

# MANAGEMENT OF GRASS/CLOVER CONTINUOUSLY GRAZED WITH DAIRY COWS.

## 1. Herbage height, yield and clover percent

By

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### 1. Abstract

A system developed for the planning and controlling of continuously stocked grass/clover was tested on 7 farms over 3 years. From this test it can be summarized:

Sward height. The average sward height between rejected areas and percent rejected areas were in general close to the recommended values.

In the first year 4 farms out of 7 were topping to control elongated stems and percent rejected areas, after learning by mistake the regulation of grazing intensity in the next two years was made only by regulating grazing area and by regulating concentrate feeding. The biggest variation was found in percent rejected area, and the farmers quickly became confident with judging the sward conditions.

The milk yield increased by 5% in May compared to winter milk yield, and declined 10% (= 2 kg ECM/cow/day) during the grazing season.

Herbage intake during the grazing season was high. Typically 10-12 SFU/cow/day was achieved during spring and summer.

An average clover percent at 25-40% was achieved when 128-230 kg N/ha was applied. Under drought and without irrigation the clover percent declined dramatically.

Annual net herbage production was estimated to be 6900 SFU ( 83000 MJ ME or 8300 kg DM)/ha, 22% silage), varying between 4823-9300 SFU/ha. This represented a similar level of net production as that measured in previous investigations on private farms with pure grass used for silage and/or continuously/rotational grazing.

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## 2. INTRODUCTION

In Denmark grazed grass/clover pasture is considered to be a cheap source of animal feed due to the absence of harvesting costs and the low N-fertilization requirement (Kristensen and Kristensen 1993). With continuous grazing of grass/clover pasture the sward height, the area rejected for grazing and milk production per ha and per cow are good indicators of the management level (Kristensen and Kristensen 1993). If, for example, the grazing intensity is low, then the herbage height, rejected areas, intake and milk production per cow will be high, but the milk-production per ha will be low, because much herbage will senesce before it can be eaten by cows. The management system takes into account the general variation in herbage-production within and between the years in accordance with plant available water and fertility on the given soil-type.

Other factors in focus are clover content; the level of N-fertilization; irrigation and the area used for silage making. The main goal of the system was to maintain an optimal balance between milk production and utilization of herbage fields under practical conditions. The strategy was to fulfil the milk-quota with a minimum of cost. The cost-minimization include a maximal intake of grazed grass, a minimum of silage and a low N-fertilization level compensated with N-fixation by clover.

## 3. Materials and methods

All the farms had sufficient grassland (0.35 ha grass/clover per LU (Livestock Units of Holstein Frisian cows); varying from 0.20 to 0.63) permitting a high herbage intake per cow. Besides the grass/clover in crop rotation the farmers had 0.04 (0-0.14) ha permanent grassland per LU and for winter-roughage, they utilized 0.08 (0.02-0.18) ha whole crop silage plus 0.10 (0-0.18) ha fodderbeet per LU. In total the farmers had 1.01 (0.65-1.27) ha per LU. Contractors were used for silage-making and in general, the farmers wished to avoid making grass silage. The management system for grassland utilization has been described elsewhere (Kristensen and Kristensen 1993).

Every 14 days a technician visited each farm to measure the sward height and amount of supplemental feeding in the stall.

### Herd measurements

\_\_\_\_\_ The milk yield was recorded for each cow each month.

\_\_\_\_\_ The liveweight of each cow was measured on 1st May and 1st November, and on entering or leaving the herd.

\_\_\_\_\_ A grassland calendar for each field was filled in by the farmer each day to keep records of the grazed field, fertilization, irrigation, silage production and topping.

\_\_\_\_\_ The silage yield was estimated as the sum of silage feed to the herd measured every two weeks until the end of the following winter. Silage quality was measured from sample analyses for dry matter, protein and organic matter digestibility.

\_\_\_\_\_ The intake of herbage in terms of energy was estimated by subtracting the energy supplied in concentrate from the energy necessary to account for the milk production and liveweight gain observed.

### Herbage measurements

Botanical composition was measured in early spring, midsummer and in the autumn. In each field used for grazing, at least 10 random areas were evaluated. The sward composition was distributed between grass, clover, bare soil and weeds by visual assessment of volume percent within approximately  $\frac{1}{4}$  to 1 m<sup>2</sup>.

