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TEACHER: CATRIONA HENDRY

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TOPIC: GRASS – (i) Grassland Management (ii) Conservation of grass

CONTENTS

INTRODUCTION / USES OF GRASS

The purpose of these notes is to familiarise students with the principles of grassland and grazing management, and then to cover the ways in which we conserve grass for winter use.

Grassland has two main purposes in Agriculture. The first is to provide grazing and immediate nutrition for livestock through the summer months. The second is to be harvested in the summer to be stored away and provide nutrition through the winter months.

All livestock enterprises that raise cattle or sheep are dependant on grass for their productivity. When you think of it that way you can begin to understand why managing the grass is so important. Grass is a crop just like barley or potatoes, and so attention needs to be paid to making sure it grows well to achieve the peak productivity possible.

A farmer that grazes livestock through the summer as well as making their own hay and silage for the winter will need to very carefully plan the management of their pastures to balance both requirements.

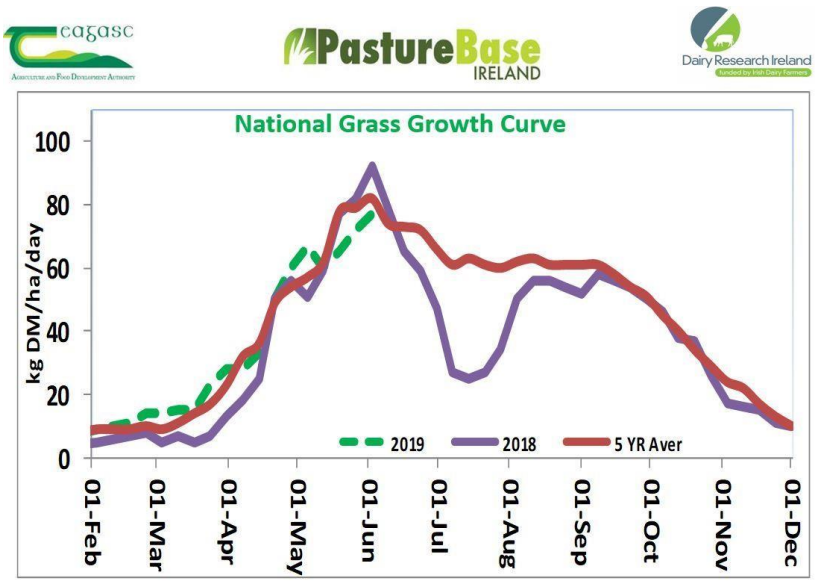
Through careful monitoring of grass growth it is possible for a farmer to budget their grass. By working out the amount of grass their stock will need, and comparing this to the expected output per pasture the farmer can ensure that he will have adequate supply through the year.

The farmer also needs to ensure that each pasture is grazed to its maximum potential, otherwise excess grass will grow past its best and be wasted in the field . Good grassland and grazing management is critical in ensuring the efficiency of the farm enterprise.

Deciding when to close the pastures for the winter is also important. A farmer will need to being closing some of the pastures in late summer in order to ensure that there will be some pastures recovered and ready for spring grazing the following year.

Figure 1 : Shows the annual grass growth curve for 2018, and the 5 yr average. You can see that the drought in 2018 caused a summer of poor growth.

This would have had significant impacts on the grass budget for farmers in that year as there would not have been enough grass available to support summer grazing as well as storage for winter feed.



LIVESTOCK UNITS

To understand the budgeting of grass, we need to know two things. First, how much grass we expect the pasture to produce, and second, how much we expect each animal to consume . The grass production can be estimated based on pasture size, grass growth curves, and monitoring of real-time growth in that season.

The amount we expect an animal to each will vary greatly depending on the type of animal, the sex of the animal, and the age of the animal. To simplify this we use "LIVESTOCK UNITS". Each animal has a livestock unit value based on its age and sex etc.

We can use the livestock units (LU) to measure the amount of livestock grazing in a pasture.

The total LU can be used to quantify the amount of green herbage (grass) needed for the herd for the year. We can also use the LU of the herd to calculate the winter fodder needed.

A dairy cow has an LU value of 1.0. This is one standard livestock unit, and all other animals are compared to this. For instance, we would expect a bull to require more nutrition than a dairy cow, so his LU value will be higher than 1.0. A sheep on the other hand, will consume much less than a dairy cow, and so we would expect the LU for a sheep to be significantly less than 1.0.

Table 1 (next page) gives the LU values for a range of animals. A farmer simply needs to work out the total LU of his herd based on what animals he has and their lifestages, and then he can work out how much grazing (herbage) is required for his herd.

Here are the key figures that **STUDENTS MUST LEARN:**

- One LU requires 12 tonnes of herbage per year (one tonne per month).
- One dairy / suckler cow = 1.0 LU
- Cattle 1-2 years = 0.6 LU
- Cattle <1 year = 0.4 LU
- Sheep = 0.15 LU

Table 1: Example LU values for a range of livestock

Livestock unit coefficients

Bovine animals	Under 1 year old	0,400
	1 but less than 2 years old	0,700
	Male, 2 years old and over	1,000
	Heifers, 2 years old and over	0,800
	Dairy cows	**1,000**
	Other cows, 2 years old and over	0,800
Sheep and goats		0,100
Equidae		0,800
Pigs	Piglets having a live weight of under 20 kg	0,027
	Breeding sows weighing 50 kg and over	0,500
	Other pigs	0,300
Poultry	Broilers	0,007
	Laying hens	0,014
	Ostriches	0,350
	Other poultry	0,030
Rabbits, breeding females		0,020

LIVESTOCK UNIT WORKED CALCULATION:

What is the number of livestock units for a farm which has…

- 75 Dairy cows
- 22 sheep
- 12 cattle <1 year

Answer = (75 x 1.0) + (22 x 0.15) + (12 x 0.4) = 83.1

Our farmer has 83.1 livestock units in his herd. So how much herbage is needed per year?

- 1 livestock unit requires 12 tonnes of herbage, therefore:
    - 83.1 LU x 12 = 997.2 tonnes required per year

GRASSLAND MANAGEMENT –

GRAZING SYSTEMS

The grazing system is the way in which the farmer moves his livestock in order to maximise the use of the grass available. He also needs to plan to allow areas to recover in order to be grazed again later in the season. Most of these are rotational systemsthat are based on the idea that by moving the animals between areas the livestock get consistent access to fresh grazing, and the pasture gets rested and recovers in between periods of being grazed.

