MORE MILK FROM GRASS

THE IMPORTANCE OF FORAGE QUALITY

Danish Agricultural Advisory Service
National Centre

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Introduction

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

This little 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 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.

"More Milk from Grass" has been made in a cooperation between Danish Agricultural Advisory Services|National Centre and DLF-TRIFOLIUM A/S. We wish you pleasant reading and ask you kindly to contact us, if you have any comments or questions.

Denmark, February 2004

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Grass intake depends on quality

Cows are able to eat huge amounts of grass or clover grass 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 circle. The high forage intake affects the health of the cow in a positive way.

		% of dry matter		
Grass Quality	**Scandinavian Feed Units per kg Dry matter**	**NDF**	**Sugar**	**Digestible Protein**
Clover grass, 6-8 cm	0,97	36	11,0	19,3
Clover grass, 20 cm	0,91	40	12,0	16,5
Pure grass, 6-8 cm	0,95	41	12,0	17,5
Pure grass, 20 cm	0,89	45	13,0	14,7
Old grass	0,63	53	10,0	8,3

Table 1. Quality of grass and clover grass at different stages of development.
Feedstuff table, Composition and Feeding Value of Feedstuffs for Cattle, Report no 91, 2000.
The Danish Agricultural Advisory Service, National Centre.

See vocabulary on page 11 for explanations and definitions of the terms used in this booklet.

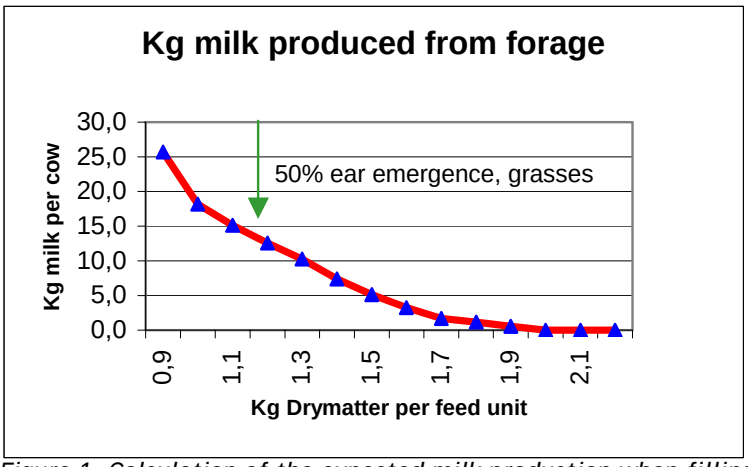

Figure 1. Calculation of the expected milk production when filling factors of the grass/silage and capacity of the rumen is used.
Danish Agricultural Advisory Service, National Centre.

Figure 1 shows how much milk a cow is able to produce when offered only silage or fresh grass of different qualities - e.g. when offered fresh grass of perfect quality a cow is able to produce approximately 20 kg milk per day. When offered poor quality hay with big stalks a cow will produce no milk based on the forage because the rumen is filled up with low quality hay, which only covers the energy for maintenance (approx. 6 KE or 72 MJ). The cow will still be producing milk but from energy released from body fat. The result will be a thin cow

and after some time milk yield stops. Practical use of these experiences is made especially in New Zealand and Ireland, where cows can reach 20 kg milk produced on quality pasture grass only and are fed quality hay/silage in dry periods.

What is good quality?

A number of parameters can be measured to determine if the forage quality is optimal. Table 2 lists some of the key figures. For explanations, see vocabulary page 11.

	Height of grass, cm	Scandinavian Feed Units	Digestible Protein, %	Crude Fibre, %	NDF %	Filling factor	Sugar %
Pasture grass	6 – 10 [1)]	> 1,1	16 – 18	< 20	< 40	< 0,4	> 8
Silage	20 – 30 [2)]	> 0,9	14 – 17	< 27	< 50	< 0,5	> 3,5

[1)] 6-8 cm in a continuous stocking system and 6 – 10 cm in a paddock system [2)] VersaMax 20 cm and CutMax 30 cm at cutting.

Table 2. Important key figures (content per kg dry matter) for optimal quality of fresh grass or silage

Consequently, the grazing system must be managed well to ensure a "good bite". The aim is to plan for a high and homogeneous quality (feed value). Short grass must ensure the high quality. In a continuous stocking system, the height of grass in general must be kept to 6-8 cm 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, fresh grass at all times, and a maximum feed intake in the paddock system, the cows must be moved regularly. One day in each paddock will ensure the above conditions. Moving cows two times a day is even better. 3 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.