Sward height was measured every 14 days in 50-100 quadrats. The sward height was measured by a plate meter, plate 30 x 30 cm, 3.8 kg m<sup>-2</sup>. The meter was operated by placing the stick vertically in the sward, while the plate was held above the sward surface. Then the plate was lowered slowly, until the sward could carry it. Height from ground level was read in mm. The height made within rejected areas was recorded separately. A rejected area was defined as apparent ungrazed area or area with sward height over 15-20 cm.

## **4. Results and discussion**

Regulation of the continuously grazed herbage was in relation to sward height and rejected areas (Kristensen and Kristensen 1993). In Table 1, the sward height is shown on each farm in spring, summer and late summer. At the bottom the average and recommended sward height is shown.

The average sward height declined during the season from an average of 70 mm during the spring to 53 mm during the late summer. The average grazing height was lowered during the years, especially in spring and summer. The reason for this development was that the farmers became more confident with the grazing rules (Kristensen and Kristensen 1993).

On average, the higher grazing intensity did not affect the milk production. In 1991 the summer milk production was higher than in previous years; the low grazing height in spring may have led to a better stem control and a higher leaf-content in the summer grass.

The rejected areas increased from 4 to 14% during the season. It should be noted that the sward height during summer and autumn includes areas used for 1st cut silage (2nd cut silage on herd-no. 74-9) and areas that have been topped (marked with <sup>2)</sup> in Table 1). In these areas, the sward height will not be lower than stubble height and the percent rejected area should be 0-5% during the first 8 weeks (Kristensen and Kristensen 1993), because there is no faeces causing fouled herbage.

In the first year after introducing the grazing recommendations, 4 farms were topping, whereas in the following two years only herd-no 38-7 was using topping.

The milk production increased 5% during the first grazing period and declined 6 and 5% (= 1.2 kg ECM/cow/day) during late summer (31/7-15/9) and autumn (16/9-1/11).

The herbage intake per livestock unit per grazing day is shown on the right side of Table 1. Typically the herbage intake in spring and early summer was 25% higher than the average shown, and in autumn 25% less. Except for herd no. 74-9, only a little silage was made during summer periods and the regulation of feeding level according to current herbage growth rate was done only by regulation of concentrate feeding.

The herbage yield in relation to irrigation, N-fertilization and clover percent is shown in Table 2.





Four farms had irrigation facilities and the herbage was irrigated in accordance with evaporation, and it can be assumed that water deficit was not depressing the yield. At the 3 farms without irrigation the herbage growth was depressed by drought for at least 1-2 months each year.

The clover content was on average 25-40% of visual sward volume. No close relationship could be made between grazing, fertilization and clover content. In 1991 a drought in August was the reason why clover virtually disappeared on herd-no 73-9 (clay) and 74-9 (silt).

The N-fertilization was lowered from 230 in 1989 to 128 kg N/ha/year in 1991, and the average yield was 7400 SFU/ha/year in 1989-90 and 6000 SFU/ha/year in 1991. In the year 1991 the spring was cold and the growth potential was less than previous years; for this reason the yield decline should not be explained only by the lower N-fertilization.

### Cases

In herd-no. 74-9 the farmer had a high preference for milk production and there was a large herbage area - 55% of the yield was harvested as silage (Table 2). For this reason up to 4 SFU-silage were used per cow per day during the whole grazing period and the grazing intensity was low (15 and 25% rejected areas in 1990-91). A high milk yield (low grazing intensity) and a high herbage yield were achieved.

In herd-no. 87-7 a low milk quota was the reason for a strategy based on relatively low milk yield per cow and a high grazing intensity in 1990 and 1991 with a maximum of 5% rejected area. The herbage yield was also high considering the cold, wet humus soil. Normally the grazing period is 4-6 weeks shorter than on farms on mineral soil. A large milk yield depression in late summer and autumn and a relatively high herbage yield were achieved. The average herbage yield stands in good relation to previous investigations on private farms with pure grass for continuous/rotational grazing and/or silage (Kristensen and Jensen, 1989; Kristensen *et al.*, 1986).

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Kristensen, E.S. and Jensen, M., (1989). Græsmarkers udnyttelse til mælkeproduktion - styring og produktionsresultater. National Institute of Animal Science. Report 661, 15-53 (in Danish).

