

More Milk from Grass

Your Guide to Better Grassland

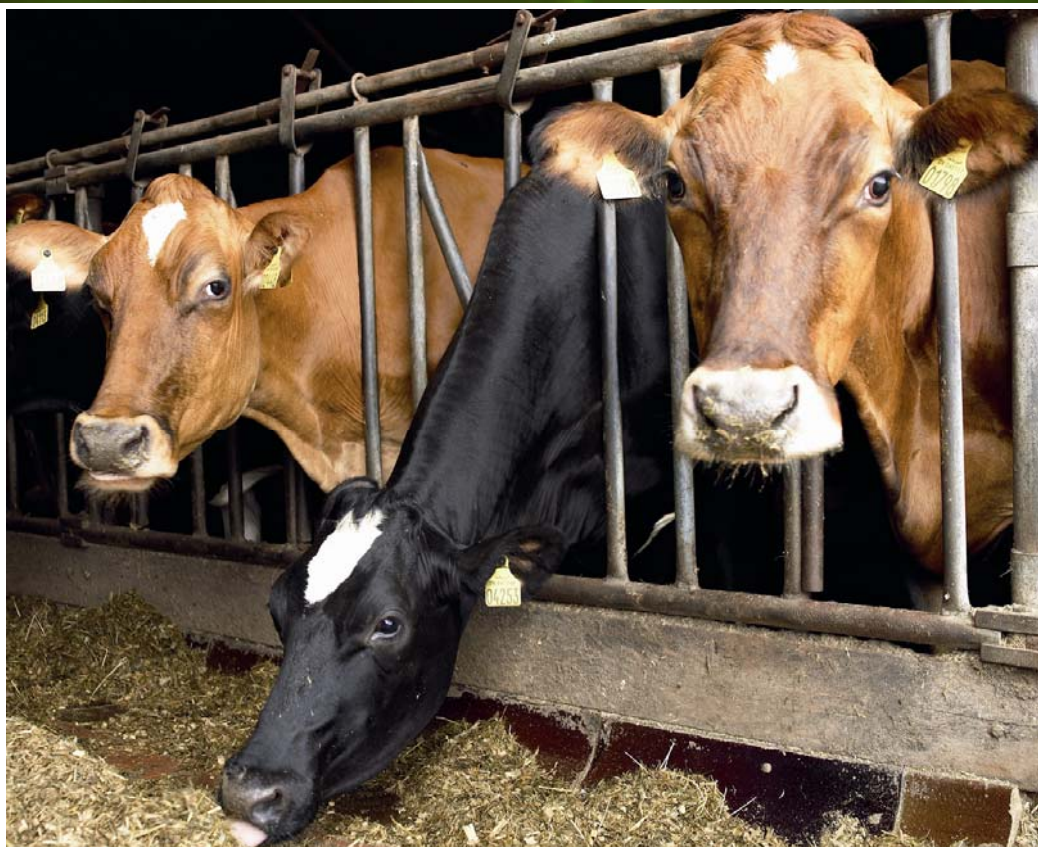


More Milk from Grass

Your Guide to Better Grassland

CONTENTS

HIGH YIELD AND QUALITY FORAGE FROM GRASSLAND	3
ESTABLISHMENT AND MANAGEMENT OF GRASSLAND	7
PASTURE MANAGEMENT	12
MAKE QUALITY SILAGE	14
MAINTAINING HIGH OUTPUT FROM GRASSLAND	18
A YEAR IN THE GRASS FIELD	21
MIXTURES AND SPECIES	23
VOCABULARY	31
LITERATURE	32

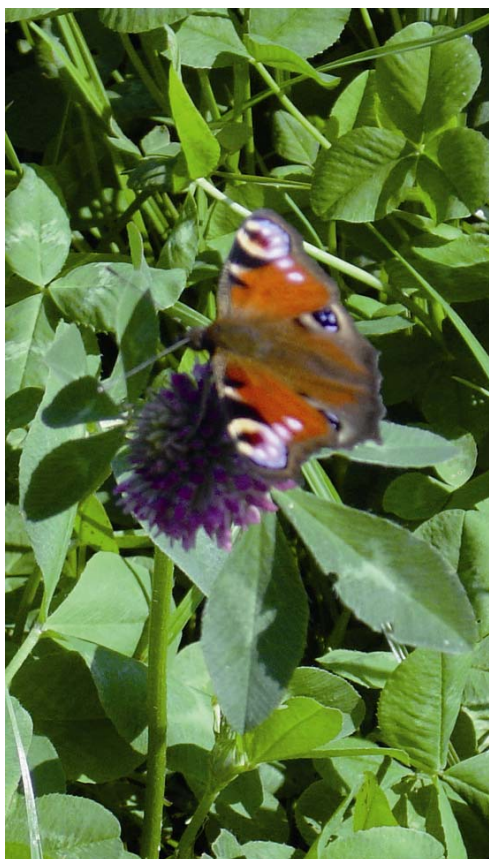


INTRODUCTION

The economy in production of milk and beef is very much dependent on the availability of large quantities of roughage of the best possible quality. Grass and grass and clover mixtures are the cow's natural feed and with the use of modern grass and clover varieties, modern techniques for establishment, maintenance and utilisation of grass fields and good feeding practices, it is possible to obtain a high production of milk or beef.

This book is a roundup of some important aspects of grass production. Focus is on quality in the broad sense of the word - from the correct choice of mixture via establishment and harvest to the storing and feeding. This book is meant to be a short introduction to the topics. For further reading we recommend the titles mentioned in the literature list and you are always welcome to contact DLF-TRIFOLIUM.

Denmark, March 2009
DLF-TRIFOLIUM



High Yield and Quality Forage from Grassland

Grass Intake Depends on Quality

Dairy cows are able to eat huge amounts of grass or grass and clover mixtures and consequently produce a lot of milk. A daily intake per cow of 19 kg dry matter in fresh grass or 16 kg silage dry matter is possible, but the amount of milk produced depends mainly on the quality of the feed. As the rumen of the cow can only contain a certain amount of feed, the concentration of energy in the available diet must be high and the content of non-digestible fibres must be low. When the forage quality is improved, the daily milk production increases because the fermentation of carbohydrates in the cow speeds up and the flow of forage through the rumen accelerates. As a consequence, forage intake increases. Clover in combination with grass increases feed intake, because clover has a lower content of fibre than grass. Inclusion of up to 50% white clover in the diet increases forage intake by 10-20%. This is a healthy cycle. The high forage intake also affects the health of the cow in a positive way.

What is good quality?

The content inside the plant cells is close to 100% digestible, whereas the cell walls degrade slowly or are even totally indigestible to the ruminant. See figure 1 and 2. The digestibility of organic matter, including cell walls, decreases as the grass or clover plant gets older, and at the same time yield of dry matter increases. The challenge is to determine the optimal time of harvest with the best compromise between yield and quality.

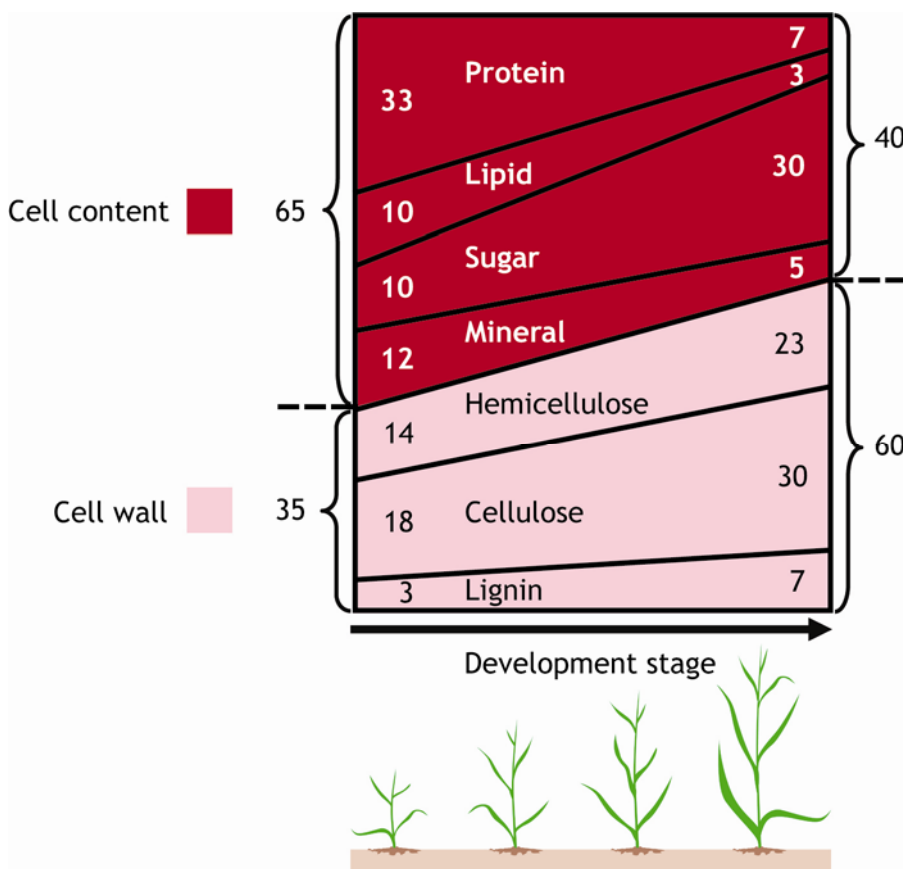


Figure 1. Plant dry matter composition changes as the grass grows.