When producing silage of high quality, an early cut is essential. The grass must be cut before any heading takes place. Good and careful silage making is the key to high quality forage and high milk yield per cow.

How to obtain the highest quality?

A. The right species and varieties of grasses and clovers must be chosen

The best feeding value can be obtained with a combination of ryegrass and clover. Depending on conditions, species with special features can be included. Ready-made mixtures exist covering most needs and conditions – see table 3.

	Management			
	Grazing and cutting	**Cutting**	**Grazing**	**Cut and 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**	**GrazeMax**	**CoverMax**
Remarks	For combined management. Persistent, tasty.	For silage. Very high yield.	High content of sugar, high palatability, tasty.	High yield, winter hardiness, ground cover.

Table 3. Grass mixtures prepared for different utilisations

B. The ley must be well established

A good, even stand of grass and clover is essential for good results. Sowing can take place in spring or late summer when conditions for germination are optimal. Sowing depth for grass and especially clover must not exceed 1 cm and the sowing rate should be adequate to ensure a safe and even distribution of plants – normally 25-35 kg seed pr. ha is recommended. Drill sowing ensures fast germination and cross sowing ensures a better distribution, hence an even covering of the surface which limits development of weeds.

C. The grass must be harvested/grazed at the right stage

As the grass develops and yields of dry matter increase, the quality decreases. With increasing number of stems in the crop, the digestibility of organic matter and cell walls declines. Also the content of protein is highest in spring.

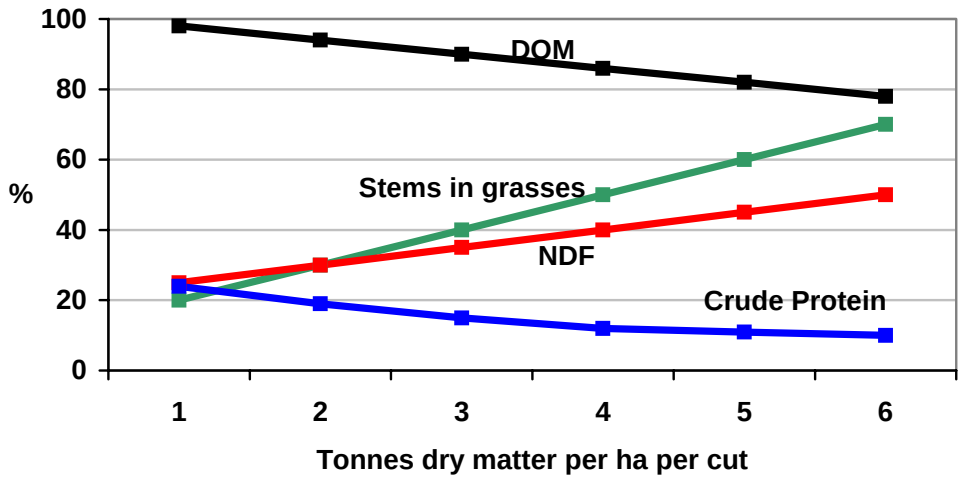

Figure 2. The grass development during growing season. Schematic illustration. DOM = Digestible Organic Matter, NDF: Neutral detergent fibre.

Figure 2 shows that grass yield between 2-3 tonnes dry matter contain a reasonable amount of fibre and protein. The energy density then depends on the content and digestibility of the fibre. Grass species, which do not produce early stems but a lot of leaves, are important for the cow's feed intake and productivity.

D. The grass must be mixed with clover and fertilised

A correct application of nutrients, mainly nitrogen, phosphorus and potassium, is essential. A high productive pasture demands 25-50 kg P, 150-400 kg K and 10-30 kg Mg, depending on expected yield and reserves in the soil. The recycling of P and K from cows manure will reduce the need for fertilizers. When day and night grazing is used, 75 kg K and 20 kg P from fertilizer will normally cover the extra demand.

Nitrogen application varies a lot depending on clover content and utilisation of the grassland. More than 50% clover in the pasture will normally cover the demand for nitrogen but on the other hand this might cause problems with the cows health, e.g. bloat, mastitis and other diseases related to feeding.

In general the demand for nitrogen is 1-2 kg per day per ha from April to July (3-4 months). 1 kg nitrogen is normal when clover content is more than 50% and 2 kg shall be applied when there is no or very little 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, this is easily done with nitrogen application.

