersown DB Plus CloverMAX etc.	YES	5 L	7 L/ha	Similar weeds controlled as above but weaker on chickweed and certain annual weeds.
Docks and Chickweed	Legumex DB + Triad	YES	5 L 5 tabs	5.0 L/ha + 10g/ha	Similar weeds Controlled as Underclear etc. Add Triad to the tank first and then Legumex DB.
	Binder Hurler, Reaper, Highload Mircam etc.	NO	1 L	0.75 L	Use where docks and chickweed are in high numbers Apply from 3 leaf grass stage

Talk to your local distributor for advice on the most appropriate herbicide

Seedling Broad-leaved Dock

Photo of seedling dock taken 5 weeks after re-seeding

Seedling Chickweed

Photo taken 5 weeks after re-seeding

Pest Attack

The three most significant pests of reseeds are:
- Frit fly
- Leatherjackets
- Slugs

Frit Fly

Frit Fly is most prevalent in autumn after a dry summer, and in reseeded swards with high levels of debris (minimum cultivation).

- The maggots (larvae) bore out the centre shoot.
- The centre shoot will turn yellow and the plant dies.
- New grass sown after grass or grassy cereal ground is most at risk.
- Reseeding carried out by direct drilling is also at risk.

Control involves:

- Leaving ground unsown for 6+ weeks after ploughing (not a very practical option).
- Spraying a suitable insecticide (Decis for example) if 10% or more of shoots of plants are damaged.*

**Walk diagonally across the field and tug 100 central shoots of new plants. If 10% of shoots pull away easily apply an insecticide. You may need to consult your local adviser or merchant representative.*

Leatherjacket

Leatherjacket is most active in wetter/heavier soils. Leatherjacket damage is characterised by dead plants on the soil surface. Ensure to roll the reseeded field is very important, firm seedbed will reduce the impacts of leatherjackets. Up to the time of tillering is the highest risk time, so try and ensure the sward moves to this stage as fast as possible.

Slug

Slug attack is most prevalent during wet weather or where fields tend to be damp, such as headland areas. Having high levels of trash in the seedbed will also increase the likelihood of slug attack. The most common evidence of slug attack is shredded leaves. Slug attack is more prevalent where reseeding is carried out by direct drilling. This method creates slits in the ground which act as a protective shelter for slugs. The likelihood of damage to the new grass plants can be greatly reduced by ensuring a firm seedbed by rolling. Most of the major slug species cannot burrow into the soil. Slug pellets can be applied to control the problem. Usually applying slug pellets to the margins of fields/paddocks is adequate. Higher seeding rates should be considered where reseeding is carried out by direct drilling to counteract slug attack.

3.8 Reseeding Investment

Reseeding is one of the most cost effective investments that can be made on a grassland farm.

	Projected costs	**Actual costs**
	€/acre (/ha)	
Spraying	10 (25)	
Glyphosate (Round-up (2 litre/acre)	16 (40)	
Ploughing (€30)/ Till & sowing (one pass) (€40)	70 (173)	
Fertiliser (2.5 bags × 10:10:20)	54 (134)	
Fertiliser spreading	10 (25)	
Levelling	10 (25)	
Rolling	10 (25)	
Lime + Spreading (2t/ac)	24 (60)	
Grass seed	70 (173)	
Post emergence herdicide sprays		
Legumex DB - (2.8litre/ac - €18)	18 (45)	
Spraying	10 (25)	
Total Costs	**302 (750)**	

**Both fertiliser and Lime are common grassland costs*

3.9 Reseeding – What to watch for

1. Periods of moisture deficit

In periods of dry weather post emergence when seedlings have germinated, spread 1000-1500 gallons of water/soiled water per acre to aid germination – otherwise the germinated reseed may fail. Do not leave emerging reseeds without moisture for too long.

2. Patchy establishments

Over sow with extra seed or direct drill new seeds.

3. Mild damp autumns

Monitor reseeds closely for leatherjacket and slug infestations.

4. Rolling

Make sure the reseed is rolled – even post emergence, unrolled reseeds loose moisture fast and plants can be pulled up when grazed.

5. Weed Infestation

Post emergence weed control is either forgotten or weather conditions are not suitable (particularly in autumn) for spraying and large populations of weeds can become established. Chickweed in particular can be a problem as it will smother new grass.

