FOREWORD

Forage Management is the tenth of a series of management manuals published by Veepro Holland. The aim of these manuals is to provide you with useful management information. Dairy cattle worldwide need to be managed well in order to utilize their genetic potential to full extent.

No single booklet can cover every aspect of a subject as diverse and complex as dairying. Nor can everyone associated with dairying agree on all of the points covered in one publication. However, we of Veepro Holland believe the combination of this manual and other publications on the subject may broaden your knowledge on roughage utilization and subsequently contribute to a healthy and highly productive herd.

Veepro Holland is indebted to those who contributed to this manual, particularly, Ing. Jan Corporaal of the Applied Research Station for Animal Husbandry (PR) and Ing. Henk van Dijk, formerly of the National Reference Centre for Livestock Production (IKC), both at Lelystad, for their constructive criticism.

We would like to thank IPC-Livestock/Dairy Training Centre ‘Friesland’ at Oenkerk for their valuable assistance in the preparation of this manual.

Many thanks also to those associations and publishers who permitted us to use various data and illustrations.

VEEPRO HOLLAND
INTRODUCTION

Good-quality forage is the basis for economic milk production. As long as there is a good and plentiful supply of palatable forages, the use of concentrates can be limited, resulting in lower feed costs, depending, however, on the area you are dairying in. It is important to mow grass at the correct stage of growth in order to avoid nutritive losses. This is particularly important during periods of excessive grass growth. Excess grass can then be ensiled and used during periods of insufficient growth, in dry seasons and/or indoor periods.

The production of quality forages starts with growing outstanding crops of grass and maize. These crops should be harvested at a stage of optimal nutritional value and within a short period of time and in such a way as enables good conservation of the forage. Grass can be conserved as hay or as silage. Haymaking requires a period of favourable weather whereas grass ensiling is less dependent on the weather conditions. To minimize ensiling losses, utmost attention is required to the ensiling process and, last but not least, the sealing of the clamp. Furthermore, it is important that the quality of the product being ensiled is maintained throughout silage removal.

In order to ensure efficient utilization of ensiled forages by ruminants, it is essential to have a basic understanding of the nutritive values of silage to be able to properly formulate well-balanced rations for optimal milk production. Monitoring of animal production parameters, such as total dry matter intake, live weight gain, milk yield and milk composition, are essential. Please consult the Feeding Management manuals, Volumes 1 and 2, for more detailed information about ration formulation.

Good-quality forage is the basis for economic milk production.
FORAGE PRODUCTION IN THE NETHERLANDS

In the Netherlands, grass is the most important foddercrop, with about 1,100,000 hectares in pasture (1 hectare is slightly less than 2.5 acres). The second most important crop is maize. In 1995 about 235,000 hectares of maize were planted for silage cropping. During the summer season most cows are rotationally grazed in paddocks. In winter, cattle are housed for about 180 days during which period grass silage is the most important forage. On average, total forage production consists of 65% grass silage, 30% maize silage and 5% hay.

Grassland management

The Dutch dairy farms make intensive use of the grassland. The grassland is mainly of a permanent type and is dominated by perennial raygrass species. Under the Dutch climatic conditions, perennial raygrass gives the highest dry matter yield and feeding value per ha of grassland at low inputs. Nitrogen application to pastures varies from 200 to 400 kg per hectare per annum, including organic fertilizer from farm slurry. Phosphorus and potassium dressings are based on soil tests. It is essential that paddocks be well-drained, which contributes positively to the harvesting conditions. Optimal drainage improves the botanical composition of the grass sward, resulting in the highest dry matter yield and feeding value of grass per hectare. Attention should be paid to the condition of the sward. An open and unequal sward causes soil contamination of the mown grass and consequently lowers forage quality. Most dairy farmers practise a rotational grazing system whereby the cattle graze one paddock for up to 4 days before moving on to a fresh one. Most paddocks are both grazed and mown. On average, paddocks are mown 1.8 times per year. Regular mowing of paddocks means there will always be sufficient fresh young grass available for grazing and conservation. For this reason, the assumption of the principle ‘the quantity of forage production determines the quality of grazing’ is essential. It means that under all circumstances the utilization of pastures has first priority for the provision of good-quality fresh grass for grazing. The largest amount of dry matter for grazing is obtained when cattle are brought into the pastures at a grass length of 12 to 15 cm. The dry matter yield is then about 1,700 kg per hectare. Grazing at shorter grass lengths will result in yield losses and grazing at longer grass lengths means less good utilization, resulting in a lower quality of the sward. If this system is used, high milk production during the summer months is possible, with a limited amount of concentrates being fed and consequently resulting in higher financial returns.
Silage making