After a pasture has been grazed the grass takes 3 weeks to regrow to the point where is can be grazed again, and so all of the systems assume no pasture is returned to within that time

Students need to know examples of the grazing systems (including a diagram for each), and also how they can be combined with other management options like a leader-follower system.

NOTE: Access to water is CRITICAL when dividing up the land for grazing, regardless of the system.

NOTE: Rotational grazing also helps break the lifecycle of endoparasites

ROTATIONAL GRAZING:

In a rotational grazing system the animals are moved around through the grazing season. **After the area has been grazed it is allowed to recover, and then will be grazed again on the next rotation.** Sometimes the rotation will be between entire fields, somet imes a large field will be divided up and the rotation will be between different sections of the field.

BLOCK GRAZING:

Block grazing is when a large field is divided into smaller blocks that are grazed independently.

Block grazing is similar to strip andpaddock grazing. The difference is that in block grazing the animals are left on each block for longer (1 week or more) In strip and paddock grazing the animals are moved every single day.

Block grazing is a good option for part time farmers, or if the labour is just too much daily.

Advantages of block grazing:

- It is cheaper (due to reduced fencing and labour costs) and less labour intensive than strip or paddock grazing

Disadvantages of block grazing:

- It is not as efficient as paddock or strip grazing.
- This means there is more wastage of good grass

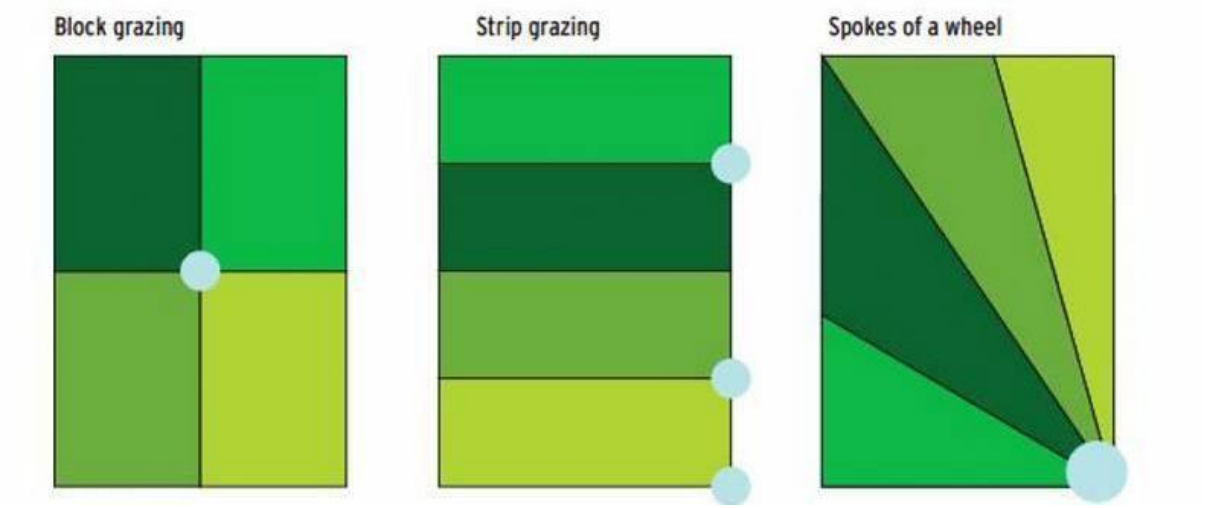
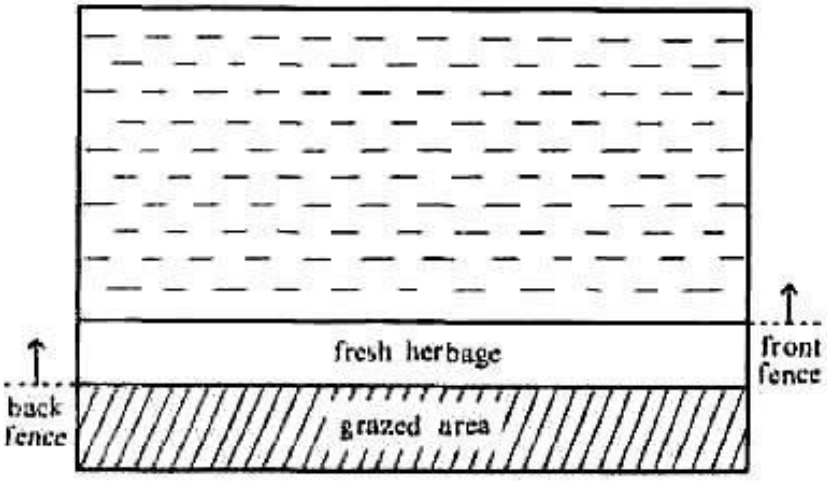


Figure 2: Shows the ways in which a field can be divided. Note that there is always access to the water source (the blue circles). These divisions can be used for block, strip, and paddock grazing. Remember… the difference between block grazing and paddock / strip grazing is the length of time that the livestock remain in the area on a rotation (block = up to a week, paddock/strip = 24hrs).

STRIP GRAZING:

The field is divided into long, narrow strips. Each strip has 24hours worth of grass.

Electric f ences are used to define the strip, and they are moved each day to move the grazing strip onto fresh grass. There needs to be a back fence as well as a front f ence to prevent the animals trampling the previously grazed strips. There is either a mobile water source that is moved each day, or a "run -back" pathway is made back to the trough.



Advantages of strip grazing:

- Fresh grass is always available and no grass is wasted
- Animals are not allowed back onto previously grazed pasture, so it can recover

Disadvantages of strip grazing:

- Requires a lot of management and attention from the farmer. Moving fences and water sources every day is extremely labour intensive
- Fixed water sources are a problem

PADDOCK GRAZING:

In paddock grazing the available space is divided into e qual sized paddocks, and each one contains one day's worth of grazing.

This means there needs to be at least 21 paddocks so that the grass can have 21 days to recover before being grazed again.

When drawing a diagram for this, make sure to state that while you might only have drawn 6 or 8 paddocks, the system requires 21.