Increasing yield but decreasing feeding value.

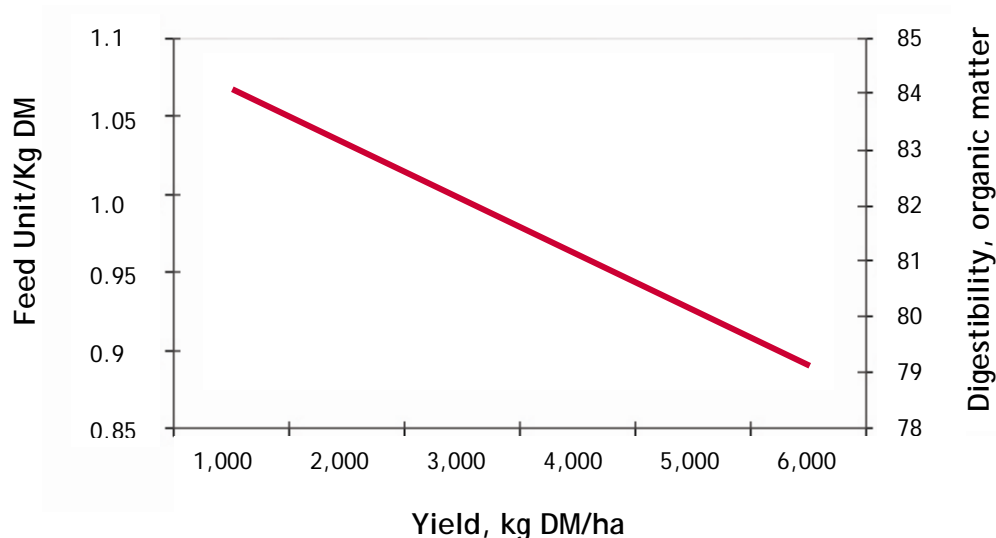


Figure 2. Development in grasses.

A number of these parameters can be measured to determine if the forage quality is optimal. Consequently, forage analysis is an important tool for planning cattle feeding.

Table 1 is a list of some of the key quality figures. For explanations, see vocabulary page 31.

QUALITY PARAMETERS IN GRASSES							
	HEIGHT OF GRASS, CM	DIGESTIBILITY ORGANIC MATTER (DOM) %	DIGESTIBLE PROTEIN, %	CRUDE FIBRE, %	NDF, %	DIGESTIBLE NDF, %	SUGAR, %
Pasture grass	6-10 ¹⁾	70-80	16-18	< 20	< 40	> 70	> 8
Silage	20-30	65-75	14-17	< 27	< 50	> 70	> 3.5

¹⁾ 6-8 cm in a continuous stocking system and 6-10 cm in a paddock system.

Table 1. Important key figures (content per kg dry matter) for optimal quality of fresh grass or silage.

A compromise between yield and feeding value always has to be made for silage. The higher the yield, the lower the quality and feed intake - and vice versa. When producing silage of high quality, an early cut is essential. The grass must be cut before heading takes place. Good and careful silage making is the key to high quality forage and high milk yield per cow.

For grazing, the system must be managed well to ensure a "good bite". The aim is to plan for a high and homogeneous quality (feed value). In a continuous stocking system, the height of grass in general must be kept at 6-8 cm in order to keep an even grass sward - in the spring it is 8 cm and autumn 6 cm.

In a paddock system, the aim is to plan for high quality and high feed intake in particular. The grass height must be around 15 cm at the start of grazing and 6-8 cm when cows are moved to the next paddock. To ensure high quality, make sure fresh grass is available at all times. A maximum feed intake in the paddock system is required, and the cows must be

moved regularly. One day in each paddock will ensure the above conditions, and moving the cows twice a day is even better. Three days in each paddock is maximum, but then the feed intake will be lower. The paddock system ensures the highest feed intake and milk yield per cow.

The Importance of High Digestibility

Several investigations have shown the value of forage with high digestibility - high concentration of energy per kg dry matter. If the digestibility of organic matter or cell walls is improved by 1 unit (%), the intake of forage dry matter will increase by around 0.2 kg DM per cow per day and the milk yield will grow with 0.25 litres or more per cow per day.

Figure 3 shows the theoretical production curve for dairy cows fed only on grasses, when milk yield is related to energy concentration in silage. The yield of milk changes from a very high level when using young grass without stems to zero when using old grass of low quality where all energy from the forage is used for the animal's basic functions.

The digestibility is mainly determined by two factors:

- Composition of the mixture in the field
- Time of harvest in relation to grass development

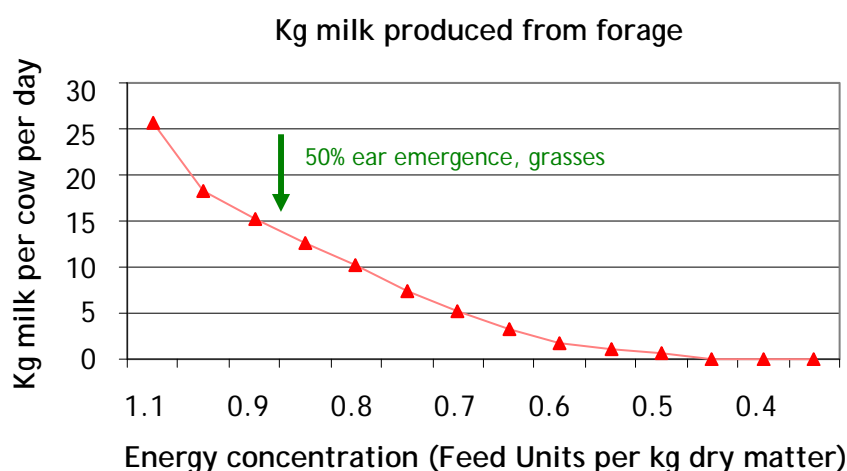


Figure 3. Calculation of the expected milk production when filling factors of the grass/silage and capacity of the rumen are used.

Source: Danish Agricultural Advisory Service, National Centre.

Clover Means Better Forage

Clover brings several benefits to a grass mixture:

- Higher palatability under grazing
- More even distribution of the annual production in the field
- Higher feed intake - both under grazing and in silage
- More protein in the feed

- Higher milk yield - see table 2
- Nitrogen to the field - saves expenses

A well-established stand of 30-40% clover in the field can replace around 200 kg of nitrogen per ha per year. At the same time, grass mixed with clover increases grazing animals' intake by 10-20% and distributes the production more evenly over the summer, due to a different growth rhythm to grasses.

CLOVER - MORE MILK PER COW				
	PURE RYEGRASS	RED CLOVER/ GRASS	WHITE CLOVER/ GRASS	LUCERNE
Digestibility, DM	72	69	72	64
Silage intake, Kg DM/cow/day	11.4	12.9	13.2	13.6
Kg ECM/cow	26.5	31.0	30.7	29.3

Table 2. Digestibility, intake and milk production per cow per day of silage from pure ryegrass, red and white clover grass and Lucerne. Dewhurst et al. 2003.

Figure 4 illustrates the same relation for silage of grasses compared to Lucerne and red clover: the low feeding value (energy concentration) brings the lowest intake, but at the same feeding value, the intake of clover and grass mixtures is around 3 feed units (25-30%) higher per day than for pure grass.

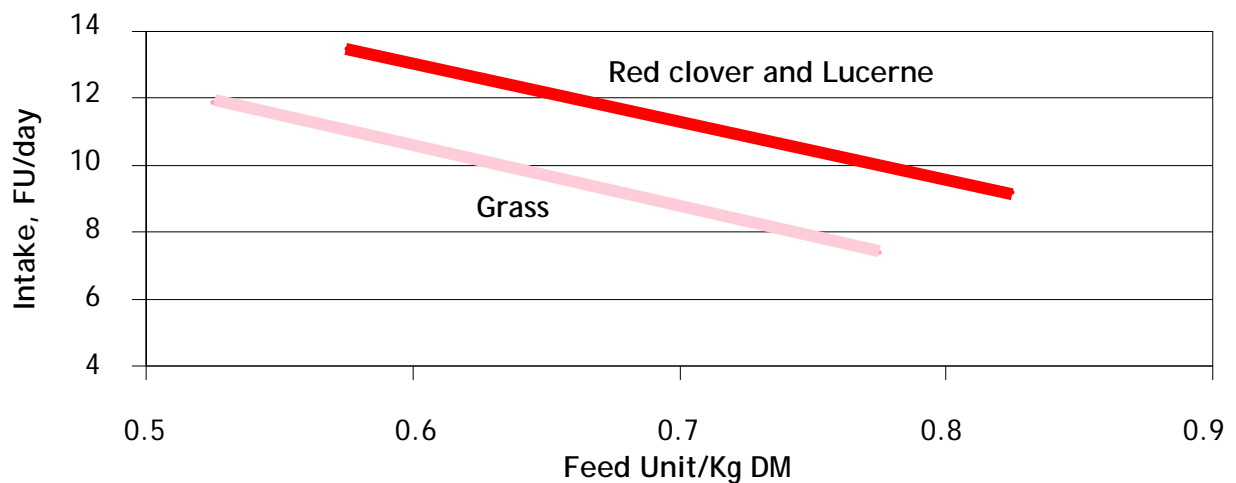


Figure 4. Clover means higher intake.