In view of the sudden changes in the Dutch climate haymaking is less suitable on intensive grassland farms. Therefore, haymaking is only limited to periods of favourable weather during late spring and summer. When making high dry matter silage with 40 to 45% of dry matter, one needs a shorter wilting period and is less dependent on the weather. This will result in a palatable silage, optimising a high feed intake, without using any additives. Where young, leafy, protein-rich grass is concerned, this is the best and most inexpensive way to produce good silage. The advantages of ensiling over haymaking include:

- less weather dependency;
- shorter wilting period;
- less nutrient losses in the field;
- higher rate of work per day;
- lower labour requirement;
- better quality.

In the production of ideal grass silage, three factors are particularly important:

- grass cutting at an early stage;
- restricted wilting period to achieve 40 to 50% dry matter;
- a good ensiling and storage system.

To optimise yield and quality, the best time to cut grass is when the dry matter yield per hectare is about 3 to 4 tonnes. The length of grass will then vary from 20 to 30 cm. Mowing at a very early stage (less than 2.5 tonnes dry matter per hectare) yields a better quality silage. However, this is more than offset by higher fertilizer, machinery and labour costs, when measured on a kg of dry matter basis. Furthermore, when mowing is done earlier, the grass growth is not utilized to its full potential.

Restricted wilting period

The Dutch climate is rather changeable. Therefore, mowing is done when the weather forecast predicts two or three dry days of good weather in succession.

Grass should be mown at the right stage to obtain a high amount of good-quality grass silage.

Regular mowing provides sufficient fresh, young grass for grazing and conservation.
Immediately after mowing (preferably with a mower conditioner), the grass is tedded. This is also done during the following days. In reasonably dry weather the desired dry matter content of 40 to 45% can be achieved in two days.

Under very favourable conditions it may even be achieved in one day. A shorter drying time implies a shorter field period and less weather dependency, incurring fewer losses of quantity and quality. A field period of no longer than three days (including mowing and ensiling) is advised. If the grass has not reached the desired dry matter content within three days it should, nevertheless, be ensiled. In these cases the use of an additive for good conservation is advised.

**Harvesting**

Wilted grass has to be ensiled quickly, within 1 day, as otherwise the temperature in the silage clamp will rise too high. This will adversely affect the conservation process. Most Dutch dairy farmers ensile 3 to 8 hectares of grass at one time. Self-loading forage wagons (with many knives) are used 75% of the time, self-propelled precision forage choppers are used for 20% and high-density rectangular bigbalers account for the remainder.

In the Netherlands about 50% of silage is made with the help of contractors. Ensiling with precision forage choppers and bigbalers is done by contractors as well. Precision forage choppers are particularly attractive for ensiling low dry-matter grass with additives. They not only chop the grass but also mix the grass and additive into a homogeneous product. This is beneficial for the fermentation process.

**Additives**

About 10% of grass silage is made with additives. Of these, Molasses and Foraform (salt of formic acid) are the most important. To obtain good results, the recommended amount and proper distribution of the additive is necessary. The additives are normally applied when the grass is picked up in the field. Like the other equipment required for silage making, good applicators for self-loading wagons with cutting devices, forage choppers and high-density rectangular bigbalers are available. The use of additives is a more expensive and less effective alternative to wilting. The best tool for making good silage is natural sunshine.