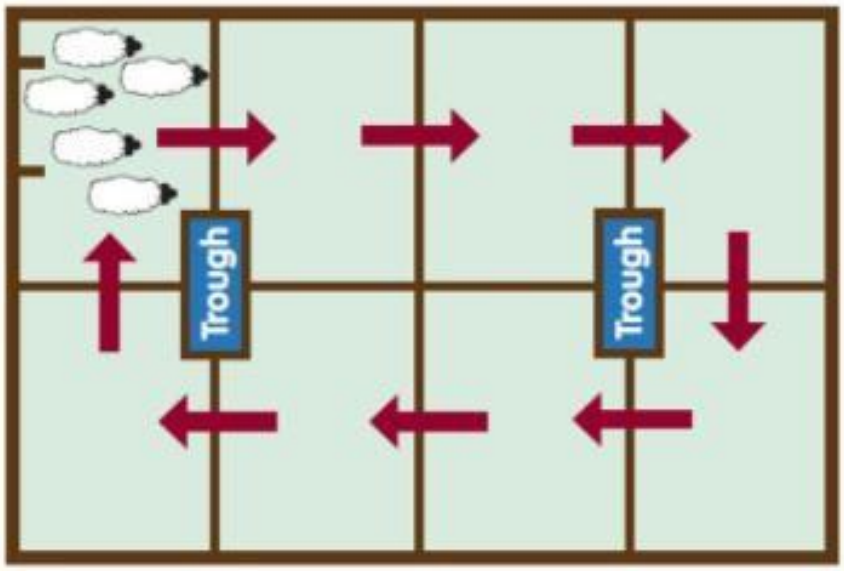
The fencing can be electric or fixed, but fixed fencing would be extremely expensive. In this system multiple paddocks can share the same water source.

Advantages of paddock grazing:

- Fresh grass is always available and no grass is wasted
- Potential for silage production from any excess
- Paddocks are allowed to recover in between rotations.

Disadvantages of paddock grazing

- It requires a lot of fencing, multiple water sources, and access to each paddock . This is expensive to set up
- Requires a lot of management and attention from the farmer
- Very small paddocks are hard to cut for silage



SET STOCKING:

In set stocking there is n o division of the pasture. The farmer knows the size of the field, and the animals turned out at a set rate per unit area. Set stocking is often used on very large areas, on rough grazing, or on areas that are hard to access daily.

Advantages of set stocking:

- It is cheap, are there are no expensive mobile fences or mobile water sources required.
- There is a low labour and low maintenance requirement, which again reduces costs.
- Poaching and density issues are minimised as stock are much more spread out

Disadvantages of set stocking:

- It is n ot very effective in terms of grass usage , animals may be selective about which grass they eat
- Good grass may get trampled and ruined
- Un-grazed grass turns stemmy and unpalatable, or undigestible
- There is constant exposure to pests and disease

ZERO GRAZING:

Zero grazing is exactly what it sounds like. The animals do not go onto the pasture in order to graze. The grass is cut by machine and then taken to the livestock housing . The animals eat the grass fresh, but in their housing rather than on the pasture.

Zero grazing is also called ex-situ grazing and is useful where animals are housed all year round.

Catch crops can also be used for zero grazing.

Advantages of zero grazing:

- No poaching or compaction of the land
- Energy is not wasted on movement, which gives higher LWG and higher milk yields
- Distance from yard is not an issue as the animals don't need to go there
- Water sources and fencing not an issue as the animals are not on the field.

Disadvantages of zero grazing

- It is extremely labour intensive for the farmer
- It is costly in terms of labour and diesel etc

COMPLEMENTARY GRAZING SYSTEMS:

These are animal management systems that w ork alongside the rotational systems that we just learned. We could use creep grazing in a paddock rotational grazing system for instance.

Students need to know these systems, and make sure you understand that **they work in combination with one of the other grazing systems, not instead of one**.

CREEP GRAZING:

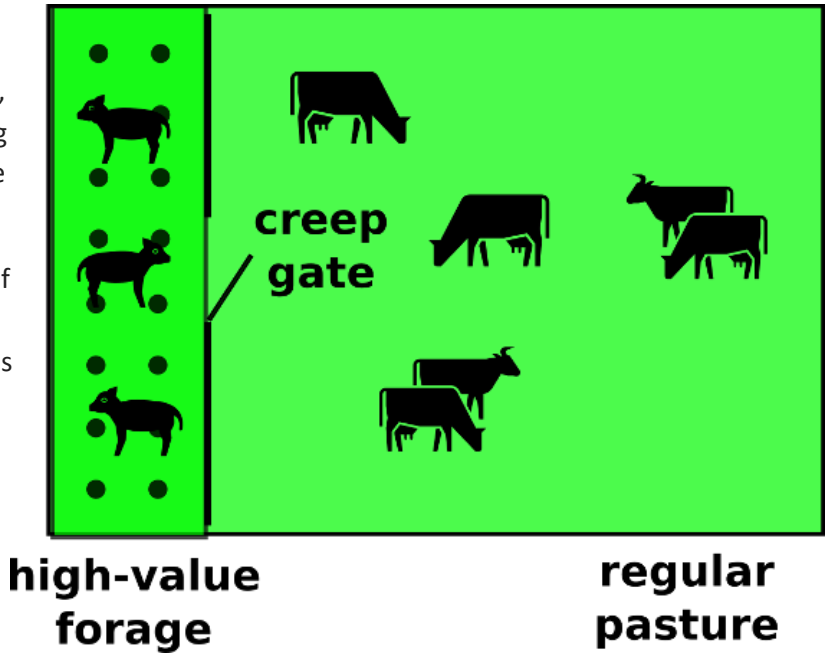
Creep grazing is used when young animals are grazing alongside adults (ewes and lambs, or suckler calves and dams). The paddock is subdivided so that the young animals are given access to a paddock of fresh grass that the adults cannot access. Usually this is done by placing a gate that is too small for the adults to get through. The young animals can move freely back and forth to be with the adults.

Advantages of creep grazing:

- Young animals can suckle for longer
- Young animals have access to fresh grass for weight gain
- The farmer can provide additional concentrate rations (creep feed) for the young in the creep area and the adults will not be able to eat it.
- Avoids disease and parasite build up in young animals.