Establishment and Management of Grassland

Establishing Leys, Preparations and Sowing

A good foundation of a productive sward is essential. The conditions must be right for seed germination and growth of the plants afterwards. Seeding is between 15-25 million seeds per hectare, depending on species and seed rate. In a good establishment, 15-25% of the seedlings will have survived after a few months. The aim is to have 3-500 plants per m² with 10-12 tillers per plant that is 3-6,000 tillers per m².

The Seedbed

Ploughing followed by harrowing creates the best conditions for germination.



- Especially when followed by rolling in order to keep the surface moist. The seedbed must be even and moist to ensure an even and quick germination. Figure 5 shows the principles.

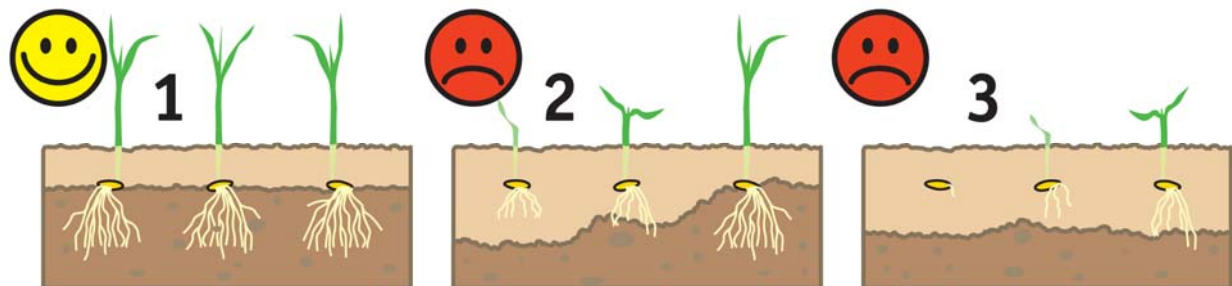


Figure 5. The best establishment.

Methods of Sowing

Drilling is often superior to broadcasting when the soil conditions are dry or the soil is light, but drilling in rows leaves better room for weeds in between the rows - this can be somewhat compensated for by drilling in two directions. Broadcasting gives a better distribution and ground cover, but it must be ensured that the seed is covered and brought in good contact with moist soil.



A cover crop can protect the new ley but also give the young grass and clover plants competition if it is too dense. A cover crop must therefore be relatively open and not lodging. It may harm the new grass if the cover crop is removed at a critical time (e.g. very hot summer). When using a cover crop, e.g. spring or winter cereals, this must be drilled first and the grass mixture sown immediately after. Seeding depth for grasses must not be more than 1-2 cm and for clovers not more than ½-1 cm. Ryegrasses in pure stand may develop satisfactorily from 3-4 cm. Normal seeding rate: 25-35 kg per hectare.

% GERMINATION				
	SEEDING DEPTH			
	1 CM	2 CM	4 CM	6 CM
White clover	40	34	8	0
Red clover	42	39	17	0
Lucerne	38	35	11	0
Italian Ryegrass, T	76	73	57	32
Italian Ryegrass, D	75	68	43	13
Perennial Ryegrass	62	63	45	11
Meadow Fescue	48	40	8	2
Red Fescue	64	53	12	1
Cocksfoot	47	35	11	2
Timothy	34	10	0	0
Poa pratensis	30	12	0	0

Table 3. Field experiments showing the influence of seeding depth on the germination of different species.

Time of Sowing

Spring or late summer is the best option. In spring, the moisture is almost always adequate - in midsummer this is often not the case. Again in late summer and early autumn, the moisture content in soil is normally sufficient and at this time, soil temperature ensures a good and quick germination.

Fertiliser Application

Soil analysis is a good guide to fertilisation. The eventual cover crop is fertilised according to local norms and the grass field does not need any extra until the following year (maybe some nitrogen in late summer, if the field has already been used in the first year). Pure leys in spring need some fertilisation.



Fertilising has an influence on yield as well as on quality of the grass crop. The main nutrients required are nitrogen, phosphorus and potassium, but also magnesium, sulphur and a range of other elements. The recycling of P and K from cow

manure will reduce the need for fertilisers. When day and night grazing is used, 75 kg K and 20 kg P from fertiliser will normally cover the extra demand.

Nitrogen

The application of nitrogen increases yield, shoot density and protein content in dry matter as well as improving the energy concentration in the feed. It is important to focus on the content of nutrients per kg dry matter. The optimal level of nitrogen application depends on the species composition in the field (clover or not), the expected yield and the soil type.

An experiment carried out in Poland showed that for each application of 1 kg nitrogen per ha, the grass yield increases with 9-10 kg dry matter per ha in the first cut. The nitrogen response was clearly positive at all N-levels from 50-150 kg in one application. The grass seed mixture was similar to VersaMax.

Similar results have been obtained in Denmark, see table 4. For every kg N applied, on average 10 kg of dry matter was obtained when applying 150 kg N per hectare in the spring. 5,700 kg dry matter was harvested in the first cut alone. The quality of the grass had also improved.

NITROGEN - IMPACT ON YIELD AND QUALITY			
		REMAINING PART OF YEAR	
KG N APPLIED, TOTAL KG PER HA	FIRST CUT DRY MATTER, KG PER HA	CUT DRY MATTER, KG PER HA	ROTATIONAL GRAZING DRY MATTER, KG PER HA
0	4,526	5,911	4,742
75	4,778	5,989	4,465
150	5,753	6,208	4,881
225	5,853	6,731	5,271

Table 4. Nitrogen application to grass, 2000 - 2001.

Source: "Bilag til Grovfoderdag", The Danish Institute of Agricultural Sciences, Foulum, 2000-2001.

Depending on the clover content and utilisation of the grassland, nitrogen application varies greatly. The demand for nitrogen will normally be covered with more than 50% clover in the pasture, but on the other hand this might cause problems with the health of the cows, e.g. bloat, mastitis and other diseases related to feeding. The optimal clover content is 30-40% of dry matter.

In general the demand for nitrogen is 1-2 kg per day per ha during the spring and summer period (3-4 months). 1 kg nitrogen is normal when clover content is 30-50%, but should be applied with 2 kg when there is less clover in a pasture. When the grass is used for silage, an extra 25% should be added to these figures. If a downward adjustment of the amount of clover in the field is necessary, it is easily done with nitrogen application.

NITROGEN APPLICATION AMOUNT - GRAZING

GRAZING	EXPECTED YIELD, KG DM/HA/YEAR	KG N PER HA/YEAR
30-50% clover	7,500	100
10-30% clover	8,500	200
< 10% clover	9,500	300

Table 5.

NITROGEN APPLICATION AMOUNT - CUTTING

CUTTING	EXPECTED YIELD, KG DM/HA/YEAR	KG N PER HA/YEAR
30-50% clover	8,500	250
10-30% clover	9,000	300
< 10% clover	10,000	350
Pure grass	10,000	400

Table 6.

The production in the field might be highly affected by the distribution of the applied nitrogen. The table below is a guideline for the distribution of applied nitrogen:

NITROGEN APPLICATION TIME - GRAZING

GRAZING	MARCH/APRIL	MAY/JUNE	JULY	AUGUST	TOTAL KG N/HA/YEAR
30-50% clover	40	30	30	0	100
10-30% clover	60	60	40	40	200
< 10% clover	60	60	50	30	300

Table 7.

NITROGEN APPLICATION TIME - CUTTING

CUTTING	MARCH/APRIL	MAY/JUNE	JULY	AUGUST	TOTAL KG N/HA/YEAR
30-50% clover	100	80	70	0	250
10-30% clover	130	90	80	0	300
< 10% clover	150	90	70	40	350
Pure grass	170	100	80	50	400

Table 8.

Phosphorous

The annual demand for phosphorous is 30-50 kg P (70-115 kg P_2O_5) per ha per year at normal level in soil.

Potassium

Grass and clover have a relatively high demand for potassium - from 150-400 kg K (180-480 kg K_2O) per ha per year - depending on soil status. There can be a big variation in the potassium content in different soils and the variation during the year is considerable. Too much potassium can create animal health problems and the level must be controlled by soil analysis and by applying potassium several times per year. Especially before winter the potassium status in soil and grasses must be good as this improves the winter hardiness in plants.

Other nutrients

The need for magnesium for grasses is 10-30 kg Mg per ha per year. It may be necessary to apply magnesium as fertiliser. A grass crop removes 25-50 kg sulphur (S) per ha per year and fertilising with sulphur is often needed.

Use of animal manure

The best use of animal manure for grassland is to plough it in before establishment. The use of liquid manure (slurry) on established grassland should be limited to fields used for cutting only. The best time for using animal manure is early spring when growth begins. 25-35 tons slurry per ha is a recommended amount to apply.

Weeds - pests

Weed control is normally not needed when grassland is sown with a cover crop. Spraying against annual weeds can be necessary in pure leys, where competition is less. Perennial weeds must be treated with a total herbicide before sowing the grassland.

The young plants can be vulnerable to pests such as leatherjackets, frit flies, etc. It may be necessary to spray against pests at this early stage of growth.

Pasture Management

The cheapest and most natural way to feed animals with grass is to let them graze. The challenge is to regulate the growth and always ensure there is an adequate amount of forage for the animals without the grass growing too high – and not leaving too much feed unused. The aim is to have at least 90% sown species in the field.