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## 2. Management tools

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### 1. Abstract

A management system is described for optimum utilization of a grass/clover area by continuously stocking with dairy cows. The main aspects of the system are:

- Calculating on a tactical basis the utilization of the pasture in order to achieve a balance between herbage production and herd demand.
- Daily control of the sward condition by measuring height and rejected area.
- Adjustment of grazed area or amount of supplemental feeding if sward condition differs from target.
- Monthly control of herbage production calculated from milk production, grazed area, and supplemental feeding.

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## 2. INTRODUCTION

On commercial farms, the aim of optimizing the utilization of grassland must be incorporated into a complex farming system that imposes additional objectives and constraints. The grassland area is only a part of the roughage production on a dairy farm in Denmark; typically 3-5 crops are grown in a rotation system (Kristensen and Kristensen 1993). The grassland management is dependent on and interacts with these other crops. The strategy is often to use the grassland solely for grazing; winter feed is supplied by whole crop cereal silage and fodder beet.

In Denmark, the grass/clover is normally undersown in cereals, which often is used for whole crop-silage for winter feeding. Normally the aftermath after cereals will have a high clover content, when low amounts of N are used. The grass/clover sward will normally be utilized for grazing in the autumn and the following two years. Then the sward will be ploughed for cereals or fodder/sugar beet. If the clover disappears, the farmer can either use more N-fertilizer or exchange the field with a 2-year old grass/clover-sward with a good clover stand. The silage cost for making grass/clover silage is higher than the cost for making silage from whole crop-cereals, leading to a strategy for maximal grazed amount of herbage, and a minimum of grass/clover silage. The area for whole crop silage is adjusted in accordance to winter feed demand.

The pasture production based on grass/clover with moderate N-fertilization in a crop rotation system, and the costs of fencing favour a system with continuous stocking. Control of the grassland utilization under these conditions aims to maximize utilization of the daily herbage growth by grazing to fulfil the given milk quota, at lowest cost of fertilizer and supplemental feeding.

The close connection between milk yield per cow and herbage production per ha makes it necessary to incorporate milk production and herbage utilization in one system. Uncontrollable factors such as climate make it impossible to incorporate all the details in the tactical plans. For this reason the system starts off with a grassland budget and summer feed plan, which include the tactical goals for production of milk and silage and the expected growth rate of grass/clover. The tactical goals are the guidelines for the control at the operative level. This relationship is based on "the iterative approach to the farm planning process" described by Sørensen *et al.* (1993). It is therefore essential that the system is self-adjusting through a constant check on the grass and milk production.

The control on an operative level is based on daily registration of the grass/clover condition, sward height and the areas with rejected grass. The registrations are compared with the goals, made during the planning process of the grassland utilization. In the case of disagreements between the registered conditions and the goals, adjustments are made in relation to the alternatives set up in the plan.

Here we present a management system for tactical/operational planning and control on commercial farms. The tool is developed to include optimum utilization of a given grass/clover area through a growing season, continuously stocked. The system is developed to be used by advisers as well as farmers. On the basis of the theory of the iterative approach to the farm planning process a management system on mainly pure grass has been developed and tested from 1987 to 1989 (Kristensen and Jensen, 1989). This paper presents the system developed for the planning and control of continuously grazed grass/clover herbage. Results from the tests performed at 7 dairy farms in the period 1989-1991 are presented by Kristensen and Kristensen (1993).

## 3. Tools for planning and adjustment

### 3.1. Tactical strategy for feeding and grassland utilization

On the tactical level a plan for summer feeding and the overall grassland utilization was made during the winter.

Tactical goals were specified for following periods:

Spring: May (until 1st grass/clover silage cut).

Summer: June-July (until harvest of 2nd cut, grass/clover silage or whole crop cereals).

Late Summer: August-September (until start of supplemental feeding during night-time).

Autumn: September-October (until start of winter feeding).

Winter: November to April

Since the end of the first two periods correspond to the normal time for silage cuts, it was therefore possible to adjust the area for grazing at the beginning of these times. For each period a grassland utilization budget was calculated based on a typical net production rate of grass/clover and animal requirements for herbage. This estimate is dependent on soil type, irrigation, grass/clover condition, N-fertilization and season. During the planning process, the amount and time of season for N-fertilization, and use of either silage or grazing, were used to manipulate the growth rate in favour of a high amount of the pasture production for grazing. Feed rations for the dairy cows were formulated in relation to herbage intake and target production level.