Regular tedding of grass is essential for the production of high dry matter silage.
MAIZE FOR SILAGE

In the Netherlands, the hectarage of silage maize increased rapidly over the past 20 years. Today it is the largest arable crop and is popular amongst Dutch farmers. It is mainly grown on the eastern and southern sandy soil types. For the northern parts of the Netherlands, only early maturing varieties will ripen sufficiently to give quality silage, due to the climate.

Maize is an ideal crop to ensile and is wellknown for its palatability. It gives a high yield of digestible nutrients. Maize exceeds most other forage crops in yield of dry matter and digestible nutrients, particularly as regards energy value, but it is rather low in protein yield per hectare. Therefore, it is most suitable for combination with protein-rich green grass in summer and grass silage in winter.

Growing maize for silage

Maize is originally a (sub)tropical crop. It needs an average temperature of 20 to 25 °C for optimum growth, although newly selected varieties grow well in moderate climates. Maize has a high water requirement, but is one of the most efficient field crops in the production of dry matter in regard to water usage. The average dry matter yield in this country is about 13 tonnes per hectare. Depending on the area and soil type, the crop needs well-distributed rainfall. Maize can be grown on a wide range of soil types, provided the pH is between 5.5 and 6.0. Heavy clay soils and peat soils should preferably be avoided, because of the potential problems of low early growth and difficult harvesting conditions.
Maize requires well-structured and well-drained soils, with a large amount of organic matter. The seed beds should be free of weeds and properly prepared, to ensure maximum retention and absorption of moisture. Fertilizer application should be based on soil test, crop history, fertilizing programme, and target yield. In the Netherlands, the land used for silage maize production is mainly fertilized with liquid manure (slurry) from livestock farms. Depending on soil conditions, it may be recommendable to apply nitrogen and phosphorus row fertilization during planting to ensure good germination of the maize seed.

Selection of hybrid varieties

A large amount of dry matter yield per hectare, rather than tonnes of green chop should be the criterion for selecting certified maize hybrids for ensiling. Another important factor to be considered is the yield of grain, as the best quality silage contains a large amount of grain. Most hybrids producing high yields of grain also produce high yields of quality silage. Soil type and fertility, rainfall and temperature play an influencing role in maize growth. The varieties should be selected on basis of research data derived, such as early or late maturing, yield, sensitivity to stemrot, and stem strength, under local climatic conditions.

Planting

To obtain an optimum plant population for silage, it is recommended to aim at 90,000 to 100,000 plants per hectare, seeding 100,000 to 110,000 seeds per hectare to compensate for germination losses. In light and sandy soil types fewer seeds should be planted. Higher plant numbers may boost green yields, but are of little advantage to dry matter yield. A too high plant population affects grain production negatively, and consequently reduces the nutritive value of the silage. Maize should be planted in 75 cm rows. Plant depth should be 5 to 6 cm, if mechanical weeding is applied, and 4 to 5 cm if herbicides are used.

In general, certified maize seeds are treated with a fungicide and insecticide against soil-borne pests and diseases. This treatment provides good protection against wireworm, frit fly, birds and rotting.
Mechanical weeding is also a good option. Sometimes, weed control problems do occur. In these cases, specialist advice from advisory services or research centres should be sought.

**Harvesting**

Maize for ensiling should be harvested when the grain has reached its late dough stage of maturity, with the top of the grain starting to dimple. At this stage, the maize has obtained a dry matter content of between 28 and 32%. The importance of achieving a high dry matter content cannot be over-emphasized, as it improves silage fermentation, reduces effluent problems, increases dry matter intake and, above all, improves animal performance. At harvesting time maize should contain 50 to 60% ear, which compares with about 40 to 50% grain, and accounts for its high energy value. The stover (leaves and stem) is the less digestible part of the plant, forming 40 to 50% of the total dry matter yield.