GRASSLAND MANAGEMENT				
GRAZING SYSTEM	YIELD LEVEL IN FIELD, INTENSITY	STOCKING RATE COWS PER HA SPRING-JUNE/ JUNE-WINTER	MANAGEMENT REQUIREMENT	LABOUR REQUIREMENT
Continuous grazing, no regulation	Low	5/3	Low	Low
Continuous grazing, regulated	Medium	10-12/3-5	High	Low
Paddocks, no rationing	Medium-high	7-8/4-5	Medium	Medium-high
Paddocks, with rationing	High	9-10/4-5	Medium	High
Zero grazing	Very high	-	Medium	High

Table 9.

Continuous grazing

Without regulation, continuous grazing means all cows are grazing in one field all season. It is mainly used for young stock and where machines cannot be used – often permanent grass fields. Quality of grass is normally low, and over the season production per ha decreases significantly. The advantage is that labour and management requirements are very low.

Continuous grazing with regulation is an improvement of this system. Here the animals are only allowed to graze a limited area in spring and the rest is harvested for silage. During summer the grazed area is increased by 3-4 times, usually after each cut. Quality and yield can change rapidly and management must be careful to ensure that silage is always in stock for supplementary feeding.

Paddock grazing

Grazing in paddocks can be arranged in different ways. The number of paddocks can vary from 3-14. With a low number of paddocks, the time cows spend on one field is 7-8 days, but there is a risk of variation in the daily milk yield due to fluctuations in forage quality. A separation of the field into more paddocks is therefore recommended.

With 8-10 paddocks the grazing becomes very intensive and cows will spend a maximum of 2 days in each field. In spring, only about half of the paddocks will be in use for grazing – the rest must be harvested for silage or hay. Later an increasing number of fields will be grazed. The number of paddocks used for grazing always depends on the growth of grass.

The aim is to have 10-15 cm sward before grazing and 6 cm after. Cows must eat all grass in the field - if the growth is too high for this, the rest must be left for cutting. In order to succeed with paddock grazing, careful planning is needed before the season - and intensive management during the grazing season is required as well.

Rationing grazing

Paddock grazing can be even more restrictive when rationing is used. 8 paddocks are established, and cows are offered a new section twice a day by using a movable fence. The aim is to give the grazing animals just enough grass for half a day's grazing from 10-15 cm down to 6 cm.



This is a very intensive system used for high yielding cows. It must be very well prepared and the front barrier has to be moved often. On the other hand, it provides grass with a very constant quality and feeding management is easy to handle.

Zero grazing

Zero grazing is a system where cows are fed every day with fresh grass, cut and delivered to the cattle yard. This is a very labour intensive system, but can be used where fresh grass is wanted or where grazing for some reason is not possible. The quality of forage as well as the yield in the field can be very high with zero grazing.

Combined management

If possible, the combined management - changing between grazing and cutting - is very healthy for the grass field. Two rotations with grazing followed by a cut ensure a uniform and high quality of grass for grazing. At the same time, the risk of infesting animals with parasites related to continuous grazing is reduced.

Make Quality Silage

The process of silage making is important to obtain a satisfactory quality to ensure a high milk yield per cow. In the field, silage quality is mainly determined by time of cut related to the development of the plants. 2 or 3 cuts per year will generally give forage with low digestibility, but a high yield of dry matter. 4, 5 or even 6 cuts per season create a better chance for combining high yield with high quality of forage.

The best silage is possible when a fast wilting of the crop to 30-35% dry matter is obtained, and the grass or grass and clover mixtures have a moderate content of crude protein, 16-18% in dry matter. After fermentation, the content of sugar should be 3-5% of dry matter.

How to Make Quality Silage

Processing in the field

Cut the grass for wilting at the development stage "early stem extension" (before ear emergence) and distribute in an even layer over the whole field. Preferably a weather forecast for the coming 2-4 days will show a dry period. In order to ensure a quick re-growth in the field, stubble height must not be below 6-8 cm (only exception is prior to a grazing period - then 5 cm is better).

30-35% dry matter gives least loss and maximum intake of silage.

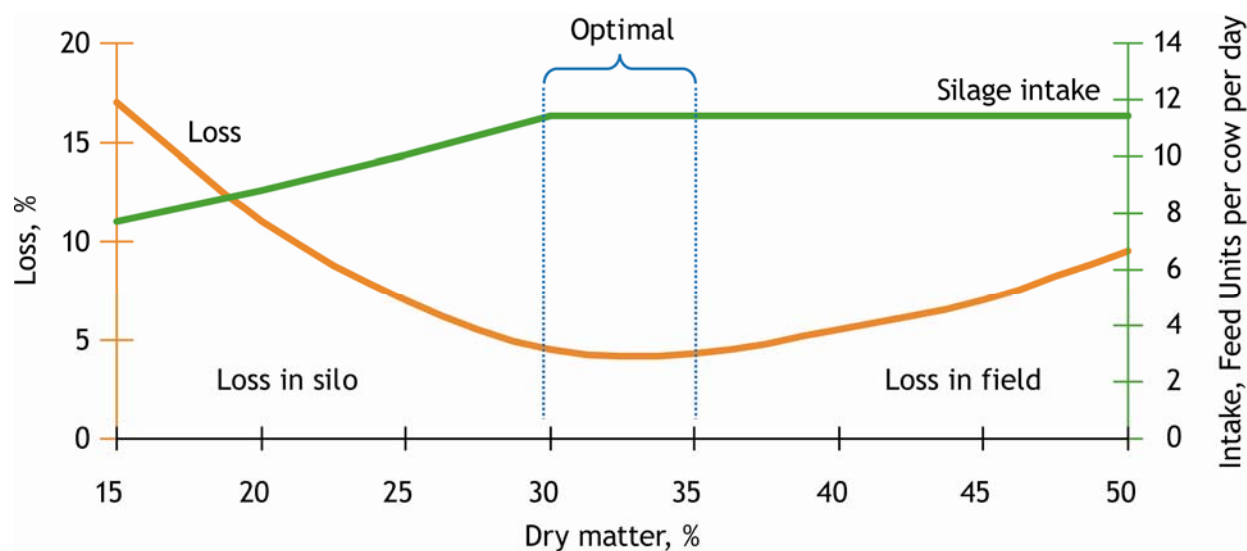


Figure 6. 30-35% dry matter in grass, clover and green crops gives the best intake and the least loss in field as well as in storage.

Source: "Dyrkning af grovfoder", Landbrugsforlaget.

Collect the grass in rows and harvest it when the dry matter content is more than 30% but below 40%. Ideally, this should happen within 24 hours after cutting, if there has been no rain. Preferably, cut the grass into fine pieces of 1-3 cm. For wrapped bales the aim is 45-50% dry matter at harvest and no fine cutting is needed. It is in all cases very important to have an even field in order to avoid sand/soil in the silage.

Processing in the silo

Silage can be made in wrapped bales, in a silo with concrete bottom and sidewalls or in a stack in the field. But most important is a fast process with a firm packing of the grass crop and a 100% firm airtight closing of the silage.

For silage making in a silo or field stack, some preparations must be made. The silo must be cleaned and holes or cracks in the surface must be repaired. Before filling, the bottom of the silage pit or clamp must be covered with foil using only high quality foil, which fits the size of the pit or clamp, see figure 7 below.

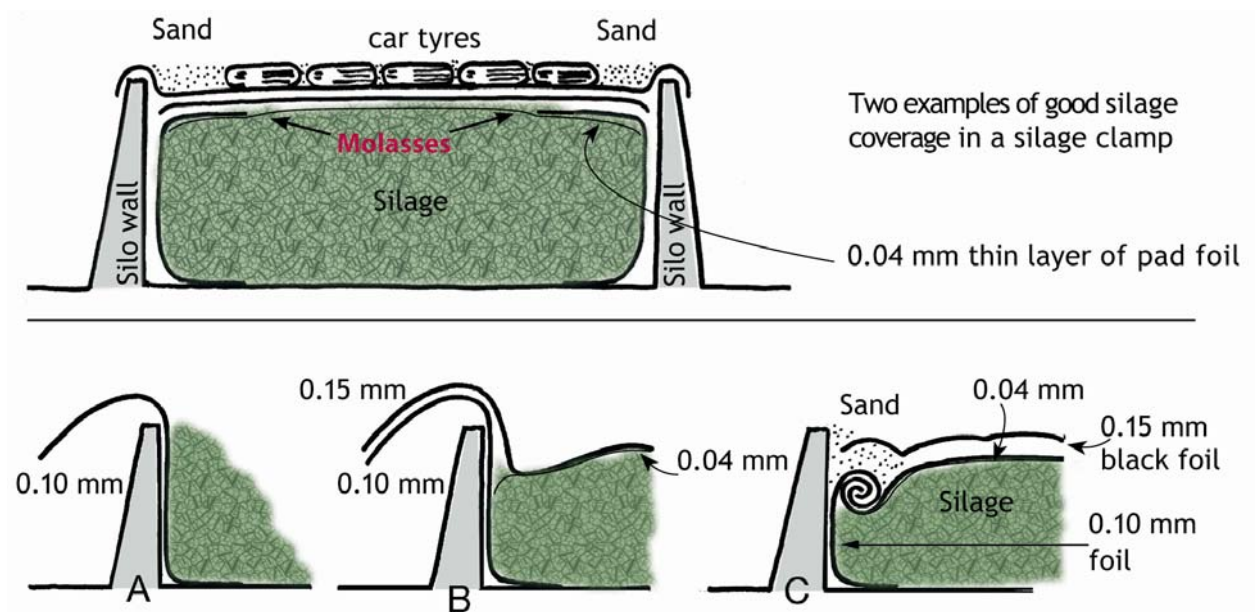


Figure 7. Making good silage.