An example of a summer feeding plan and grassland utilization budget is shown in Table 1. The plan is for a dairy herd with 100 Holstein-Friesian dairy cows, milk yield capacity 28 kg ECM (energy corrected milk, 4.2% fat, 3.1% protein)/day during the first 24 w.p.p. (weeks post partum) equal to 8000 kg ECM/cow/year. Total area with grass/clover 0.20 ha/cow, and in addition 0.10 ha/cow of whole crop.

The herbage supply from both the pasture area and the area with grain undersown with grass/clover is estimated. The grain area can be used either for cereals or for whole crop silage for winter feeding, and the aftermath can be grazed. In periods with both silage and grazing, grazing was normally recommended in the fields with the highest clover content and highest tiller/stolon numbers. Herbage planned for silage was normally supplied with the highest level of N and this, together with undisturbed growth for cutting, is the reason for a higher expected growth potential than from the grazed sward.

Pasture intake per cow daily was calculated in relation to hours on pasture, clover content in pasture, season and total energy level. During the planning process, the amount of supplementary feed was manipulated in order to reach a high fresh herbage intake and to adjust milk production in relation to milk quota.

The planning process is then iterative, where the goal is for each of the four periods to balance the herbage production with the herd intake, in order to fulfil the overall goals in relation to milk quotas and minimization of the costs of concentrates and N-fertilization. This is achieved by trying to manipulate some of the factors mentioned earlier. The system does not include any specific rules to optimize the plan. Often a lot of practical factors, such as field size, maximum number of cows, silage facilities etc., have a significant impact on the optimal plan, under practical conditions.

The planning, therefore, has to be prepared by an adviser, with a good theoretical background, and the farmer.

A very important part of the planning process is to set up alternative plans, if the average conditions should not be reached. At the bottom of Table 1 adjustments in supplemental feeding if herbage production is either in situations of surplus or shortage. It is assumed that these regulations will not affect the daily milk yield per cow.

In the example the grassland area is sufficient for maximum herbage intake. As the growth rate declines during the season, the grazed area is increased. In the autumn, night feeding with silage and fodder beets compensate for the declining herbage growth rate. During the season the expected herbage intake per cow is 1600 SFU, or around 50 % of the total energy demand. The strong focus on a high amount of fresh herbage is expected to result in only 13 percent of the herbage production for silage, while the rest is utilized by grazing.

### 3.2 Control and adjustment

Control of the tactical plan is done in two ways. On a daily basis the balance between herbage production and herbage intake has to be controlled in order to get a satisfactory utilization of the pasture area. On a periodic basis, the tactical goals for herbage production, amount of supplemental feeding, and area for grazing can be controlled in order to get information to be used in the tactical planning for the next season.

The daily control has to be done by daily inspection of the sward. Sward height is measured by the farmer, and the amount of rejected area is calculated. If the actual conditions differ from the plan, the expected balance between herbage production and herd demand will not be reached. In principle imbalance can be a result of three factors: supplemental feeding, utilized herbage area, or herbage production per day. If one or more of these factors are in disagreement with the plan, it will result in an incorrect grassland utilization.

In principle the daily adjustment, on the basis of sward condition, can be made in two ways:

1. Adjusting the grazed area, or
2. Adjusting the feeding level of supplemental feeds.

In Table 2 the recommended principles for grassland utilization is shown, and at the bottom of Table 1 the planned adjustment in supplemental feeding is shown. The size of adjustment and nature of the adjustment (adjusting area or supplemental feeding) are decided by the farmer.

Optimum utilization of the pasture is assumed to be related to sward height and/or amount of rejected area. Adjustments are necessary if the pasture deviates from either target. Working with continuously stocked pasture, it is important to focus on both factors. Under some circumstances (e.g. the start of the grazing period), it is easy to detect deviations from the target sward height while it is more difficult to observe rejected areas. Later in the season, lax grazing will often first be registered by a deviation from the target amount of rejected area. The periodic control is done by monthly registration of number of cows, milk production, amount of supplemental feeding, utilized areas for grazing, and silage production. From these factors net herbage production per ha per day can be calculated indirectly. This control is used to adjust the planned amount of silage from whole crops and used to adjust the expected herbage production, when making plans for the next season.