The choice of harvesting machinery is influenced by the area to be harvested - an operation well-suited for contractors. It is important to achieve a short and uniform chop length because:

- material with a short chop length (< 8 mm) allows better consolidation and exclusion of air from the clamp at ensiling;
- a high proportion of grain is shattered;
- silage digestibility and animal performance are improved.

It is essential that precision forage choppers have sharp and correctly adjusted chopping blades for optimum performance. Generally, this implies fitting the maximum number of knives, with regular sharpening and adjustment to the speed of the feed roller intake.

**No additives**

Maize has ample sugars for rapid fermentation into acids during the ensiling process; it ferments rapidly to give a well-preserved, sweet-smelling product. Therefore, it is not necessary to use additives to support fermentation. Some additives may improve fermentation a little. However, in most cases this is insufficient to be cost-effective. Low dry-matter crops are fermented more extensively than high dry-matter crops, resulting in higher losses of nutrients.

Well-adjusted machinery is a must for achieving a proper particle length of the maize silage.
ENSILING GRASS AND MAIZE

The objective of silage conservation is to retain, as much as possible, the nutritive value of the ensiled product through a lactic acid fermentation process, while discouraging the growth of undesirable micro-organisms. It is important that the ensiled fodder be stored under strict anaerobic conditions. This means that air- and watertight sealing is required. When forages first enter the silo, the plant cells are still alive. The cells continue to respire plant carbohydrates while finishing up any oxygen trapped within the silage clamp. The more oxygen available, the more valuable carbohydrates are wasted. This has a negative effect on the ensilability, the feeding value and the aerobic stability after opening of the silage clamp for feed removal. If lactic acid production is too low, clostridial fermentation may proceed, resulting in a loss of nutrients and unpalatable silage.

In the Netherlands wilted grass and maize are mainly ensiled in clamp or bunker silos. The number of tower silos in the Netherlands is small (100 to 200 towers) due to the higher investment, maintenance and running costs. About 75% of grass silage is stored in clamp silos, about 15% in bunker silos and the rest is baled and kept in clamps. Maize silage is mainly stored in bunker silos, because maize is harvested all at once and bunker silos allow better compaction of the sides of the silo.

During ensiling, the forage is placed in the silo layer by layer and then compacted by a heavy tractor or shovel. Therefore, it is important that the silo be filled rapidly, and sealed airtight as soon as possible after ensiling to prevent heating up. Most clamp and bunker silos with grass are filled up, once or twice during the season. This has no detrimental effect on the quality of the silage as long as the silo is kept airtight in between these periods.

Air- and watertight sealing is a pre-requisite for optimal silage conservation.

Sealing the silo

In the Netherlands, most clamp silos are sealed with two layers of plastic sheeting (0.15 mm thickness) placed on top of each other. The plastic sheeting should be secured with a collar of sand around the edge and be held tightly in place, often with the aid of old, used car tyres. The sheeting should be carefully handled to avoid puncturing. To avoid damage by birds, vermin, dogs and cats, a special

---

Table 1 The average nutrient composition of grass and maize silage in the Netherlands per kg fresh product and on a dry matter basis in 1994

<table>
<thead>
<tr>
<th></th>
<th>DM</th>
<th>CF</th>
<th>CP</th>
<th>DOM</th>
<th>TDN</th>
<th>NEL</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass silage</td>
<td>45</td>
<td>108</td>
<td>83</td>
<td>297</td>
<td>317</td>
<td>0.64</td>
<td>2.34</td>
<td>1.76</td>
</tr>
<tr>
<td>Grass silage</td>
<td>100</td>
<td>240</td>
<td>185</td>
<td>660</td>
<td>705</td>
<td>1.43</td>
<td>5.20</td>
<td>3.90</td>
</tr>
<tr>
<td>Maize silage</td>
<td>30</td>
<td>63</td>
<td>26</td>
<td>207</td>
<td>217</td>
<td>0.45</td>
<td>0.57</td>
<td>0.57</td>
</tr>
<tr>
<td>Maize silage</td>
<td>100</td>
<td>210</td>
<td>85</td>
<td>690</td>
<td>724</td>
<td>1.50</td>
<td>2.00</td>
<td>1.90</td>
</tr>
</tbody>
</table>