It is important that foil covers the sides of the silo walls and has an overlap in order to keep oxygen out of the silage.

Source: "Dyrkning af grovfoder", Landbrugsforlaget.

Execute fast silo processing. The grass being brought to the clamp must be distributed evenly in thin layers - max 10 cm - and pressed continuously with a heavy tractor in order to press as much air out of the mass as possible.

After finishing, the silage must immediately be sealed tightly with 2 layers of foil and covered with an animal safe cover. Armed foil can be used (it is possible to reuse the foil for up to 10 years) or a 10 cm thick layer of sand without stones. The last option provides the safest cover.

For wrapped bales, the process takes place in the field with special equipment ensuring the correct compaction and packing. To ensure high quality fermentation, bales should be wrapped with 6-8 layers of foil. The aim is a dry matter of 45-50%.

Use of silage additives

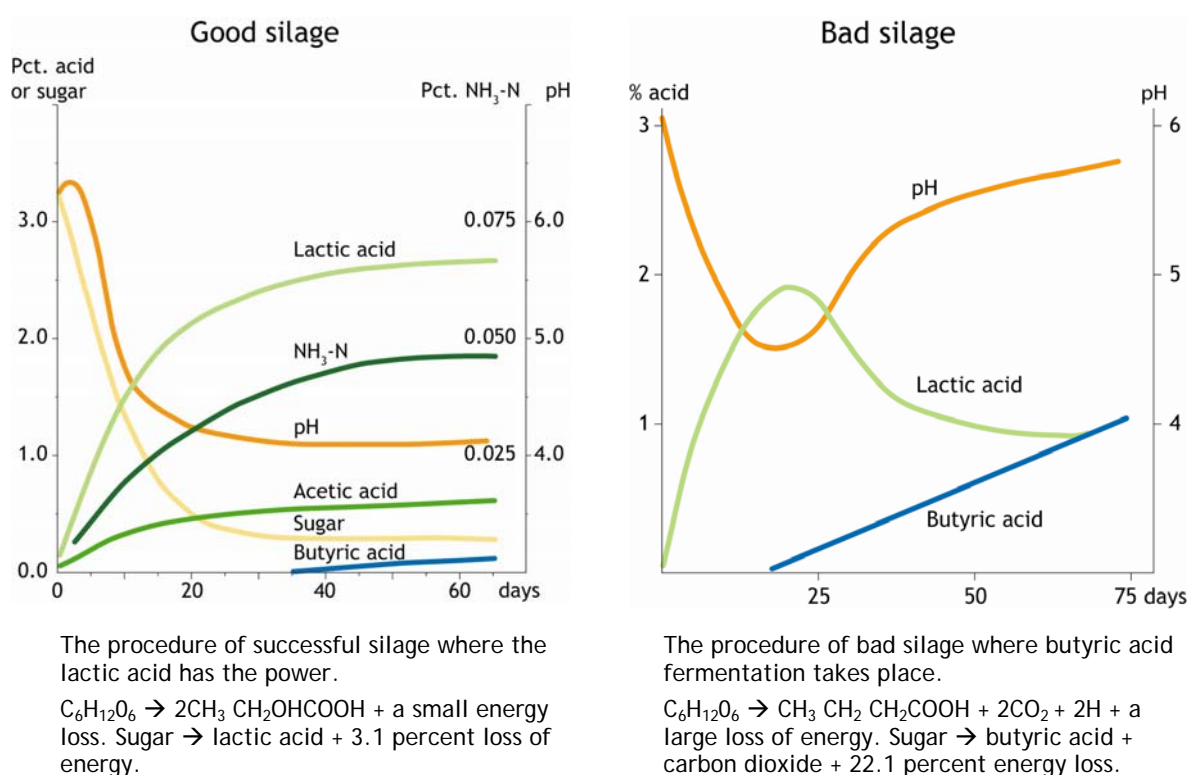
In some cases it may be beneficial to support the process by adding silage additives. For grasses with normal dry matter content, products containing homo fermentative lactic acid bacteria are preferred. The use of additives is mainly relevant if the dry matter content is

below 28% after 2 days of wilting - which limits a proper fermentation - or there is more than 60-70% clover in the crop, which makes the silage dark or black, or there is a risk of soil contamination, which limits the fermentation.

No silage additive is able to replace a good silage technique, but sometimes it can improve the silage quality. To choose the correct additive, please see the booklet "Ensiling - a craftsmanship".

Silage quality

The ensiling process is normally complete after 3-4 weeks and it is time to make an analysis of the result. Figure 8 shows the process of making good and bad silage.



E.J. Nørgaard Pedersen, Ensileringsprincipper, 1972

Figure 8. Good and bad silage - a huge difference.

Silage with good quality is characterised by pH 4.5 or below at normal dry matter content. The content of lactic acid must be high, of acetic acid moderate and of butyric acid very low. The content of ammonium N must be low, preferably less than 8% of the total N. Finally, the silage must be low in content of anaerobic spores. Otherwise the result will be milk with a lower quality and corresponding lower price. Good silage should have a clear odour of lactic acid without any mould and be palatable to the animals.

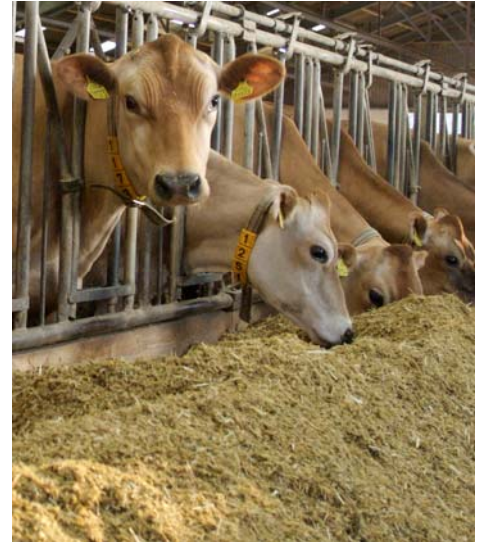
Risks when silage quality is low

Poor silage quality has a very high impact on production. The result is a low feed intake leading to low production of milk and meat. Anaerobic spores from the silage may contaminate the milk and will spoil cheese production. Wet, mouldy or rotten silage is certainly not good feed for animals.

Intake depends on quality

In good, fresh grass or silage, the energy concentration in the dry matter is high (above 7 Mega Joule_{NEL}), and grass and silage intake have to be evaluated in terms of energy per cow (and not in quantity of feed), measured in terms of feed units, Mega Joule or kcal.

A high level of energy intake depends on high energy level in dry matter and making the best use of filling capacity of the cow. Cows react immediately to the taste of the grass and silage and they prefer short and young pasture grass, rich in leaves with no stems and weeds. They also favour high quality silage with good smell and taste in the trough 24 hours a day (more time feeding per day). The response from the animals to good forage will be more milk, better health and better profitability for the farmer.



Maintaining High Output from Grassland

Grassland changes over time. Young fields yield better than old ones and after some time the relation between species will not be the same as the ones originally sown. However, the grassland farmer has some tools to help maintain yield and quality in the field.

Pastures

In fields used for grazing, a good way of keeping a productive field is to control sward height. The grass height should be kept at 6-8 cm - and never shorter - between the rejected grasses around dung patches. Shorter grazing height can damage the plants and eventually kill them.

When there is a risk of too low grazing height, the cows should be moved to another field or fed indoors and the grass should be left for at least one week to recover. If the growth on the other hand is greater than the animals can manage to graze, a part of the field should be used for cutting.

In order to be prepared, it is necessary to make a plan for the grazing season and decide which fields should be used for grazing and cutting at which time. The plan should aim at

- Utilising the grass fields as efficiently as possible in order to save costs for concentrates
- No overgrazing in the fields, with lower grass production as a consequence
- Avoiding big variations in the grass production - an even supply of fresh grass is essential

Generally a combination of grazing and cutting is good for the maintenance of a good sward as well as a tool for the best utilisation of grass in the feed ratio.

Grassland for cutting

The use of grass for cutting exposes the field to risks of several rather tough treatments:

- Too low cutting height - if the sward is cut lower than 6-8 cm, the regrowth will be slow (for fields to be used for grazing afterwards, the sward height can be 5-6 cm)
- Too high sward before cutting - the time used for re-growth is considerably longer when the previous cut is made at a late stage of development
- Bad equipment for cutting - knives in the cutter must be sharp in order not to damage the plants unnecessarily
- Use of heavy machinery for slurry application, harvesting and transportation often means considerable damage of grass and clover plants as well as a risk of soil compaction

These dangers are of course combined with the climatic impact on grassland productivity and the grassland manager has to monitor the fields in order to react accordingly - see page 21 for observations needed during the season.