Disadvantages of creep grazing:

- As with the block grazing, the costs of mobile fencing and water sources can be high
- It can be labour intensive if used in combination with strip grazing and the fences need moving every day



LEADER FOLLOWER GRAZING:

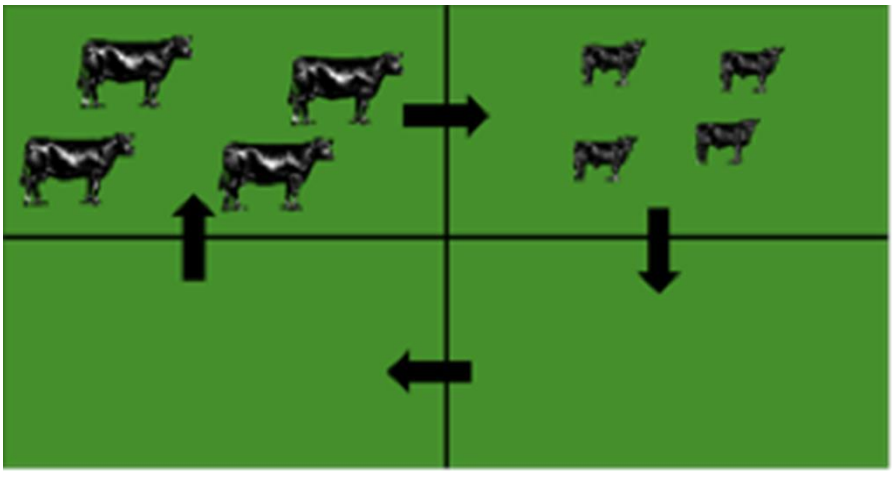
Leader-Follower grazing is an extension of a r otational system, and can be used with any of the rotational systems. Unlike creep grazing, the young and older animals are in separate paddocks for the whole rotation. The young animals are put onto each pasture first, and then when they are moved to the next paddock in the rotation then the older animals go on to the pasture that has just been grazed.

Advantages of leader-follower grazing:

- The freshest grass is provided to the youngest animals to help them grow
- The farmer avoids disease and parasites in young animals as they are on un -grazed pasture, and so cannot pick up parasite eggs from the grass
- Following with older animals increases usage of the grass, as they will graze out any grass the young animals left behind

Disadvantages of leader-follower grazing:

- The disadvantages are the same as the rotational systems
- It is costly if there is a lot of mobile fencing and mobile water sources involved
- It is labour intensive if animals and fencing are being moved daily



MIXED GRAZING:

Mixed grazing is a system in which c attle and sheep are grazed together on the same pasture at the same time. Note that you cannot graze sheep and goats together as they share the same endoparasites. This system takes advantage of the differences between sheep and cattle in terms of their grazing and their parasite types.

Advantages of mixed grazing:

- No grass is wast ed as s heep are less fussy than cattle . This means adding sheep to a cattle pasture increases the productivity of that pasture in terms of meat output for instance.
- Mixed grazing r educes the internal parasite numbers in each species as the density of each host animal is lower, and cattle do not share the same parasites as sheep.
- The production of each animal type is actually increased by 10-15%
- The t illering of grass increased by close cropping grazing of sheep , which means more production for the next rotation.

Disadvantages of mixed grazing

- The density of each animal type is lower , so you can have fewer cattle on the land than if it was only a cattle herd there grazing.
- It has the same disadvantages as the rotation system used in terms of cost and labour

EXTENDED GRAZING

Extended grazing is keeping the animals grazing out for more of the year, into the period they would normally go into winter housing (December to March). This can greatly reduce the carbon footprint of the enterprise.

Grazing land has to be closed off from July to allow for sufficient grass build up, as grass grazed in late August onwards will not regrow fully.

Advantages of extended grazing:

- It reduces need for winter housing and feeding, which can greatly increase the profit margins for the farmer as winter housing and feeding is expensive.
- It reduces need for silage and concentrates, which means more grass can be used for grazing, and the farmer is less reliant on the market prices for concentrate feeds.
- Extending the grazing season makes the enterprise more sustainable, and reduces carbon footprint.

Disadvantages of extended grazing:

- The grass is of poorer quality in the autumn and winter, which may be reflected in the LWG of the livestock
- Weather conditions can result in the land being unusable (flooding or poaching)
- Grazing in the winter means closing pastures early, and this reduces the pasture available for normal grazing in the latter half of the year
- Can result in a decrease in the proportion of ryegrass in the pasture, and more annual meadow grass and other grasses with a lower nutrient content

GRASSLAND MANAGEMENT – FERTILISING GRASSLAND

The grass grown for rearing cattle should be as carefully maintained and managed as any crop. This means that sometimes we might need to fertilise grassland just like we do tillage fields in order to maintain maximum output. Grass needs relatively high levels of nitrogen, especially when intensively grazed.

Nitrogen must be applied to the land following the nitrates directives. When we are talking about grazed land (rather than an tillage field) we must take into account the amount of manure that is deposited during grazing as part of our nitrogen budget before we apply supplemental nitrogen.

One dairy cow (one livestock unit) produces 85kg of nitrogen per year. We use LU in the same way here as when we calculate herbage needs, so a herd with a total of 10.2 LU would produce 867kg of nitrogen per year (this would be spread across multiple hectares of land).

The composition of the grazing sward should also be taken into account when calculating the nitrogen needed, as when there is clover present then the N requirement is reduced.

NITROGEN:

Students should remember that when fertiliser is applied it is always after soil testing, and in response to the soil index. If the index is high enough then no additional fertiliser is needed.

The table below shows the maximum amount of nitrogen contributed by livestock given a certain stocking rate. Generally the max would be 170kg per hectare per year (which is a rate of 2 LU per hectare) as most farms have a lower stocking rate than that. The table shows some higher figures which may apply to an intensively stocked enterprise, like a dairy farm.

In the final column the maximum required N is shown, and so the amount supplemented would be the difference between the livestock N and the max N. At a stocking rate of 2LU/ha the max additional nitrogen would be in the region of 36kg for instance.