* DM = Dry Matter, CF = Crude Fibre, CP = Crude Protein, DOM = Digestible Organic Matter, TDN = Total Digestible Nutrients, NEL = Net Energy for Lactation, Ca = Calcium and P = Phosphorus
Optimum feeding speed keeps the quality of the ensiled product at a high standard.

type of protective sheet can be used and placed over the other plastic sheetings. If car tyres are used, they should be laid as closely together as possible. When holes in the sheeting appear during storage, they must be taped off to control wastage. It is advisable to check the plastic sheeting weekly for holes. In areas of sandy soils a layer of soil (10 to 20 cm) is often placed over a single layer of plastic sheeting. This is the most secure system, but is only possible with small silos. Additional labour is then required to apply and remove the soil.

Silage quality

Forage analysing is particularly useful for composing well-balanced feed rations for dairy cattle. Under Dutch conditions, good-quality forages within a balanced ration are the basis of high milk production at limited feed costs. Maize silage, with its high energy and low protein content, combines very well with grass silage. In rations based mainly on maize silage, it is essential that adequate mineral supplements be used, owing to the low mineral content of maize silage. It is advised to follow the recommendations described in the Feeding Management manual, Volume 2, for appropriate balancing of rations with minerals. Table 1 (see page 10) gives nutritional information about good quality grass and maize silage on both an as-fed and a dry matter basis.

Silage removal

The major objectives in removing grass and maize silage from storage are the same. The emphasis should be on preventing aerobic spoilage of silage during the feeding period. The starch in the grain and the acids produced during fermentation are good deterrents against the growth of yeasts and moulds when the face of the silage clamp is exposed to air. The silage clamp may easily heat up again (secondary fermentation) and mould may develop. This can be reduced or prevented by prompt feeding of the silage so that air exposure is restricted. Good practice is to feed at least 2 metres of silage per week if the silo has no soil cover and 1.5 metres per week if there is soil cover. To achieve the right feeding speed, the size of the silo, especially the width of the silage clamp, should match the number of livestock. It is also important that the surface of the clamp remain smooth to prevent air penetration. Tractor-mounted block and rotary silage cutters are ideal for keeping the surface smooth. If the surface of the silage is warm, it is likely there has been contact with air for several days. Severe secondary fermentation means high dry matter losses, lower feeding value and lower palatability, resulting in reduced feed intake. Chemicals to control overheating and moulding (e.g., propionic acid) are rarely used in practice and serve only as a poor alternative to good ensiling and feeding practice.
SUMMARY

The production of high-quality grass silage starts with good grassland management. The grass should be cut at an early stage and wilted in a short period. The production of maize silage starts with growing the right maize varieties under optimal conditions. The time of harvesting is determined by ripeness. Both wilted grass and maize must be promptly ensiled in air- and watertight silos. During removal, care should be taken to avoid heating of the silage. Time spent on producing highly nutritious and palatable forages will contribute optimally to the profitability of milk production.

The basic guidelines for the production of quality grass and maize silages are:

1. cutting grass at a yield of 3 to 4 tonnes dry matter per hectare;
2. making sure of good weather for at least 3 days in succession for grass silage;
3. aiming at 40 to 45% dry matter content of grass at ensiling;
4. using additives only when the dry matter content of grass is below 35%;
5. harvesting and ensiling grass should be done within one day;
6. harvesting maize when the kernels are in a late dough stage;
7. well-adjusted machinery and a chopping length of 8 mm for maize silage;
8. solidly compacting the silage clamp with a heavy vehicle;
9. eliminating wastage by good sealing of the ensiled product;
10. prompt feeding to reduce overheating and moulding.
FURTHER REFERENCES

- Pastures and Foddercrops, Lecture notes IPC-Livestock/Dairy Training Centre ‘Friesland’