	Energy content, Russian Feed Units per Kg Dry matter	**Digestible Protein, % of Dry matter**
The Effect of Nitrogen, applied end June		
30 kg N/ha	0,79	11,4
60 kg N/ha	0,82	15,1
90 kg N/ha	0,87	16,6
The Effect of Clover		
Late July: VersaMax, (+ clover)	0,80	21,5
Late July: Russian timothy, (– clover)	0,63	10,0
Late August: VersaMax, (+ clover)	1,09	13,0
Late August: Old pasture, (- clover)	0,86	6,1

Table 4. Effect of N-application and the use of clover on forage quality.
Results of demonstrations in Ruchyi and Novgorod, Russia, 2002 executed by DAAS, National Centre.

Receive further information about fertilizing in the booklet "Grass for Cattle" including recommendations for seasonal application according to expected yields.

Table 4 shows that the application of nitrogen increases the content of protein in dry matter as well as improves the energy concentration. It is important to focus on the content of nutrients per kg dry matter.

Use of clover has the same effect – in other experiments it was shown, that 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 the intake by grazing animals of 10-20 % and distributes the production more evenly over the summer, due to a different growth rhythm to grasses (see figure 3).

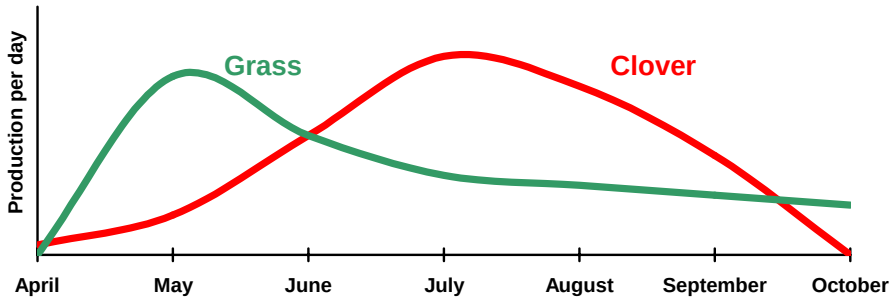

Figure 3. Standardised growth curves for grass and clover, production per day. DLF-TRIFOLIUM.

An experiment carried out in Poland showed that application of 1 kg Nitrogen per ha increases the grass yield 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 mixture was similar to VersaMax. See table 5.

Experiment no.	Kg Nitrogen per ha	Kg Dry matter per ha	Scand. Feed Units per kg Dry matter	Feed Units per ha	Protein, % of Dry matter	Protein, gram per Feed Unit	Dry matter kg per kg Nitrogen
1	48	3441	1,02	3510	10,0	98	9
2	95	3895	1,04	4051	15,5	150	9
3	113	4051	1,06	4294	16,9	159	9
4	145	5018	1,01	5068	11,9	118	14

Table 5. Nitrogen response at first cut of grass.
Results from Dairy demonstration farms in Olsztyn in North East Poland, Danish-Polish Project: Olsztyn 1999-2001. Danish Agricultural Advisory Service (DAAS), National Centre.

Similar results have been obtained in Denmark at the Danish Institute of Agricultural Sciences, Foulum (table 6). For every kg N on average 13 kg of dry matter per cut was obtained. 5,700 kg dry matter was harvested in the first cut when 75 kg N was applied in the spring. The quality of the grass was also improved.

		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 6. Nitrogen application to grass, 2000 – 2001.
"Bilag til Grovfoderdag", The Danish Institute of Agricultural Sciences, Foulum, 2000–2001.

E. Silage must be made very carefully
The process of silage making is important to obtain satisfactory quality to ensure a high milk yield per cow.

Processing:

1. 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.

2. Harvest the grass within 24 hours if there has been no rain and the content of dry matter is more than 30%

3. Execute a fast clamp processing. Distribute the grass evenly and press it

4. Prepare the silage pit or clamp with foil before filling using only high quality foil, which fits the size of the pit or clamp. E.g. 14m x 50m x 0,15 mm

5. Seal the silage tightly with 2 layers of foil and cover with an animal safe cover. Armed foil can be used (it is possible to use again for up to 10 years) or a 10 cm thick layer of sand without stones. The last option provides the safest cover

6. Alternatively round bales of grass wrapped with 6 layers of foil also ensure high quality fermentation but is more expensive. The content of dry matter must be 45-50%

Use of additives for preservation is recommended if:

- The content of dry matter is < 28% after 2 days of wilting, which limits a proper fermentation
- There is more than 60-70% clover in the crop, which makes the silage dark or black
- There is a risk of pollution with soil, which limits the fermentation

No additive is able to replace a good silage technique, but sometimes can improve the silage quality. For choice of the correct additive, please see the booklet booklet "Ensiling – a craftsmanship".