Stocking rate (kg/ha/yr)	Stocking rate (LU/ha)	Max N (kg/ha/yr)
<170	<2.0	206
171-210	2.0-2.47	282
211-250	2.48-2.94	250

PHOSPHORUS:

Once again, additional fertilisers are only applied after soil test have been carried out, and only if the soil index shows that the soil is deficient in a particular nutrient. This prevents the over -use of fertilisers.

Phosphorous application will depend on the Soil Index, at index 4 no additional P is needed.

As with Nitrogen, the amount of Phosphorus needed will depend on the stocking rate.

At the highest stocking rate (211 -250 kg/ha/yr) and assuming the lowest soil index (1) the maximum amount of P applied would be 39kg/ha.

If the grass is being cut for silage with no grazing, then at the poorest index (1) the max P is 40kg/ha before the first cut, and 10kg/ha before the second cut.

Image: sheep grazing on a semi-natural mixed species sward. Note the longer sward length. This would be good for biodiversity, and for grassland spiders in particular.

INDIRECT IMPACTS OF GRASSLAND MANAGEMENT

Remember… the primary goal of grassland management is to optimize the amount of grass produced, as well as the quality of that grass.

The grass grown is needed for the year round feeding of livestock, either as grazed grass or as winter fodder.

With that in mind, each of the management actions taken in the different grazing systems are designed to maximise the amount of grass produced, the quality of that grass, and the efficiency of the use of the grass by the livestock.

Our management of grasslands can have knock-on effects on animals as well as the outcome for the grass itself. There are benefits to the livestock, as well as impacts on wildlife. Students should be aware of the ways in which our management of grasslands indirectly affects the livestock and wildlife of the farm.

IMPACTS OF GRASSLAND MANAGEMENT ON LIVESTOCK:

Grassland management can be used as a tool to reduce disease and mean fewer endoparasites.

- Parasites such as nematodes and liver fluke do not reach such high levels when stock are not grazed on one area of land permanently.
- Rotational grazing breaks the life cycle of the endoparasites as long as there is sufficient time between rotations
- Disease is minimised when animals do not graze around their own dung.
-

The management of the grazing can result in higher growth rates of the livestock even on the same pasture:

- Mixed grazing results in higher growth rates for both sheep and cattle when they are grazed together.
- Mixed grazing can also help decrease parasite load in cattle as sheep do not share the same parasites

Optimized grazing for mothers and young:

- Creep grazing (where there is an area specifically for lambs or calves to graze) allows the calves to still have access to their mothers for suckling.

IMPACTS OF GRASSLAND MANAGEMENT ON WILDLIFE:

Use of pesticides and herbicides:

- How we apply agrochemicals has a significant effect on wildlife (pollinators in particular).
- Generally this is not such a problem with grazing grassland management, as using these chemicals would be harmful to the livestock.

Use of Fertiliser:

- Excess application of nitrogen fertilisers results in decreased div ersity of invertebrates in the soil. There may actually be a higher abundance of invertebrates in over-fertilised soil, but they will all be the same one or two species.
- Run-off from poorly applied fertiliser can get into waterways and cause eutrophication.
- Efforts to diversify the grazing swards (e.g. adding clover) to minimise additional nitrogen requirements result in a direct benefit to pollinators and other insects.

Ploughing and reseeding of grassland:

- Decreases biodiversity if old permanent pasture is replaced with a new ley.
- If the pasture is reseeded with a diverse mix of grasses and clover then the impact is not as bad.
- Ploughing has a negative impact on soil structure and soil invertebrates.

- **Effect of Intensive grazing:**
  - High stocking rates can results in a high amount of nitrogen on the pastures
  - High stocking rates often result in soil compaction
  - Both of these are bad for biodiversity.
- **Effect of Sward height:**
  - Semi-natural and rough grazing have the highest bird and butterfly diversity
  - Closely cropped grass dramatically decreases the number of invertebrates found there, which has knock-on effects up the food chain
  - Spiders are usually extremely abundant in grass land, but they need a taller stem length
  - Farmers are encouraged to plant a diversity of meadow plants to increase sward height and therefore biodiversity

GRASSLAND MANAGEMENT – HEALTH AND SAFETY

A significant part of the new specification for Ag Science focusses on Working Safely. This means taking into account health and safety considerations in every enterprise. Here we will look at the health and safety surrounding grassland management. Most of the points raised here will apply to the tillage enterprise too, and there is crossover with the general livestock enterprises.

As always we will consider the Hazard (i.e. what is the thing that can harm you), the Risk (i.e. what is it that can happen to you),and the Precautions (i.e. what can you do to keep yourself safe).

WORKING WITH LIVESTOCK:

Hazards associated with livestock are relevant to grassland management as the farmer has to handle the livestock to move them from pasture to pasture.We already looked at this in the animal enterprise notes, but here is a quick recap:

What is the Hazard?

The hazard is the livestock (cattle or sheep) that the farmer has to move between paddocks in the grazing system.

What is the risk?

The risks with livestock are : being kicked, trampled, crushed, bitten, and injuries from horns.

What are the recommended safety precautions?

- Always ensure you have an escape route plan from the field or pen
- All handlers should be capable and experienced, and understand cattle behaviour
    - Cows in heat are unpredictable
    - Mothers with young are protective
    - Don't put a bull in a field with public access
    - Do not isolate or corner an animal away from the herd
- Caution should be taken to prevent escapes from the pastures
    - Inspect and maintain fencing
    - Gate locks and latches should be operational and checked frequently
    - External fencing should be stock-proof
- When moving livestock:
    - Again, all handlers should be experienced and capable.
    - Have a plan for how to move the animals before you begin. You should ensure paths and roads are clear, and that gateways are in correct position
    - Be calm and do not panic the animals by loud noises or sudden movements
    - There should only be one option for the cattle to take, this minimises confusion and stress

WORKING WITH FERTILISERS:

What is the Hazard?

The hazard is the fertiliser itself. Fertilisers are very harmful agrochemicals. They tend to be strongly oxidising, and can cause serious physical harm.

What is the risk?

Fertilisers can cause irritation and burning of the skin and eyes, and inflammation of the respiratory system.

High nitrate fertilizers represent a fire hazard in combination with other materials.

The decomposition of fertilisers can result in the release of dangerous chemicals such as ammonia.

What are the recommended safety precautions?