### **4. Discussion**

From a theoretical point of view, the ideal grass/clover field management system for continuous stocking will be particularly complicated and therefore hard to incorporate into practical farm management. The primary purpose of this management system was to increase the farmer's understanding of the key factors in utilizing the grass/clover fields. This was achieved by careful introduction and from two to three visits during the season. The aim has been to base daily management on an overall understanding of the factors determining good grassland utilization by the farmer rather than giving specific instructions for a management system. This philosophy appears to have been decisive for the system being well accepted. The system has gained widespread esteem, the Central Advice Bureau, for instance has, from the developed system, created manual as well as computer-based tools (Jacobsen, 1992).

### **5. References**

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**Table 1. Example of a grassland utilization budget and summer feeding plan.**

National Institute of Animal Science Herd-no. 99-9  
**SUMMER FEEDING PLAN AND FEED BUDGET**

Yield capacity 1-24 w.p.p.	28.0	Breed	HF	Date	17.1
Grassland system <i>Continuously stocked grass/clover</i>					

**Herbage production**

Date	1/5 - 9/6	10/6-30/7	31/7-15/9	16/9-31/10	Expected yield SFU/ha
GRAZED PASTURE, ha	Net herbage production SFU/ha/day/utilization				
<i>Grass/clover, 1 year old, 10 ha</i>	<i>70 grazed</i>	<i>55 grazed</i>	<i>35 grazed</i>	<i>15 grazed</i>	<i>7910</i>
<i>Grass/clover, 2 year old, 10 ha</i>	<i>70 grazed</i> <i>90 silage</i>	<i>50 grazed</i>	<i>35 grazed</i>	<i>15 grazed</i>	<i>8040</i>
<i>Barley, 10 ha</i>			<i>20 grazed</i>	<i>20 grazed</i>	<i>1840</i>
Silage ha by SFU/ha silage	Grass	<i>4.3 ha x 3150</i>			Total,SFU <i>13545</i>
	Wholecrop		<i>10.0 ha x 6000</i>		

Herbage budget SFU	Production/ Requirement	<i>1100 / 1100</i>	<i>1050 / 1000</i>	<i>900 / 900</i>	<i>450 / 450</i>
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**Herbage requirement**

Feed	Feed plan SFU/cow/day				Total,SFU per cow
Number of cows	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>1600</i>
Pasture (cow/ha)	<i>11 (6.4)</i>	<i>10.5 (5.0)</i>	<i>9 (3.3)</i>	<i>4.5 (3.3)</i>	
Silage				<i>3.0</i>	
Fodder beets/barley	<i>1</i>		<i>1.0</i>	<i>3.0</i>	
Milk yield kg ECM/cow/day	Concentrate feed				
Heifers Older cows	Protein conc./dry beet pulp				
1-24 w.p.p.	<i>4.0/2.0</i>	<i>4.5/3.0</i>	<i>5.0/3.0</i>	<i>5.5/2.0</i>	
<i>19.5 22.0</i>	<i>2.0/1.0</i>	<i>2.5/2.0</i>	<i>3.0/2.0</i>	<i>3.5/1.0</i>	
<i>14.5 17.0</i>	<i>1.0/0</i>	<i>1.5/1.0</i>	<i>2.0/1.0</i>	<i>2.5/0</i>	
Dry cows	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	
Mineral (Ca, P, Mg)	Type III	<i>120 g per cow</i>			

Adjustments, when surplus/shortage of herbage allowance

Feed	<i>Beets</i>	<i>Prot.conc.</i>		
Surplus	<i>- 1.0 FU</i>	<i>- 1.0 FU</i>		
Shortage	<i>+ 1.0 FU</i>	<i>+ 1.0 FU</i>		

**Table 2. Principles for grassland utilization at continuous stocking with dairy cows.**

Recommendation for sward height in grazed area and area with rejected (mainly fouled) herbage.

Weeks after start of grazing	Planned sward height min. - max.	Planned area with rejected min. - max. herbage
0 - 8	5 - 7 cm <sup>1)</sup>	0 - 5%
8 - 16	4 - 6 cm <sup>1)</sup>	10 - 15%
16 - 24	4 - 5 cm	15 - 25%

*1) In older swards with high tiller/stolon density down to 3-4 cm sward height can be accepted before adjustment is needed.*

**Herbage shortage.** Sward height or amount of rejected area less than planned.

Use feed plan "shortage\*" or expand grazed area.

**Herbage surplus.** Herbage height or amount of rejected area more than planned.

- Rejected area >5% above planned area.

Use feed plan "surplus\*" or close up grazed area.

- Rejected area >10% above planned

Top the paddock or graze by young stock or silage after 3-6 weeks rest.

\* see foot of Table 1