3.10 Teagasc Pasture Profit Index (PPI) 2017

Variety Details			Pasture Profit Index Sub-indices (€ per ha per year)						
			Dry Matter Production						
Variety	Ploidy	Heading date	Spring	Summer	Autumn	Quality	Silage	Persistency	Total € ha/year
AberClyde	T	May 26	44	49	34	59	19	0	206
AberMagic	D	May 31	36	51	68	33	11	0	199
Nifty	D	May 27	70	53	57	-7	16	0	191
Fintona	T	May 22	58	39	50	11	21	0	178
AberChoice	D	June 9	11	49	47	63	6	0	175
AberWolf	D	May 31	58	39	34	29	12	0	171
Rosetta	D	May 24	89	29	40	2	11	0	170
AberGain	T	June 5	17	44	42	64	20	-19	169
AberPlentiful	T	June 9	39	50	40	29	9	0	167
Seagoe	T	May 28	33	40	43	19	33	0	167
Dunluce	T	May 30	17	44	46	41	17	0	165
Meiduno	T	June 6	43	45	41	32	12	-11	163
Solas*	T	June 10	8	43	55	30	15	0	151
Magician	T	May 22	46	33	33	6	23	0	141
Astonenergy	T	June 2	-9	36	38	61	5	0	131
Xenon	T	June 11	7	37	30	45	10	0	130
Kintyre	T	June 7	10	37	53	32	6	-11	126
Solomon	D	May 21	65	30	31	-24	22	0	125
Alfonso	T	June 4	-5	36	34	50	-2	0	113
Aspect	T	June 6	6	40	24	37	5	0	110
Boyne	D	May 22	55	31	26	-39	34	0	107
Carraig	T	May 24	37	39	32	-12	9	0	105
Navan	T	June 6	-6	38	48	20	3	-5	98
Drumbo	D	June 7	13	33	32	43	-6	-19	96
Kerry	D	June 1	19	40	39	-1	2	-5	93
Glenroyal	D	June 5	11	39	39	2	2	0	92
Delphin	T	June 2	2	39	25	16	15	-5	91
Clanrye	D	June 6	21	39	15	-10	11	0	76
Majestic	D	June 2	22	30	37	-16	-8	0	65
Glenveagh	D	June 2	8	32	20	-12	3	0	51
Stefani	D	June 2	4	25	21	-3	3	0	50
Piccadilly	D	June 3	10	29	16	-24	15	0	46
Tyrella	D	June 4	24	17	14	2	-7	-28	23

Teagasc Pasture Profit Index (PPI) 2017 – Notes and information

The Pasture Profit Index (PPI) should be used in conjunction with good grassland management practices. The Pasture Profit Index is designed as a guide to assist in variety selection when planning to reseed. Variety selection may depend on the intended grazing management to be practiced (e.g. grazing, silage, etc.).

All data used in the compilation of this Index has been generated from data within the Simulated Grazing (frequent cutting) protocol in the Department of Agriculture, Food and the Marine (DAFM) Recommended List Trials. It is advised that the PPI should be used in conjunction with the DAFM 2017 Recommended List to ensure selection of the most appropriate perennial ryegrass varieties to meet particular enterprise requirements. Only varieties that have completed a minimum of 2 harvest years in the DAFM Simulated Grazing Protocol have a PPI value assigned to them.

Guide to reading the table:

Variety details: Variety, Ploidy (T= tetraploid; D= diploid), Heading date

PPI details (Total €/ha per year): indicates relative profitability difference when compared to the base values.

For further information on the PPI

www.agresearch.teagasc.ie/moorepark/PastureProfitIndex/index.asp.

PPI sub-indices: Seasonal DM yield (spring, summer and autumn), Quality (April, May, June and July), Silage (1st and 2nd cut), Persistency. Persistency is modelled over 12 years which is in line with industry practice (Creighton et al., 2012)

This indicates the economic merit of each variety within each trait, summed together this provides the overall PPI value. When using the index evaluate varieties across there sub index values and choose the most appropriate for the intended enterprise.