General chemical safety:

- Agrochemicals should always be fully labelled with the name of the chemical, the risks associated with it, and the safety precautions.
- Chemical storage should be correct and specific to each chemical
- Any persons handling a chemical should wear suitable PPE
- Use automated chemical sprayers where possible.
- Ensure that all parts of the sprayer are clean and well maintained before use. All valves, lines, and connections should be secure.

Specific safety for fertilisers:

- Store bags of fertiliser at least 10m from drains and waterways
- Do not mix types of fertiliser in the same storage space
- Do not store fertilisers with combustible materials, or near heat sources / sources of ignition

Image: an example of a suitable warning sign for fertiliser storage

WORKING WITH MACHINERY:

What is the Hazard?

The hazard is the vehicles and machinery used to fertilise or plough and reseed grassland.

What is the risk?

The risks associated with farmmachinery should be well known to students after covering the material on working safely in Strand 1. Here is a recap of some of the risks associated with farm machinery:

- Being crushed or struck by the machine
- Being pinned or thrown from the tractor
- Falling from the tractor or machine
- Entanglement in the PTO
- Injury caused by moving parts /blades of a machine

What are the recommended safety precautions?

Any of the precautions students learned in the Health and Safety part of the syllabus relating to machinery or tractors apply. For example:

- Checking that all machinery is in good working order, and roadworthy if it needs to go onto public roads to reach the fields
- Ensuring all operators and drivers are trained
- Parking on flat, solid ground. Lowering machinery to the ground when parked.
- Caution working around the PTO shaft

ONE ADDITIONAL RISK IN MANAGING GRASSLAND:

Electric fencing:

Electric fencing is used to set up rotational grazing systems, it is useful as it can be moved each day.

- Risks:
  - There is a danger of shocks to persons or machines. The risk of serious injury is highest if the shock is prolonged, or applied to the head or neck.
  - There is a danger of entanglement the fencing
- Precautions:
  - NEVER use barbed wire for electric fencing
  - Never work near live fencing in an enclosed space
  - Never try to crawl under live fencing

CONSERVATION OF GRASS

The conservation of grass **does not** refer to conservation in terms of ecological and biodiversity conservation.

Conservation of grass refers to the **storage and saving** of grass for future use.

Conserved grass is critical as a winter feed for livestock . The grass is produced in the summer, and then conserved and stored away until the winter. This means that a farmer can make the most of the excess growth during the summer, and keep his herd fed through the winter with a minimal amount of reliance on external feed sources (such as concentrates).

To conserve grass as hay or silage is relatively cheap, and usually easy for farmers to do as most of the time their land will produce more grass than the herd can eat during the summer.

There are two main ways to conserve grass. It is e ither fermented and conserved as **silage**, or dehydrated and conserved as **hay**.

Students need to know details of the production and pros/cons of both hay and silage, as well as the health and safety considerations for each.

Below left: Silage.

Below right: Hay

CONSERVATION OF GRASS AS SILAGE

The process of conserving grass as silage is called "ensiling". There are many things to take into consideration when producing high quality silage. These are discussed below.

HOW AND WHEN TO CUT THE GRASS FOR SILAGE PRODUCTION:

Factors to take into account when deciding when to cut for silage include:

The weather: Needs to be good weather, not windy or wet

The heading date of the grass: Early = May, late = June. This will determine the peak productivity

Aiming for the peak digestibility: This is the peak DMD of the grass (around 75% at the heading out day, then declines after that).

Aiming for peak carbohydrate level: Carbohydrates are needed for the fermentation process , so we want to maximise the carbohydrate content at cutting

MAXIMISING CARBOHYDRATE CONTENT:

The acids that are vital for preserving the grass are produced by the fermentation of carbohydrates. Therefore it is extremely important that the farmer takes some of the following steps to ensure that the grass contains the maximum amount of carbohydrate at cutting.

Cut at peak vegetative growth: This is when the highest level of photosynthesis occurs in the growth cycle, and so the maximum amount of carbohydrates are being produced

Do not cut soon after rain: Water dilutes the carbohydrate

Let the grass wilt on the field after cutting: This reduces water content

Cut grass in the afternoon: This gives time for photosynthesis to occur through the day

Use additives: Molasses etc can be added to ensure fermentation takes place

ADDITIVES:

There are various chemicals which can be added to silage before storage. This can improve the quality of the silage.

- **Acids** = Aid preservation. Lower pH prevents unwanted bacterial activity.
- **Sugars** = Increases carbohydrate concentration for fermentation (e.g Molasses)
- **Enzymes** = Can help break down the grass fibres to release carbohydrates
- **Bacterial inoculants** = adding bacteria to speed up fermentation

BIOCHEMISTRY OF SILAGE PRODUCTION:

Grass is preserved as silage due to acid produced during the fermentation of carbohydrates in the grass. Bacteria use the carbohydrates for respiration, and produce acid as a by-product. The pH of the acid is what preserves the grass rather than allowing it to rot and decay as it usually would.

All of the oxygen needs to be removed from the grass before the process of fermentation can begin, because the bacteria responsible for the fermentation are **anaerobic**. The fermentation does not occur properly if there is oxygen present.

The rolling of the grass, and then sealing in plastic is how we ensure the oxygen is removed. This is why the bales need to be carefully wrapped, and why the silage pit needs to be carefully covered. If oxygen gets in then the silage rots rather than preserves, and the whole bale /batch is useless.

SILAGE QUALITY COMPARISION:

Silage quality	High	Low
Sugar content (carbohydrate)	High	Low
Bacteria	Lactobacillus	Clostridium
Acid	Lactic acid	Butyric acid
Characteristics	Palatable and digestible	Unpalatable. Low nutrient. Smells less pleasant and spoils quickly

SILAGE PRODUCTION METHODS: BALE SILAGE VERSUS PIT SILAGE

There are two ways to store silage. One is wrapped in an individual bale, and the other is all together in a specially constructed covered pit. Students should know the details and advantages of each approach.

PIT SILAGE:

The grass is cut and allowed to wilt in the field , the same as with bale silage. Next though, instead of being picked up by the baler the silage is collected from the field with a forage harvester and brought to the silage pit.

The silage pit is a 3-sided concrete structure with a concrete base, and channels to drain effluent into a secure storage tank.

The grass is piled up in the pit, and machinery is use to roll over the pile of grass in order to force out as much oxygen as possible.