When and How to Renew Grassland

No matter how good and careful the grassland management is, there will always be a decline in productivity and an increase in the number of unwanted species. This is due to the above-mentioned factors, but also to the simple fact that young grass plants are more vigorous and productive than older ones. A yield decrease of 10-15% per year is normal and at the same time forage quality gets poorer, too. If possible, the best way to renew grassland is to remove the old sward and reseed. This solution, however, is in many cases not desirable or possible - instead overseeding is a good option.

Guidelines for overseeding

Remove all surplus growth by cutting or hard grazing. Scarify the area in opposite directions using a grass-scarifying harrow. It is essential that this operation exposes the soil surface and that a tilth is produced, which will ensure the seed has good soil contact and rapid establishment.

Sowing

Sow at the same time as scarifying with around 25 kg per ha of the appropriate seed mixture. Sowing can also take place in a separate operation using a normal drill or a drill especially developed for direct sowing.



Immediately after sowing roll the field to consolidate the ground and ensure good seed - soil contact. It cannot be emphasised enough that time spent on the preparation and sowing of the land ensuring that the seed is in contact with the soil, is of the greatest importance.



Timing

Overseeding should take place immediately after silage cut in the late summer season or after a hard graze in the spring or autumn. These timings usually present an envelope of opportunity when the ground is at its most exposed and with little or no thatch to be removed to ensure good establishment.

Fertiliser

Allow the seedlings to emerge and it is recommended to wait at least 10-15 days after sowing before using fertiliser.



Livestock reintroduction

After cutting: wait until the sward has fully recovered.

After grazing: keep stock on for 10-15 days then remove and allow sward to recover.

Substantial Benefits from Overseeding

Overseeding existing grassland improves yield as well as quality of the sward. In figure 9, results of trials with overseeding a GrassMax sward of Hybrid and Perennial ryegrass is shown. The field was established in 2005 and overseeded in 2006 and 2007 with the original mixture mixed with clover. DM yield increased dramatically and also clear improvements in all quality parameters were achieved.

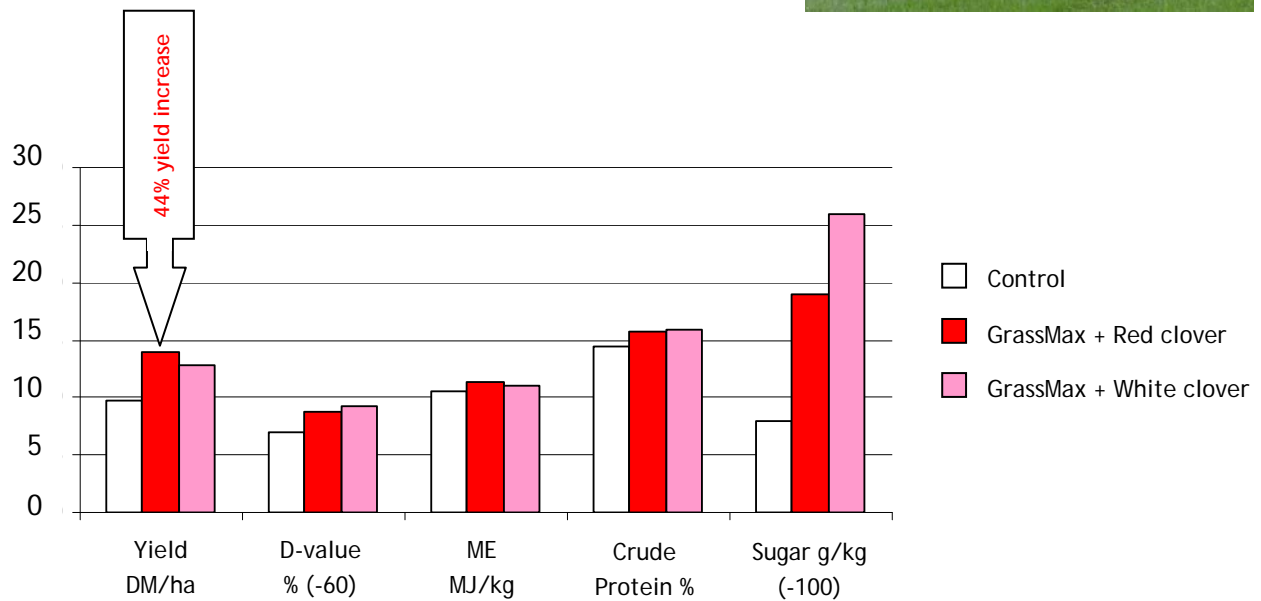


Figure 9. Overseeding with GrassMax. Control field sown 2005, overseeding with GrassMax + Red clover or GrassMax + White clover. Trials at DLF-TRIFOLIUM, 3rd year 2007.

A Year in the Grass Field

OBSERVATIONS, AIMS AND ACTIONS DURING THE YEAR			
TIME	TO BE OBSERVED	AIM	ACTION
March/Early spring	Number of plants	Even and full density	Reseeding or early overseeding
	Molehills	No moles or molehills	Control moles and level molehills
	Poached or frosted areas	Plain fields and plants with good soil contact	Rolling with cement roller
	Fertilisation	High yield, quality as required for feeding plan	Fertilisation starts at beginning of growth
	Fencing	Adjust grass quantity offered	Fencing according to the yield potential in the field
April/Spring	New ley needed	New grass field	Sowing of seed in pure stand or with cover crop
	Weeds	No weeds	Plan weed control
	Grass available for grazing	Height of grass adjusted to grazing system	Start grazing
May/Late spring	Bloat by grazing animals	Adjust clover content in field	Fertilise with nitrogen and/or change feeding
	Grass available now and during next 2 weeks	Fast re-growth	Early cut
	Grass development, time for cutting	Quality according to feeding plan	Visual observations. Analysis
	Need for irrigation	High grass production	Irrigation if possible
	Need for fertilisation	High grass production	Fertilisation according to plan
June/Early summer	Grass height in grazing fields	High grass intake and production	Adjust grazing area and feeding plan
	Rejected grass in grazing fields	High grass intake and production, persistency	Topping at 5-6 cm
	Change of paddocks	High grass intake, prevent attack by pests	Grazing after cutting and vice versa
	Perennial and flowering weeds	No weeds	Topping before seed setting
	Need for fertilisation	High grass production	Fertilisation according to plan
	Grass development, time for cutting	Quality according to feeding plan	Visual observations. Analysis

Continues...

Continued

OBSERVATIONS, AIMS AND ACTIONS DURING			
TIME	TO BE OBSERVED	AIM	ACTION
July/August/ Midsummer	Rejected grass in grazing fields	High grass intake and production, persistency	Topping at 5-6 cm
	Grass development, time for cutting	Quality according to feeding plan	Visual observations. Analysis
	Status in new ley from spring sowing	Even and dense grass and clover sward	Overseeding if needed
	Need for fertilisation	High grass production till end of season	Fertilisation according to plan
	New leys, more grass needed	New grass field	Sowing of seed in pure stand or with cover crop
	Production in existing fields	High grass production and good quality	Reseeding or overseeding
	Plant density in permanent fields	Even and dense grass and clover stand	Reseeding or overseeding
	Grass height in grazing fields	High grass intake and production	Adjust grazing area and feeding plan
	Crown rust	No crown rust	Sufficient supply of water and nitrogen
September/ Early Autumn	Potassium status	Good winter hardiness of plants	Supply with extra potassium
	Status in new leys	Even and dense sward for next year	Well established plants before grazing or cutting
October/ Autumn	Grass height	Good winter survival	Topping (6-8 cm) or grazing
	Poaching	No poaching	Remove animals from field
Winter	Planning of grassland area and management for next year	Consistent, high production of quality forage according to feeding plan	Use clover grass in rotation. Plan needs for silage and grazing according to herd size and feeding plan.

Table 10.

Mixtures and Species

ForageMax - Quality Grass Seed Mixtures

ForageMax is the name of grass seed mixtures from DLF-TRIFOLIUM and the result of many years of experience from trials and practical farming. DLF-TRIFOLIUM has, together with The Danish Agricultural Advisory Service, performed a large number of tests and demonstrations in several countries in order to formulate the best mixtures - well adapted to local climatic conditions and demands for feed.

It has been clearly demonstrated that the introduction of new, high productive ForageMax mixtures on a farm gives significant increase in milk and meat production, which leads to a higher income to the farmer.



Maximise Your Benefits with ForageMax

More than 10 different species are used when composing ForageMax mixtures. The idea is to create the basis for production of high quality forage without losing persistency and stress tolerance. In order to obtain this, ForageMax mixtures consist of 4-6 species that are all chosen according to the intended use of the field.

ForageMax - Mixture Descriptions

CutMax - Original

- very high and stable yield

With Cocksfoot

CutMax - Original is ideal for 2-4 silage cuts per year in a rotational system with renewal every 2-4 years. The mixture contains Cocksfoot, which ensures a very high and stable yield also under drier conditions. Thus, CutMax - Original is suitable for cold and temperate regions as well as hot and dry areas.

CutMax - Digest

- yield and quality in one

With Festulolium

CutMax - Digest is composed with Festulolium, which has a very high digestibility and increased sugar content. CutMax - Digest secures the highest intake and milk production. It is ideal for 2-4 silage cuts per year in a rotational system with renewal every 2-4 years. CutMax - Digest is suitable for cold and temperate regions as well as hot and dry areas.