The best silage quality is obtained when:

1. A fast wilting of the grass to 30-35% dry matter is obtained. (Wrapped bales 45-50% DM)
2. The silage has a moderate content of crude protein, 16-18% in DM
3. Some sugar is left after fermentation, 3-5 % of DM

Quality parameters:

- High energy concentration in the dry matter (> 7 MJ $_{NEI}$)
- Medium Protein content (16-18%)
- Low amount of ammonium (< 8% of total N)
- Tasty (High content of sugar ensures a good taste)

Risks when above qualities are not obtained:

- Low feed intake
- Low milk yield
- Anaerobic spores in the milk. These can spoil cheese production
- Wet, mouldy or rotten silage

Grass and silage intake

Grass and silage intake must 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 the dry matter: Filling factor of the crop and filling capacity of the cow
- Taste of the grass and silage
- Short and young pasture grass, rich in leaves. No stems and weeds
- High quality of silage in the trough 24 hours a day (more time feeding per day)

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.

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. 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 of the forage – good palatability increases intake.

Water-soluble Carbohydrates, Sugar
Mono- and disaccharides, fructanes, % 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%.

Annex

Practical experiences
Executed by Danish Agricultural Advisory Service, National Centre.

Project I:

The experiment
A demo group of 175 cows on a farm near Novgorod in Russia were grazing a 25,5 ha demo pasture with the VersaMax grass mixture found to be very suitable for Russian conditions. The quality and amount of available grass at the 25,5 ha demo pasture was very satisfactory. The VersaMax group was compared to a general group of 160 cows grazing an old local pasture. On average 5,300 Russian feed units (KE) were utilised per ha. The cost per KE was 0,30 Roubles, which is very cheap.

Milk production
The demo group increased the milk yield by 500 kg on average per day during a grazing period of 88 days on VersaMax from mid may to mid june (fig 4). The milk yield increased by 1.9 kg per cow. The total milk production per cow amounted to 1,509 kg or 17,1 kg per day. The average milk production from all cows rose from 4,509 to 5,125 kg, an increase of 616 kg.

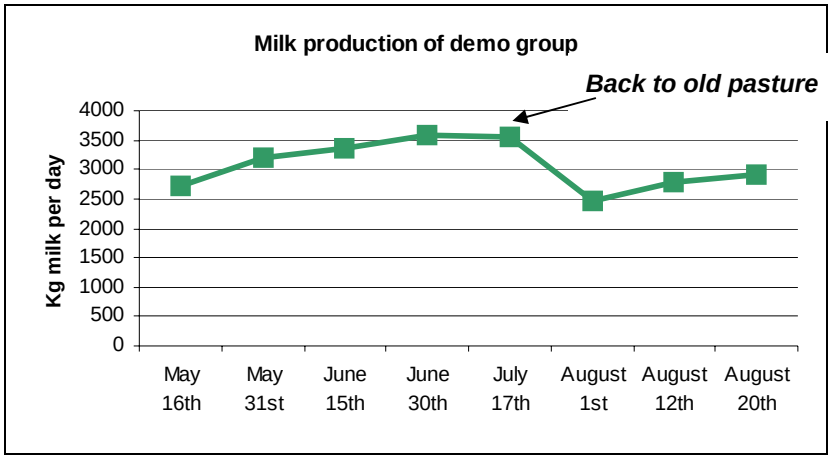

Figure 4. The daily milk production from cows grazing the demo pasture. DAAS, National Centre, International department (2002).

The milk yield dropped 1000 kg, when the cows were moved to another pasture by the end of July.