4 Land drainage design and installation

- No drainage work should be carried out before the drainage characteristics of the soil are established by a site and soil test pit investigation.
- Two types of drainage system exist: a groundwater drainage system and a shallow drainage system. The design of the system depends entirely on the drainage characteristics of the soil.
- Distinguishing between the two types of drainage systems essentially comes down to whether or not a permeable layer is present (at a workable depth) that will allow the flow of water with relative ease. If such a layer is evident a piped drain system is likely to be effective, at this depth. If no such layer is found during soil test pit investigations, it will be necessary to improve the drainage capacity of the soil. This involves a disruption technique such as moling, gravel moling or subsoiling in tandem with collector drains.
- Drains are not effective unless they are placed in a permeable soil layer or complimentary measures (mole drainage, subsoiling) are used to improve soil drainage capacity. If water isn't moving through the soil in one or other of these two ways, the watertable will not be lowered.
- Drain pipes should always be used for drains longer than 30 m. If these get blocked it is a drainage stone and not a drainage pipe issue.
- Drainage stone should not be filled to the top of the field trench except for very limited conditions (the bottom of an obvious hollow). Otherwise it is an expensive way of collecting little water.
- Most of the stone being used for land drainage today is too big. Clean aggregate in the 10–40 mm (0.4 to 1.5 inch approx.) grading band should be used. Generally you get what you pay for.
- Subsoiling is not effective unless a shallow impermeable layer is being broken or field drains have been installed prior to the operation. Otherwise it will not have any long-term effect and may do more harm than good.
- Maintenance or re-instatement of outfalls and open drains are great ways to kick start a drainage project. Most land drainage systems are poorly maintained. Open drains should be clean and as deep as possible and field drains feeding into them should be regularly rodded or jetted.

Approximately 49.5% (3.4 m ha) of the total land area of Ireland is classified as "marginal land" which is affected by natural limitations related to its soil, topography, relief and climate. The major limitation of this marginal land is its poor drainage status and much is in need of artificial drainage if its productivity is to be improved. In wet years poorly drained soils may never dry out as persistent rainfall maintains high soil moisture contents. Grass yields are limited due to the adverse effect of excess water and a lack of air at rooting depth, which limits plant respiration and growth.

In cases of prolonged waterlogging, plants will eventually die due to a lack of oxygen in the root zone. Furthermore waterlogged soils are impassable to agricultural traffic (both machinery and livestock) for long periods, due to high soil moisture content and reduced soil strength. This reduces the number of grazing days and hinders silage harvesting, thus introducing higher costs related to imported feedstuffs.

The purpose of land drainage is to remove excess water from the soil as quickly as possible. How best to achieve this will vary with soil type. There is a need therefore for a better understanding of the underlying causes of drainage problems and of the design and implementation of appropriate drainage systems to resolve these problems. We must move away from the short-sighted approach that a broadly similar drainage system can be installed in every wet field regardless of soil and site conditions. An assessment of soil type and its drainage status is a vital first step.

4.1 Causes of impeded drainage

The difficulties of drainage problems in Ireland are largely due to our complex geological and glacial history. Soil layers of varying texture and composition have the effect of irregularly distributing groundwater flow, with fine textured soils acting as a barrier to movement, impeding drainage, and lenses of gravels and sands promoting water flow, transmitting groundwater over large areas with resulting seepages and springs on lower ground. In poorly drained soils the rate of water infiltration at the soil surface is regularly exceeded by the rainfall rate due to:

- Low permeability in the subsoil (or a layer of the subsoil).
- High watertable due to low lying position and poor/poorly-maintained outfall.
- Upward movement of water from seepage and springs.

4.2 Objectives of land drainage

To achieve effective drainage the works will have to solve one or more of these problems. The objective of any form of land drainage is to lower the watertable providing suitable conditions for grass growth and utilization. A controlled watertable promotes deeper rooting which improves productivity and improves load-bearing capacity of the soil.

When planning any drainage programme, the potential of the land to be drained needs to be first assessed to determine if the costs incurred will result in an economic return through additional yield and/or utilisation. Some thought is needed in deciding the most appropriate part of the farm to drain. From a management point of view it is better to drain that land which is nearer to the farmyard and work outwards, however it may be more beneficial to target areas with high potential for improvement. This ensures a better return on the investment.

4.3 Drainage investigations

What exactly is the problem? How good is the existing drainage network (if any)? Is the whole profile made up of poor soils or is the problem caused by specific layers? Is there water movement at any depth?