CutMax - Clover Protein

- High yield with low input

Red clover with Festulolium

CutMax - Clover Protein is a short-term conservation mixture. More than half the seed is Red clover and the rest is Festulolium and together they form a highly productive mixture with the potential of delivering a great amount of forage with a high content of protein. At the same time you can save both nitrogen in the field and concentrate in the stable. CutMax -

Clover Protein is mainly for cold and temperate regions and will give the best quality in a 3-4 cut system.

CutMax - Alfa Protein

- Very high yield and stability

Lucerne with cold tolerant grasses

CutMax - Alfa Protein is a long term conservation mixture with a high proportion of legumes. Red clover and Lucerne ensure a high production of protein per hectare and both legumes have deeply developing root systems bringing about good drought resistance. The grasses chosen for this mixture are species with excellent tolerance to cold temperatures: consequently CutMax - Alfa Protein is a very persistent mixture for cold and temperate regions in a 3 cut system for silage or hay production.

CutMax - Alfa Protein - Hot & Dry

- very high yields under dry conditions

Lucerne with grasses for dry and warm regions

CutMax - Alfa Protein - Hot & Dry is a long term conservation mixture with a high proportion of Lucerne. This ensures a high production of protein per hectare. Lucerne has a very deep developing root system. The grasses in this mixture are species with a great tolerance to hot and dry conditions: consequently CutMax - Alfa Protein - Hot & Dry is a very persistent mixture for dry and warm regions in a 3 cut system for silage or hay.

GrazeMax - Original and Hot & Dry

- Exceptional quality

For grazing high producing milking cows

GrazeMax is designed for the intensive milk producer. It is a mixture of White clover and winter hardy varieties of Perennial ryegrass and can under the right conditions produce a very high amount of quality feed for grazing animals. Summer production is good and GrazeMax should be renewed every 2-3 years. There is also a GrazeMax mixture for hot and dry areas based on palatable and digestible varieties of Tall fescue.

VersaMax - Robust (previously CoverMax)

- Robust and hardy

For extensive grazing and conservation under all conditions

VersaMax - Robust is a really tough mixture to be used where stress tolerance is needed. VersaMax - Robust is designed mainly for permanent pastures, but is also very suitable for one or two early cuts of silage or hay. VersaMax - Robust consists of species that combine ground cover, winter hardiness, drought tolerance and high productivity. VersaMax - Robust is ideal, not only for cattle grazing but also for sheep and horses as it tolerates close grazing. The feed from VersaMax - Robust is palatable, but also supplies the animals with necessary fibre.

VersaMax - Original and Hot & Dry

- Multifunctional

All-round mixtures with high productivity

VersaMax - Original is delivered in two versions. One mixture for cold and temperate regions, including White clover and Ryegrasses, and one for hot and dry areas based on Red clover, Hybrid ryegrass and Tall fescue. VersaMax - Original is ideal for a combined management of conservation and grazing, where it can bring high yield with very good feeding values. It is recommended to alternate between cutting and rotational grazing.

GrassMax - Original and +iSeed®

- Quick and tasty

GrassMax is for overseeding existing fields

The output of an older sward can be increased dramatically by introducing new vigorous young plants. GrassMax uses only very quick establishing species like Festulolium, Hybrid ryegrass and Tetraploid Perennial ryegrass. These species have big seeds and fast germination that enable competition with existing plants in the field. We recommend overseeding fields that are not completely renewed on a regular basis. GrassMax - Original is also offered with iSeed®.

Foragemax Mixture Compositions

FORAGEMAX MIXTURES												
	CUTTING AND CONSERVATION					GRAZING		COMBINATION OF GRAZING AND CUTTING/CONSERVATION			OVERSEEDING	
	CUTMAX ORIGINAL	CUTMAX DIGEST	CUTMAX CLOVER PROTEIN	CUTMAX ALFA PROTEIN	CUTMAX ALFA PROTEIN HOT&DRY	GRAZEMAX ORIGINAL	GRAZEMAX HOT&DRY	VERSAMAX ORIGINAL	VERSAMAX ROBUST (PREVIOUSLY COVERMAX)	VERSAMAX HOT&DRY	GRASSMAX ORIGINAL	GRASSMAX +ISEED®
DURATION	2-4 YEARS	2-4 YEARS	2-3 YEARS	2-4 YEARS	2-4 YEARS	2-4 YEARS	2-4 YEARS	3-5 YEARS	MORE THAN 5 YEARS	3-5 YEARS	2-4 YEARS	2-4 YEARS
SEEDING RATE, KG/ HA	25-30	25-30	25-30	25-30	25-30	25-30	25-35	25-30	30-35	25-30	25-30	50-60
RED CLOVER	15	15	55	10						10		
ALFALFA				30	40							
WHITE CLOVER MEDIUM-LARGE LEAVED						10	10	10		5		
WHITE CLOVER SMALL LEAVED						5		7	5			
FESTULOLIUM TYPE RYEGRASS	20	25	20	25						25	30	30
FESTULOLIUM TYPE TALL FESCUE		25	25									
HYBRID RYEGRASS					15					40	20	20
PERENNIAL RYEGRASS INTERMEDIATE TETRAPLOID	30	20		10		40	20	54	30		50	50
PERENNIAL RYEGRASS LATE TETRAPLOID						45						
TIMOTHY	10	15		15				11	15			
COCKSFOOT	25			10	15					20		
TALL FESCUE					15		70		25			
MEADOW FESCUE								11				
RED FESCUE									10			
MEADOW GRASS								7	15			
BROMUS ENERMIS					15							

Table 11.

Breeding for High Yield and Quality by DLF-TRIFOLIUM

The aim of our breeding is to develop varieties suited to optimal dairy or beef production: high yielding varieties with reduced need for input of water, fertiliser and plant protection. Palatability and feed quality are essential, and breeding material is tested in a range of extreme and stressful conditions such as frost or drought as well as being subjected to high disease pressure. Global testing helps identify the high yielding varieties that can withstand these different pressures including variations in weather conditions.



SPECIES USED IN MIXTURES				
	COMBINED MANAGEMENT	CONSERVATION	GRAZING	EXTENSIVE GRAZING
Main species	White clover (medium and large leaf size), Perennial ryegrass	Red clover, Perennial ryegrass, Festulolium	White clover (small and medium leaf size), Perennial ryegrass	Tall Fescue, Perennial ryegrass, Timothy,
Additional species	Timothy, Meadow fescue, Smooth-stalked meadow grass	Timothy, Cocksfoot		White clover, Red Fescue, Smooth-stalked meadow grass
Mixture	VersaMax	CutMax, ProteinMax	GrazeMax	VersaMax - Robust
Remarks	For combined management. Persistent, high palatability.	For silage. Very high yield.	High sugar content, high palatability.	High yield, winter hardiness, ground cover.

Table 12. Grass mixtures prepared for different utilisation.

Species Descriptions



There is a wide range of species and types of grasses and clovers that have different qualities and properties related to growth and utilisation. Based on these differences, the grasses and clovers are mixed according to the demands for use and climatic conditions - see below about breeding for high yield and quality.

The main species for obtaining high forage quality - and always represented by the newest varieties from our breeding - are Hybrid ryegrass, Perennial ryegrass and Festulolium combined with Red or White clover. In order to ensure stress tolerance and maximum persistency, Timothy, Cocksfoot, Meadow fescue and Tall fescue form the basis of some mixtures.

Perennial ryegrass (*Lolium perenne* L.)

Perennial ryegrass thrives on most soil types, except very wet soils. The species is perennial and suitable for both grazing and cutting. Perennial ryegrass has high sugar content, high digestibility and produces a high yield of good quality. Perennial ryegrass is particularly suitable for mixtures with white clover. Diploid varieties are - compared to tetraploid - distinguished by being more fine-leaved and dense in growth. They are more resistant to damage by grazing cattle. The diploids have a higher content of dry matter.



Tetraploid varieties are typically darker and more broad-leaved, with higher sugar content, better winter stability, and more open growth. DLF-TRIFOLIUM has developed tetraploid varieties that are as dense as most diploids, making them particularly suitable for grazing.

Varieties of perennial ryegrass are classified as early, intermediate and late according to heading dates. Early types and types with heavy spring growth are efficient exploiters of winter moisture, but they also have a greater tendency to set less nutritious stems for the rest of the season. The late types that have a more moderate spring growth ensure the quality of the feed over a longer period of time.

Festulolium

Festulolium is a speciality from DLF-TRIFOLIUM, a forage grass developed by crossing fescue (Meadow fescue or Tall fescue) with Ryegrass (Perennial or Italian). This combines the best properties of the two types of grass.

The Fescues contribute with qualities such as resistance to cold, drought tolerance and persistence, while Ryegrass brings rapid establishment, good spring growth, good digestibility, high sugar content and palatability.



The individual Festulolium varieties contain various combinations of these qualities and they can be classified according to their degree of similarity to the parents. There are a number of very remarkable varieties of Festulolium from DLF-TRIFOLIUM:

Type Ryegrass. Crossing between Italian ryegrass and Meadow or Tall fescue. Appearance like Ryegrass, but with better persistency. Examples: BECHVA, PAULITA, PERUN, ACHILLES, PERSEUS, LOFA.

Type Tall fescue. Crossing between Italian ryegrass and Tall fescue. The appearance is like Tall fescue, meaning high stress tolerance, but with better yield and quality. Examples: FELINA, HYKOR, FOJTAN.