Earlier publications:

- Reproduction Management
- Young Stock Management
- Foot Care Management
- Feeding Management, Volume 1
- Feeding Management, Volume 2
- Milking Machine Management, Volume 1
- Milking Machine Management, Volume 2
- Proper Milking Management
- Udder Health Management
Dairy Training Centre Friesland (DTC-Friesland) is part of IPC Livestock. It is established by various Dutch farmers’ organisations and controlled by the Ministry of Agriculture, Nature Management and Fisheries. The Centre conducts a variety of international training programmes and courses. We also provide consultancy and management services.

All courses have a strong practice-oriented character based on the training concept of learning by doing. The practical training is very intensive; one instructor deals with groups of six students and for subjects like milking even with three students only. DTC-Friesland offers training in the following subjects:

- **Dairy Husbandry**
  - machine- and handmilking, milking machines, milk hygiene
  - feeding, ration calculation, feedplans, quality of feedstuffs
  - fertility management, heat detection
  - breeding, use of A.I., culling, body conformation
  - housing, tying/cubicle systems, hygiene
  - health, mastitis control, hoofcare
  - calf rearing
  - farm economics
  - farm administration

- **Forage production**
  - pasture management
  - fodder crops
  - silage making
  - farm machinery

- **Milk processing**
  - manufacture of cheese, butter, yoghurt, ice-cream, etc.
  - milk collection and payment systems
  - marketing
  - management of a dairy unit

- **Sheep husbandry**
- **Dairy goat husbandry**
- **Intensive beef production**
- **Horse keeping and animal traction**
- **Teaching methodology**

Visits to farmers’ organisations, A.I.-stations, Health and Extension service etc. are integrated in the courses to provide a good picture of the dairy sector in the Netherlands.

**AD HOC COURSES**

Our major activity is the organisation of ad hoc courses on request. These training programmes are tailor-made and completely designed according to the requirements.
of the client. The courses deal with one or more of the earlier mentioned subjects. Duration of the courses varies from 1 week to several months. The courses are conducted in English. For some special subjects training can be provided in French, Spanish or German. If facilities are available locally, our staff is prepared to conduct courses abroad as well.

SIX-WEEKS COURSE: MODERN DAIRY FARM MANAGEMENT

This course is especially designed for persons in charge of a large-scale dairy enterprise, and includes all aspects involved in managing a dairy herd. The course offers a good opportunity to refresh one’s knowledge and learn about recent developments in dairy farm management.

SIX-WEEKS COURSE: MILK PROCESSING

The course is designed for (assistant) managers of small to medium-sized dairy plants and future staff of new dairy enterprises; i.e. on-farm milk processing. Both six-weeks courses are conducted annually in September. However, for groups of at least six persons it can be organised at any time during the year.

TRAINING FACILITIES AND STAFF

The centre has three farms, each with a different management system. One farm is especially equipped for international courses. The total stock at the three farms includes 240 dairy cows, 50 fattening-bulls, 45 dairy goats, 85 sheep and 12 Friesian horses. Additionally, the centre maintains close relations with twenty neighbouring farms which are used for practical training. Our staff consists of fifty dedicated and well-qualified trainers. All have up-to-date knowledge of modern dairy farm management, and over 70 man-years experience is present in various dairy development projects throughout the world.

ACCOMMODATION

A modern hostel provides full board and lodging in single or double bedrooms. An international kitchen and many recreational facilities are present. Social excursions are organised during the weekends to enable the students to get acquainted with the Dutch culture.

For more detailed information on our activities, please contact:

IPC-Livestock / DTC-Friesland
P.O. Box 85
9062 ZJ Oenkerk
The Netherlands
Telephone : +31 582561562
Telefax : +31 582561628

Wilted grass of optimal dry matter content is strived for at ensiling
TOP MANAGEMENT . . .

FOR THE BEST RESULTS

VEEPRO HOLLAND
Information centre for Dutch cattle