Knowledge of previous drainage schemes in the area, and their effectiveness will often provide an insight. A number (approx. 1 per ha) of test pits (at least 2.5 m deep) should be excavated within the area to be drained to investigate. These are dug in areas that are representative of the area as a whole; consider digging in wet and dry areas for comparison sake. As the test pits are dug, the faces of the pits are observed, soil type should be established and the rate and depth of water seepage into the test pit (if any) recorded. Visible cracking, areas of looser soil and rooting depth should be noted as these can convey important information regarding the drainage status of the different layers. The depth and type of the drain to be installed will depend on the interpretation of the characteristics revealed by the test pits.

Two principle types of drainage system are distinguished:

- Groundwater drainage system: A network of piped drains exploiting permeable layers.
- Shallow drainage system: Where movement of water is impeded at all depths.

Groundwater Drainage System

Strong inflow of groundwater or seepage from the faces of test pit walls, indicate that layers of high permeability are present. Under these circumstances the use of a piped drainage system (at the depth of inflow) is advised to capture and remove this water, thereby controlling the watertable. Deep piped drains are usually installed at a depth of 1.5-2.5 m and at spacings of 15–50 m, depending on the slope of the land and the permeability and thickness of the drainage layer. Piped drains should always be installed across the slope to intercept as much groundwater as possible, with open drains and main piped drains running in the direction of maximum slope. Where groundwater seepage and springs are identified, deep drains, 2 to 4 m deep can be used to intercept flow. Pipe drains are most effective in the layer transmitting groundwater flow, characterised by high water breakthrough. This issue is very site specific.

Clean aggregate, in the 10 – 40 mm grading band, should to be used to surround the drain pipe. The gravel should be filled to a minimum depth of 300 mm from the bottom of the drain to cover the pipe. The stone should provide connectivity to a layer of high permeability and should not be filled to the ground surface. The purpose of a drain pipe is to facilitate a path of least resistance for water flow. In long drain lengths (greater than 30m) a drain pipe is vital to allow a high a flow-rate as possible from the drain, stone backfill alone is unlikely to have sufficient flow capacity to cater for the water volume collected.

Test pit excavation

Drainage trench excavation

Shallow Drainage Systems

Where a test pit shows no inflow of groundwater at any depth a shallow drainage system is required. These soils with very low permeability throughout are more difficult to drain. Shallow drainage systems aim to improve the capacity of the soil to transmit water by fracturing and cracking the soil. They rely on soil disruption techniques, namely; mole and gravel mole drainage and sub-soiling.

Mole plough showing cylindrical foot and expander

Mole drainage is suited to stone-free soils with a high clay content which form stable channels. Mole drains are formed with a mole plough comprised of a torpedo-like cylindrical foot attached to a narrow leg, followed by a slightly larger

diameter cylindrical expander. The foot and trailing expander form the mole channel while the leg creates a narrow slot that extends from the soil surface to the mole channel depth

The mole plough creates both a zone of increased permeability adjacent to the mole leg (shallower depths) and a channel for water flow at moling depth. The effectiveness of mole drainage will depend on the extent soil cracking during installation. As such the ideal time for carrying out mole drainage is during dry summer conditions, to allow for maximum cracking in the upper soil layers and adequate traction to prevent wheel-spin on the surface.

Gravel Mole plough showing hopper

Gravel filled moles employ the same principles as ordinary mole drains but are required in soils which will not sustain an unlined channel. The gravel mole channel is filled with gravel from an attached hopper which supports the channel walls. Gravel moles require a very specific size range of gravel aggregate to ensure that they function properly. Washed aggregate within a 10-20 mm size range should be used. Sub-soiling is used effectively where an iron pan or cemented layer impedes drainage. The effect is to break the layer and crack the soil. A stable channel will not be formed.

Single leg winged sub-soiler

Collector drains, which are installed across the slope at 0.8 – 1.0 m deep, are required for all shallow drainage systems. Depending on the topography and slope, the collector drains will be at a spacing of 10–40 m. A larger spacing reduces costs but results in a much higher chance of failure. The disruption channels themselves are drawn at right angles to the collectors (up-slope) at spacings of 1.0-1.5 m and a depth of approximately 0.4-0.5 m. Stone backfill for collectors should be filled to within 250 mm of the surface to ensure interconnection with the disruption channels when installed afterwards.

4.4 Outfalls/Maintenance

Every drainage scheme is only as good as its outfall. Cleaning and upgrading of open drains acting as outfalls from land drains is an important step in any drainage scheme. Before commencing land drainage the proposed outfall should be assessed and where necessary upgraded. Open drains, running in the direction of maximum slope, should be established to a great a depth as possible. Spoil from such works, where suitable, can be spread over the adjoining land filling depressions and should not impede surface runoff to the watercourse. Unsuitable spoil should be buried and covered with topsoil or removed to waste ground.