Hybrid ryegrass (*Lolium x boucheanum* Kunth)

Hybrid ryegrass is a cross between Perennial ryegrass and Italian ryegrass, combining the parental properties to various degrees. Some hybrid ryegrass varieties resemble perennial ryegrass, others Italian ryegrass, and others again are transitional forms.

DLF-TRIFOLIUM has specialised in creating varieties of Hybrid ryegrass, which combine the persistence of Perennial ryegrass with a feed quality approximating that of Italian ryegrass. These hybrid ryegrass varieties are particularly suited to grazing in early spring, when production is greater than that of Perennial ryegrass and, with their smaller number of stems, better than Italian ryegrass in the latter part of the season. This means less waste grass. Hybrids are more drought tolerant than both Perennial and Italian ryegrass.



Timothy (*Phleum pratense* L.)

Timothy is a Perennial grass, which is highly resistant to cold and very suitable for moist soils. It has a long period of spring growth before stem formation, and in a cold spring, Timothy grows better than most other forage grasses. Timothy ensures the durability of a grass field without competing aggressively with other grasses. It contributes to a good quality in spring and autumn.

The late Timothy varieties are highly suitable for grazing: neither sugar content nor digestibility is equal to those of the ryegrasses, but Timothy has favourable fibre content. The early types with a high yield in spring are used especially for silage.



Tall fescue (*Festuca arundinacea* L.)

With a large, deep root network, tall fescue is a very drought and heat tolerant grass, producing feed in periods when other grasses have stopped growing. The leaves are generally quite coarse, and there are major differences in the varieties' ability to tolerate frost. Tall fescue is used especially for cutting and grazing in hot and dry conditions, but DLF-TRIFOLIUM has also developed very winter hardy varieties suitable for the northern part of Europe.



Cocksfoot (*Dactylis glomerata* L.)

Cocksfoot is a very robust and drought tolerant grass. The growth starts early in spring, and stem formation is almost exclusively at the first cut in spring. Cocksfoot is very winter hardy after establishment. Traditional types are rather aggressive in mixtures with other grasses, but DLF-TRIFOLIUM has developed varieties which combine the ability to produce quality grass with fewer stems under dry conditions and with less aggressiveness towards other grasses.



White clover (*Trifolium repens* L.)

White clover is a valuable resource in the grass field as it increases the quality and digestibility of the feed, gives a better taste, and increases the animals' daily feed intake. Varieties with small leaves are particularly robust under grazing, while large leaved varieties are most productive when used for cutting.

After establishment, the plants spread with stolons, which can take root. This is one of the reasons why White clover tolerates grazing very well. As White clover can also survive the winter and is susceptible to few serious diseases, it is a durable plant in the grass field.



Red clover (*Trifolium pratense* L.)

Red clover is an important component in 2-3 year clover grass fields. The species tolerates less frequent grazing and therefore is best suited for cutting. With its long taproot, red clover is very drought tolerant, and thrives on a large number of soils (but not very light or waterlogged soils).

Red clover is normally used to give a very high yield when mixed with high producing grasses and, as red clover is a legume, application of nitrogen fertiliser can be reduced in a well established clover grass crop. Also feed quality and intake are improved when red clover is part of the mixture.



Lucerne (alfalfa) (*Medicago sativa* L.)

Lucerne is a forage legume known worldwide for its ability to produce forage under a wide range of climatic conditions - not least in dry areas. Lucerne is used for cutting, producing hay or silage and the plant forms a very deep taproot, which enables the Lucerne to tolerate dry periods.

Lucerne has a high level of protein, and as a legume it does not require mineral nitrogen fertiliser. However, the seed must normally be inoculated with RHIZOBIUM bacteria in order to ensure the adequate nitrogen supply through the root nodules.



Smooth-stalked meadow grass (*Poa pratensis* L.)

With its very good resistance to cold and drought and its strong resistance to wear, Smooth-stalked meadow grass is suitable for grassland used for grazing in the temperate part of the world.

Smooth-stalked meadow grass spreads with the aid of rhizomes and regenerate fields which have been thinned by wear or drought. The rhizomes (both long and short) are "sewing" in new plants in all holes. At the same time *Poa pratensis* is one of the most winter hardy species. *Poa pratensis* is one of the first grasses to start growth in the spring, and in the autumn it is also growing till late.



Red Fescue (*Festuca rubra* L.)

Red fescue thrives in almost all soil types, including dry and light soils. Red fescue is highly resistant to cold and tolerates drought and it therefore contributes to a long life for the ley.

Festuca rubra for forage is the type with stolons (*Festuca rubra rubra* L.) which is the most robust and widely adapted of the three sub-species found in Red fescue. It establishes relatively fast and with its strong runners, it can quickly cover bare patches in the field.



Vocabulary

Some definitions related to forage quality

Crude Protein

The amount of total protein in the feed, % of DM.

Digestible NDF

Part of the NDF that can be digested by ruminants.

Digestibility of Organic Matter (DOM)

The amount (%) of organic matter that can be digested by ruminants.

Dry matter (DM)

The total content of organic + inorganic components in feed when the water has been removed.

Energy Corrected Milk (ECM)

A unit for measuring energy concentration in milk where the content of fat and protein per kg milk are joined into a fixed energy factor. This makes comparisons between cows or herds possible.

Feed Unit (FU)

The energetic value of 1 kg barley (Denmark: Scandinavian Feed Unit, SFU) or oat (Russia, Baltic countries, Poland: KE). 1 SFU = 7.85 Mega Joule_{NEL} 1 KE = 12 MJ_{metabolic energy}.

Filling Factor

Refers to the filling of the forage and capacity of the rumen. The filling factor shows how much of a certain feed the individual cow in a specific stage of lactation can eat.

Intake

The amount of feed eaten by the animal.

Neutral Detergent Fibre (NDF)

Includes lignin, cellulose and hemicellulose. A part of the NDF can be digested by ruminants (Digestible NDF).

Palatability

Taste and acceptability of the forage - good palatability increases intake.

Water-soluble Carbohydrates, Sugar

Mono and disaccharides, fructans, % of DM.

Sugar content varies a lot, depending on temperature, time of day and season. At its highest in spring, it can be more than 20%.

Literature

Literature about forage production and quality



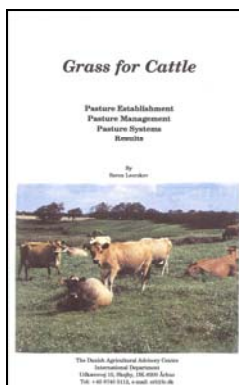
"Comparison of grass and legume silages for milk production. 1. Production responses with different levels of concentrate", Dewhurst RJ, Fisher WJ, Tweed JK, Wilkins RJ. Journal of Dairy Science. 2003 Aug;86(8):2598-611



"Dyrkning af grovfoder", Erik Helbo Bjergmark, Søren Greve Olesen, Martin Mikkelsen og Karsten A. Nielsen, Danish Agricultural Advisory Centre, Landbrugsforlaget, 2005



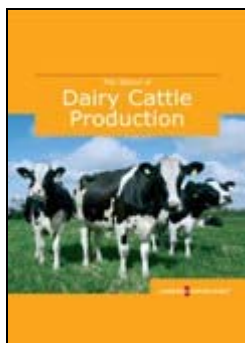
"Ensiling - a craftmanship". Karsten Attermann Nielsen, Rudolf Thøgersen og Christer Ohlsson
Languages: Danish, English, Russian and Polish.
Danish Agricultural Advisory Service, 2003
<http://www.landbrugsforlaget.dk/Planter/Foderafgroeder/EnsilingACraftmanship.htm>



"Grass for Cattle", Søren Leerskov, Danish Agricultural Advisory Centre, 2001

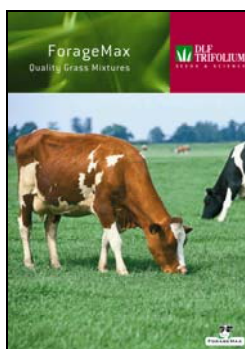
Also available in Russian.

"Establishment of a pasture". (Ukrainian project). Søren Leerskov, The Danish Agricultural Advisory Service, 2002



“The Basics of Dairy Cattle Production”. Dorte Marcussen and Annette Krog. Danish Agricultural Advisory Service, 2007
<http://www.landbrugsforlaget.dk/landbrugsforlaget.htm>

Also available in Russian -
http://www.landbrugsforlaget.dk/Husdyr/Kvaeg/Basics_Dairy_Cattle_RUS.htm



“ForageMax - Quality Grass Mixtures”. DLF-TRIFOLIUM A/S, 2008

Also available in Croatian, Estonian, Latvian, Lithuanian, Polish, Romanian and Russian -
http://www.dlf.com/Sales_and_Marketing/Marketing/Brochures.aspx

Contact

DLF-TRIFOLIUM:

DLF-TRIFOLIUM A/S
Ny Oestergade 9
P.O. Box 59
DK-4000 Roskilde
Denmark

Tel.: +45 4633 0300
Fax: +45 4632 0830
E-mail: dlf@dlf.com
Web: www.dlf.com

We thank for the use of the following photos:

Photos page 26: M. Halling

Photos page 28: S. Reynolds, A. Peeters

Photos page 29: S. Reynolds, J Koivisto, M. Halling

© DLF-TRIFOLIUM 2009