Heavy-duty plastic sheeting is used to seal the surface to prevent oxygen getting in, and it is often held down with old tyres.

Advantages to pit production of silage:

- Less plastic is used
- Large amounts can be stored in one place

Disadvantages to pit production of silage:

- If the covering fails the entire pile can rot
- Once the covering is lifted the silage must be used , it cannot be re-covered and kept for another long period.
- Not suitable for small farms, or farms where small amounts of silage are required.

Below left: rolling the grass to remove oxygen. **Below right**: the covered silage pit.

BALE SILAGE:

As with pit silage, the grass is cut and left to wilt in the field. Then it is gathered up by the baler and baled as round bales. The bales are immediately wrapped in multiple layers of plastic. This is to keep the oxygen out so that fermentation can take place.

Black plastic is the most commonly used wrapping for silage bales, but light colours are also used and have the advantage of reflecting light to avoid heating of the bales.

Care must be taken when moving and stacking the bales to ensure that there are no holes made in the plastic. If oxygen gets in at any point then the bale will spoil.

Bales should be stacked carefully.

Bale silage is a popular option on smaller farms.

Advantages to bale silage:

- Any excess bales can be sold.
- Lower spoilage compared with pit silage, as you can open them as you need them.
- Silage in bales has lower DM losses during the storage than pit silage, which means it is more nutritious on feeding.
- Baling is less expensive than building a silage pit, and there are low transport costs
- Reduces effluent if the bales are wrapped correctly

Disadvantages to bale silage:

- Higher cost per unit of silage (the pit is the cheaper way once you have a pit constructed)
- The need for individual wrapping produces more plastic waste
- More labour intensive to feed out

ENVIRONMENTAL IMPACTS OF SILAGE PRODUCTION:

The production of silage has more environmental impacts than the production of hay.

Effluent:

The waste liquid produced in the early stages of ensiling is called EFFLUENT.

Silage effluent contains high levels of nutrients and nitric acid, and so it has a relatively high BOD level. This means it is very polluting if it gets into watercourses. Effort must be taken to ensure that there is no runoff of silage effluent.

- Silage pits must be built with secure and leak-proof storage for effluent.
- There is risk of effluent leakage from the round bales than from the pit.

Effluent can be diluted and used as a ferti liser as it is nutrient rich. This is another way of minimising waste on the farm

Plastic:

There is a significant amount of waste plastic generated in silage production. Effort should be made to recycle the silage wrapping where possible. It is possible to select wrap that is more readily recycled, as well as a move towards developing biodegradable silage wrapping.

SUMMARY: ASSESSING THE QUALITY OF SILAGE PRODUCTION**:**

Students should know the key requirements for successful silage production, as well as how to assess the quality of a silage sample. Quality is assessed in the following ways:

Tests for quailty:

- High carbohydrate content = Investigate by calculating sugar content
- Acid for preserving grass = Investigate by testing pH
- *Lactobacillus* fermentation NOT *Clostridium* =
    - Investigate by smell and colour
    - Overly wet or slimy silage is a sign of Clostridium

CONSERVATION OF GRASS AS HAY

There is not nearly as much detail to cover for the production of hay as there was for the production of silage.

In Ireland only about 20% of grass is conserved as hay, the rest would be conserved as silage.

Hay production is heavily reliant on good weather conditions to dry the grass. The equipment used is similar to that used for silage production. The Mower conditioner is used to cut and make swathes, and the baler is used to make either round or square bales. The only price of machinery that is specific to hay production is the rotary tedder which is used to shake up and aerate the swathes.

One advantage of the conservation as hay is that no effluent is produced, and no plastic is required.

HOW AND WHEN TO CUT:

- Hay cutting should be done when the DMD is the highest (May or June).
- There needs to be a prolonged period of good weather, as the grass has to dry out to only about 20% moisture
- Grass should not be grazed for 6 weeks prior to hay cutting

HOW HAY IS PRESERVED:

Hay is preserved by dehydration. The hay is dried out so that it cannot rot and decay. If hay gets wet it will go mouldy and rot.

HAYLAGE:

Haylage is somewhere in between hay and silage in terms of moisture content. There is less moisture than there is in silage. The bales are wrapped in plastic to conserve the grass.

- For haylage the grass is l eft to dry for a few days, but collected up when the moisture is still around 60%.
- As with silage production it is fermentation and the acids produced that conserves the grass
- Lactic acid from *Lactobacillus* is the acid that preserves the grass

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MACHINERY USED IN GRASS CONSERVATION

Students should be familiar enough with the machinery used in the conservation of grass that they would be able to identify them and name them from an image. Images are provided here, but it would be worth performing an image search to ensure that you can identify the machines from multiple angles.

MOWER CONDITIONER

- This is the machine that cuts the grass for hay or silage production
- The grass is pushed through rollers to give a larger surface area for drying

ROTARY TEDDER:

- Shakes up the swathes of grass to allow air to pass through and help it dry faster
- Used in hay production only
- Rotary rake can be used to re-make the swathes

THE BALER

- Makes square bales for hay, or round bales for silage
- Silage bales are wrapped
- Bales are left in the field for collection and storage

FORAGE HARVESTER (image below):

- Used to pick swathes up without baling them, and drop the grass into a trailer
- Used for producing pit silage

Right: A rotary tedder

Right: A baling machine making large square bales of hay. Note that hay bales are not wrapped in plastic.

STORAGE OF CONSERVED GRASS

Whether it is the silage pit or a stack of hay bales, there are some serious risks associated with the storage of con served grass. Storing the silage or hay correctly in the first place can help mitigate accidents. Below are some guidelines for correct pit and bale storage.

THE SILAGE PIT:

Safety hazards can arise in relation to overturning of machinery when working around the pit. In order to avoid this:

- The silage pit must never be overfilled
- The sides and end should be sloped off at a safe angle
- Rails should be placed on top of the walls of sunken pits.

The fermentation of the silage under the cover will use up all of the available oxygen, and so no one should go under the cover as there is a risk of suffocation.

HAY AND SILAGE BALES:

Bale stacking:

- The surface should be level, smooth, and well-draining.
- Stacks should be positioned well away from overhead power lines.
- Removing bales from the stack:
  - Use suitable bale handling equipment operated by a competent person.
  - Remove the bales from the upper ro w first. To remove bales from the bottom or middle could cause instability and risk of being crushed by a falling bale.
  - Carefully monitor the remaining bales for settlement after removal of bales from the stack.