When a drainage scheme has been completed, the layout should be drawn and noted on a farm map. This map can then be used as a guide when maintaining the works, as well as a record of the works. Land drain outlets should be regularly cleaned and maintained especially if open drains are cleaned/upgraded as this will result in blockages at the drain outlets. The use of a concrete or un-perforated plastic pipe over the end of the drain pipe, minimum 1 m in length, will protect the outlet from damage and will make locating and maintaining it easier.

4.5 Indicative Costs

The cost of drainage works will vary depending on such factors as soil type, site access, extent of open drains, availability/cost of backfill stone, and experience with drainage works among other factors. As such, costs are quite variable and will be specific to a particular job. Table 10 provides guidelines only. Cost for the provision of open drains is not included.

Table 10 covers as far as possible the general arrangements available. Where a shallow drainage system is considered the price will depend largely on the collector drains required. If an existing drainage system of closely spaced piped drains is already in place at the appropriate depth it may be possible to pull mole drains through this existing network or from an existing open drains. In this case the cost of mole drainage can be very cost effective. Where a collector system needs to be installed the total cost will be higher.

It is of the utmost importance that the selection of a drainage system for a particular site is not decided on the basis of cost. Alternatively an effective drainage system should be designed and costed and then a decision made as to whether or not to proceed. It is important to remember that the closer the drain spacing the higher the cost.

Table 16: Approximate costs of drainage systems

Drainage System	Drain Spacing (m)	Depth (m)	Cost/m (€)	Cost/Acre (€)	Cost/hectare (€)
	Groundwater Drainage System				
Groundwater Drainage	15 - 50	1.0 - 2.5	7-9	600-2400	1400-6000
	Shallow Drainage System				
Mole Drainage	1 - 1.5	0.45 - 0.6	-	50-100	125-250
Gravel Mole Drainage	1 – 2.0	0.35 - 0.5	-	500-1000	1250-2500
Collector Drains	20	0.75- 1.0	5-7	1000-1400	2500-3500
Collector Drains	40	0.75- 1.0	5-7	500-700	1200-1700
Collector Drains	60	0.75- 1.0	5-7	350-450	800-1150

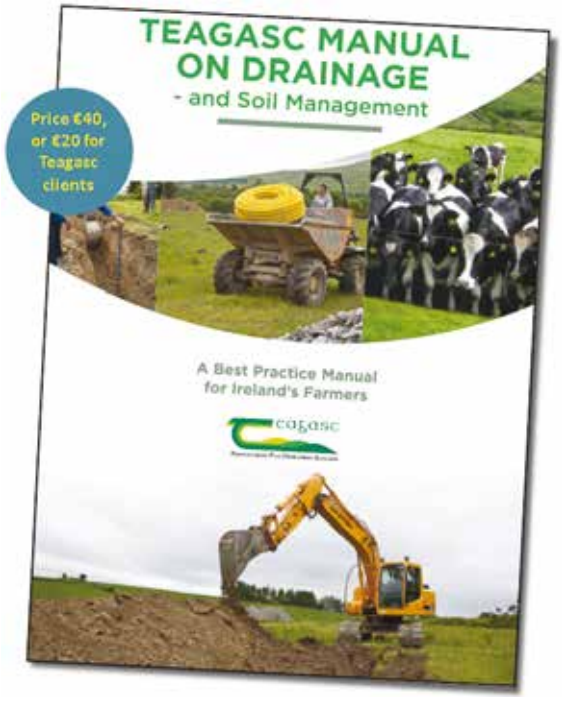
More in-depth Information

Land Drainage Booklet

A freely downloadable practical guidebook to land drainage is available via the Teagasc website, **www.teagasc.ie/publications.** Search ***"Land Drainage".***

Land Drainage Manual

The Teagasc Manual on Drainage - and Soil Management is available from Teagasc offices or can be ordered via the Teagasc website, **www.teagasc.ie/publications.** Search ***"Teagasc Manuals".***



5 Importance of biodiversity on beef farms

Summary

- Wildlife measures can play an important role in halting the decline of biodiversity and achieving the goals of sustainable production.
- The quality of existing farmland habitats should be maintained or enhanced before new biodiversity measures are established.
- New biodiversity measures could be targeted to less-productive areas of the farm.