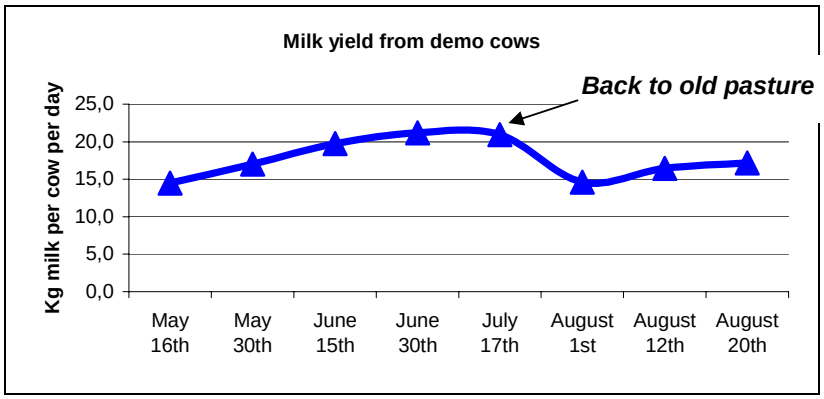

Figure 5. The average daily milk production per cow from the demo group DAAS, National Centre, International department year 2002.

By the end of July the milk yield dropped approximately 5 kg per cow per day when moved to the old local pasture. The reasons were a complex of bad grass quality, lack of water and hot weather. When the cows returned to the demo pasture the yield again, after a couple of weeks, increased to 3,000 kg per day. This move from VersaMax to the old pasture and back again cost at least 15,000 kg milk or 80,000 Roubles.

The daily grass gain in VersaMax was approximately 100 KE per ha per day in June. The grass was growing extremely fast in spring and the cows were not able to eat all of it, so 10 ha were cut for silage.

Project 2:

The experiment

A demo group on a farm near Pskov in Russia consisting of 78 cows grazing a 50 ha VersaMax pasture established in 2001. A general group consisting of 169 cows were grazing old local pastures and a ryegrass/white clover pasture.

Milk production

The demo group increased the milk yield by 310 kg more than the general group. The total milk yield of the demo group during 2002 was 6,570 kg per cow and the yield of the general group was 6,210 kg.

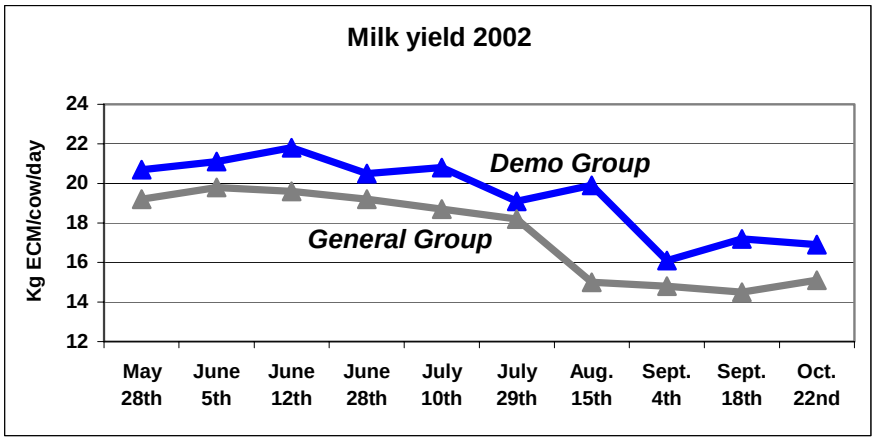

Figure 6. Milk production in experiment carried out in Pskov, Russia Demo group consists of 78 cows and general group of 169 cows.

On average the demo group produced 1,9 kg more milk per cow per day than the general group. Based upon the total grazing period of 138 days this adds up to +262 kg milk per cow or 20,450 kg in total.

Cow group	2002	2001	2000	2002-2001
All cows	6350	5200	4800	+1150
Demo group	6570	5235		+1335
General group	6210	5184		+1026

Table 7. The average amount of milk produced per cow per year before and during the project period

The demo group increased the milk yield by 1,335 kg from 2001 to 2002 and the general group increased by 1,026 kg, which adds up to 1,150 kg per year per cow in average as seen in table 7.