Round bales:

- Ideally, all round bales should be stored on their flat ends, one bale high.
- If round bales must be stacked the safest stacking method is on their curved sides in a pyramidal stack, to a maximum of 3 bales high (2 bales high if the bales are not very dense).
- Chocks or other supports sh ould be used on the bottom row to prevent the bales from moving.

Square bales:

- Square bales should be stacked using an interlocking pattern to tie -in the bales with the row underneath.
- The height of the stack should not exceed 1.5 times the width of the base.
- Take appropriate precautions if working on top of the stack (working at height).

CONSERVATION OF GRASS – HEALTH AND SAFETY

WORKING ON THE SILAGE PIT:

What is the Hazard?

The hazard is the silage pit, with steeping sloping grass stack and vertical concrete walls.

What is the risk?

The risks are:

- Being crushed or pinned by machinery overturning on the slope of the pit face
- Falling from the walls of the pit
- Suffocating due to the fermentation gases under the plastic cover.

What are the recommended safety precautions?

- Do not overfill the pit as this increases the chance of a vehicle overturning.
- The sides and end of the pit should be sloped at 45 degrees or less.
- Edges and sides of pits should be clearly marked.
- Never go underneath the silage cover once it is in place.

WORKING WITH MACHINERY: See "machinery" in the grassland management H+S section.

HARVESTING:

Harvest time is one of the busiest times of the year for farmers, and correspondingly it sees the peak in farm fatalities. The need to harvest in good weather creates a limite d time-window which places pressure on farmers, resulting in increased workloads and longer hours.

- Tractors, harvesters and farm vehicles pose a significant risk
- There are a high number of accidents associated with the improper storage, handling, and transport of bales.

Precautions:

- All farm workers should take adequate breaks for food and rest.
- Safety guidelines for working with machinery must be carefully followed
- Extra care must be taken to ensure vehicles are legal and roadworthy if there is a need to use public roads to access different pastures for harvest.

WORKING WITH BALES:

What is the Hazard?

Bales made from hay, straw or silage can pose a significant hazard while being made or handled on the farm. There is also a hazard posed by the baling machinery itself.

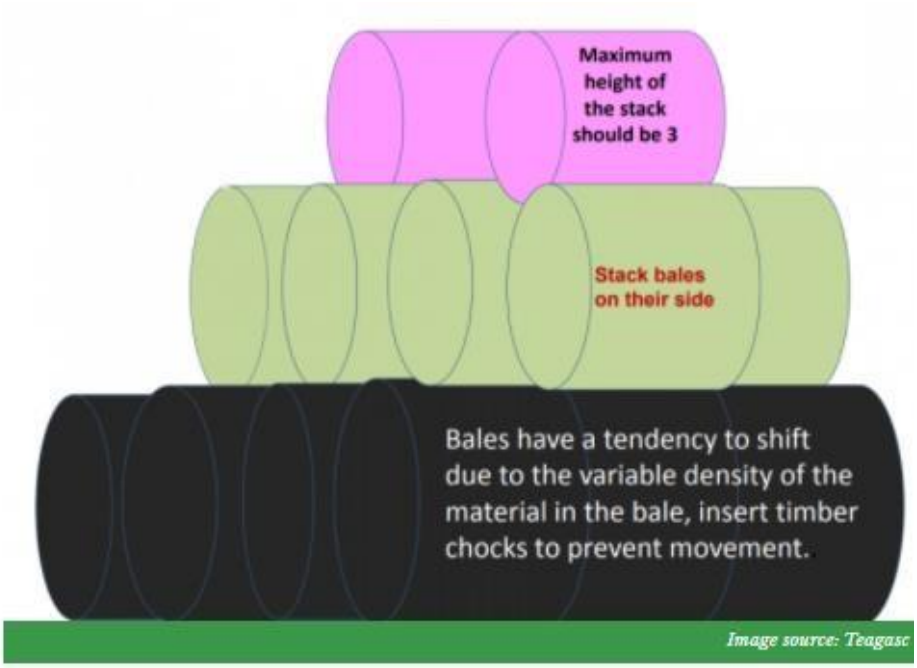
What is the risk?

The most significant risks are:

- Being crushed by falling bales.
- Falling from a height
- Being rolled over by a bale on sloping ground.
- Being crushed or spiked by bale handling equipment.

What are the recommended safety precautions?

- Never climb or play on the stacks.
- All stacks and piles should be built in such a way that they cannot collapse
- The surface should be level, smooth, and hard. If using a natural surface it should be well drained and flat.
- If stacking is necessary, round bales should be stacked on the rounded side, to a max of 3 bales high.
- Never take bales from the middle or bottom layers, always remove from the top down.



LEARNING OUTCOMES

By the end of the topic, you should be able to complete all of the Learning outcomes listed below.

This is an extremely useful way of approaching exam revision. Check off the list when revising, and go back over anything that you feel needs work.

Some of these Learning Outcomes may be covered by the SPAs, or by the IIS. There is significant overlap between these parts of the course and the current topic.

LEARNING OUTCOME	
Evaluate the impact of different crop management practices on food-producing and other animals	
Describe different options for rotational grazing management, including a diagram to help explain the system	
Discuss the management of nutrition for grass as a crop plant	
Identify farm health and safety hazards associated with the management of crops, and discuss the controls and precautions necessary to prevent accidents, ill -health and injury on the farm	
Discuss harvesting techniques and conservation of grass	
Appreciate the need for correct storage of silage and hay	
Identify farm health and safety hazards that are relevant to the conservation of grass, and discuss the precautions taken to prevent accident and injury during handling	

TERMINOLOGY LIST

Fill out the definitions for each of the terms listed below. This is a good revision exercise, and will help you remember the terminology for the topic.

TERM	DEFINITION
Block grazing	
Creep grazing	
Ensiling	
Extended grazing	
Fermentation	
Haylage	
Leader-follower system	
Livestock unit	
Mixed grazing	

Mower conditioner

Rotary tedder

Rotational grazing

Set stocking

Silage pit

Strip grazing

SPACE FOR YOUR NOTES