5.1 Introduction

Centuries of agriculture have helped shape the Irish landscape and the wildlife (biodiversity) it contains. Many of our best known farmland plants and animals are dependent on agricultural practices, and changes in these practices in turn affect farmland ecology. Intensification of agriculture over recent decades has resulted in a decline of biodiversity within agricultural systems. Whilst there is a need to increase production to cope with increasing food demands, the environment and ecosystem services it provides need not be compromised. Emerging research and policy agendas are now based on sustainable management of agricultural land.

Grass-based farming systems in Ireland are well positioned in terms of the wildlife they support within the landscape. It is estimated that natural and semi-natural habitats make up 12-14% area of grassland farms. The amount of wildlife habitats is highest on more extensively managed farmland, resulting in most focus to date being centred on sustaining and enhancing biodiversity within these more-extensive systems. Objectives of the Food Harvest 2020 and FoodWise 2025 reports include the pressing need for the development of effective methods for biodiversity conservation, as part of the development of sustainable production systems in both intensive and extensive systems. Incorporation of such measures could provide a very important and much overlooked branding and marketing opportunity to Irish farmers and retailers in terms of capitalising on Ireland's 'clean, green' image.

5.2 Measures to enhance biodiversity on beef farms

Intensively-managed systems do not typically support the same abundance or quality of habitats and wildlife as more extensive systems. However, appropriately-designed wildlife measures, targeted for intensive systems, could play an important role in halting the decline of biodiversity and achieving the goals of sustainable expansion. Such measures can also play an important role in delivering on other environmental goals such as improving water quality and reducing greenhouse gas emissions.

Maintain and manage existing habitats

It is important to optimise the biodiversity value of existing farmland habitats before new biodiversity measures are established on farms. It is typically more effective to

retain existing habitats rather than establishing new ones. Existing habitats, including woodland plots, ponds and wetlands should be protected from more intensive agricultural management. These areas should be appropriately managed and avoided when sites are being selected for 'new' biodiversity initiatives. Many of these semi-natural habitats benefit from farm management that prevent the area from scrubbing over (e.g. light grazing of woodland plots in spring and autumn can help improve the quality of the area thus benefitting a variety of species).

Hedgerow management

Appropriately managed hedgerows can have multiple benefits, including providing shelter for stock and improving biosecurity; intercepting overland flow and improving water quality; sequestering carbon; and acting as a refuge for biodiversity. Ensure that appropriate management is undertaken outside the closed period from March 1st to August 31st.

- Leave occasional trees or bushes to mature. Mature trees and bushes provide greater feeding and nesting habitats for birds, pollinators and a variety of insects.
- The sides of hedges should be trimmed, with the top allowed to grow taller. This approach provides greater shelter and stock-proofing for animals, but also improves the diversity of habitats for wildlife.
- Replant escaped or 'gappy' hedgerows with native species (e.g. hawthorn). Native species support a greater abundance and diversity than non-native species.

Watercourses and buffer strips

Riparian buffer strips are strips of permanent vegetation adjacent to rivers and streams that are typically excluded from intensive farming practices. Appropriately managed buffer strips play an important role in maintaining water quality, ensuring bank stability, providing a habitat for biodiversity and acting as a wildlife corridor. To optimally manage these strips:

- Avoid nutrient (fertiliser or slurry) or herbicide application in the buffer strip.
- Allow vegetation in the strip to develop, but avoid the strips becoming dominated by scrub. Periodic cutting or grazing can improve the buffering capacity and habitat quality of the strip.
- Instream work should be targeted from July to September to avoid disruption to spawning fish. When cleaning the channel-bed, the spoil should be deposited away from the buffer strip.

Establish new habitats

New biodiversity measures play an important ecological role where there is a lack of existing habitats. New measures could be targeted to less productive areas of the farm.

- The banks of a cattle underpass or drain could be sown with grass and wildflower mixes. This measure helps stabilise the banks, prevents undesirable plant species from encroaching into the field, and also provides a habitat for plants and animals.
- Awkward field corners could be left uncut following silage removal. This temporary measure provides food and cover for a variety of species such as farmland birds and small mammals. Corners could be grazed-off when animals are re-introduced to the field.

GLAS measures

a. Bird and bat boxes

Populations of farmland birds and bats are declining and efforts should be undertaken to enhance their populations.

- Avoid interfering with existing bird nests or bat colonies.
- Erect boxes for bats and birds on suitable trees and buildings.

b.Wild Bird Cover

Wild Bird Cover (a spring-grown mixture of cereals that is not harvested) could be sown on farms, thus providing winter food and cover for declining farmland birds. Mixtures include a cereal (oats or triticale) and oilseed rape, linseed or mustard. The measure is part of the Green Low Carbon Agri-environment Scheme (GLAS).

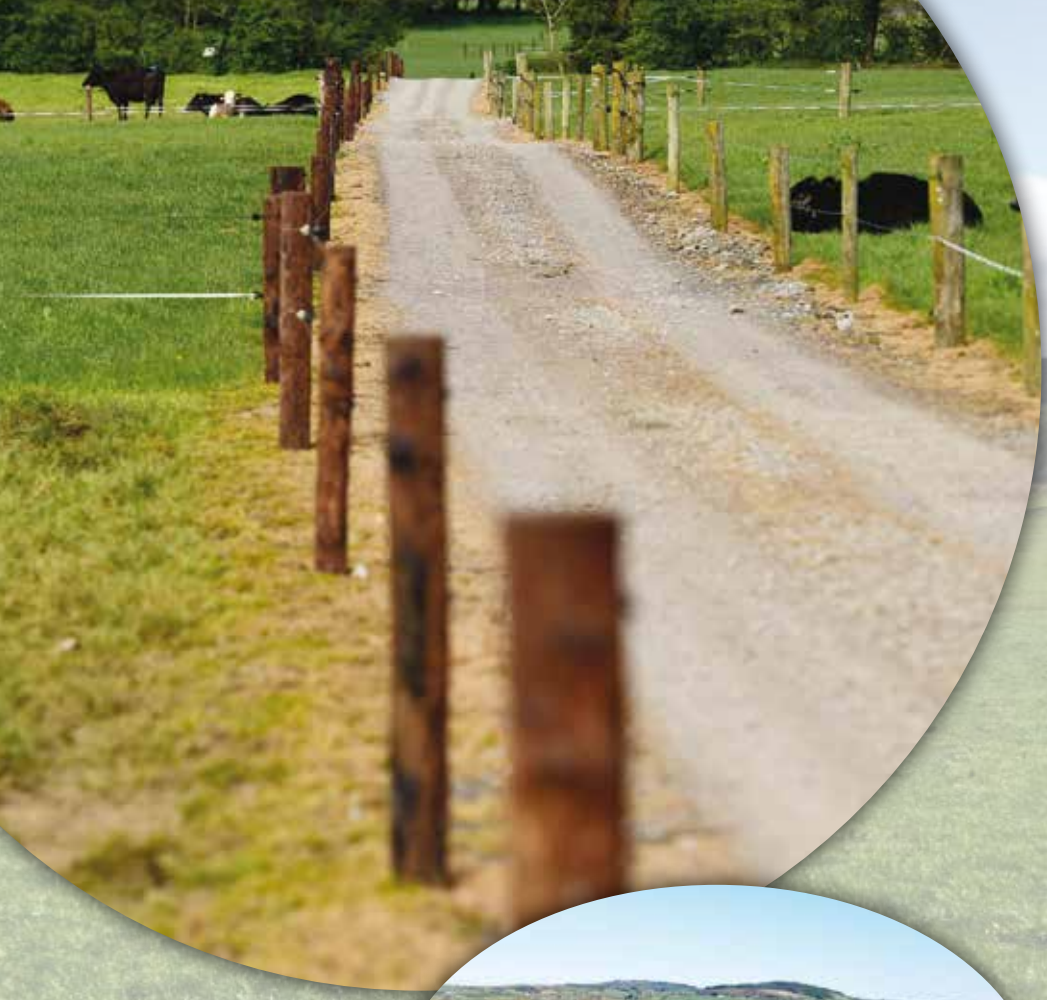
5.3 Conclusions

Biodiversity is a primary environmental indicator of sustainable agricultural systems. There is a need for effective methods to promote wildlife conservation, as part of the development of sustainable agri-production systems. This provides important branding and marketing opportunities for farmers and retailers.

Additional information

https://www.teagasc.ie/environment/biodiversity--countryside/

Planting banks with grass and wildflower mixes helps stabilise the banks, prevents undesirable plant species from encroaching into the field, and also provides a habitat for plants and animals



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