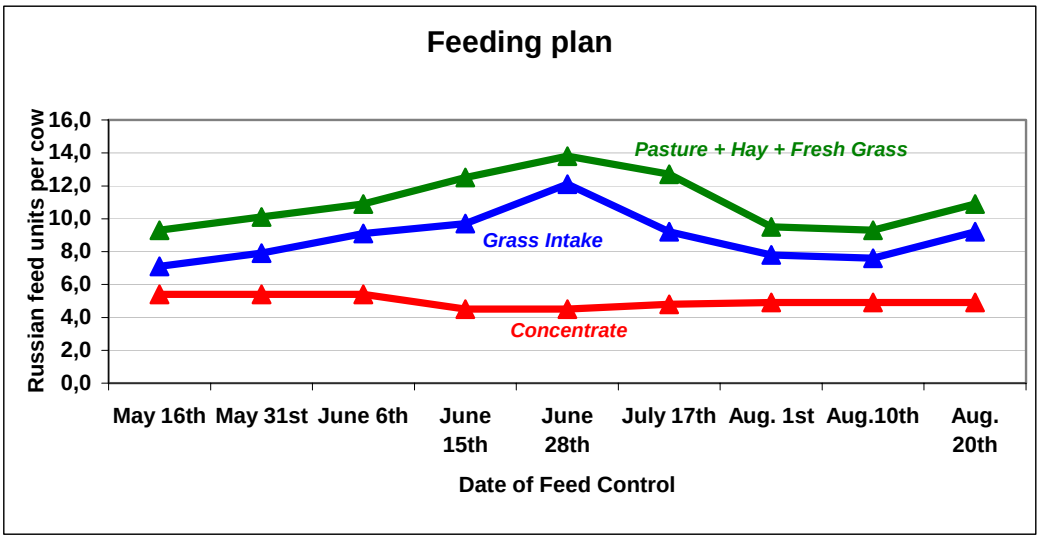

Figure 6. Feed intake by cows during grazing period at 138 days.

The grass intake was not very high (max. 12 Russian Feed Units, June 28) because the cows were only on pasture during the day, 8-10 hours. The average grass intake was 9 Russian Feed Units per cow per day or approximately 1 Feed Unit per hour. The feed recipe included grass or lucerne in the barn during the entire summer. About 5 kg concentrate of 15% protein on average fed per cow (250-300 g per kg milk depending of grass condition)

"CutMax" yields, year 2003

In year 2002, 29 ha in Pskov were established with CutMax, which was only for silage production. In autumn 2002 the crop was used for grazing heifers. In spring 2003 the crop was not fertilised at all. The crop developed extremely fast and killed all kinds of weeds. The yield of first cut in a test harvested on July 3 was 29,5 tonne fresh grass; 6,500 kg dry matter or 4,600 Russian Feed Units. The second cut appx 3,000 feed units per ha. In total 3 or 4 cuts can be utilised..

Project 3:

A practical experiment with Danish clover grass mixtures has been carried out on the farm Ruchyi near Sct. Petersburg. DAAS, National Centre has, in cooperation with local specialists, been responsible for the experiment.

Ruchyi Farm:

950 cows fed mainly on wilted grass silage. During the experimental period all cows were fed with fresh grass for one week.

The experiment:
Three different mixtures were sown in spring 2000 under a cover crop of spring barley and vetches:

A. 9 ha local Mixture consisting of timothy + red clover
B. 10 ha Danish Mixture VersaMax with white clover, ryegrass, timothy, meadow fescue and meadow grass
C. 10 ha Danish Mixture with red clover, white clover and ryegrass.

In 2000, one cut was taken for silage. In 2001 the first cut (June 4-7) was fed as fresh grass for one week. For the following three weeks, the cows were given fresh grass with declining quality from the existing local mixture. The two following cuts (July 3-4 and August 29) of the experimental mixtures were ensiled.

Foto from Ruchyi Farm

Registrations 2001:
The total yield of the three mixtures is estimated to be approximately 8,500 tonnes dry matter per ha.

Date	Feed*	Kg milk, total per day	Difference from 12/6	Kg milk per cow per day	% fat in Milk	% protein in Milk	Kg 4 % milk pr. cow/day
16.5	Silage	14.137	**-3.157**	15,1	3,50	3,00	13,7
05.6	Fresh, Mixture B+C	16.348	**-946**	18,0	3,48	3,02	16,3
12.6	Fresh, Mixture A	17.294	**0**	19,0	3,22	3,02	16,6
20.6	Fresh, Mixture A	16.333	**-961**	17,9	3,16	3,03	15,5
30.6	Fresh, Mixture A	15.121	**-2.173**	16,5	3,48	3,03	15,0
20.7	Silage	13.477	**-3.817**	14,7	3,46	3,00	13,3
07.8	Silage	13.991	**-3.303**	15,3	3,40	2,99	13,7
20.8	Silage	13.896	**-3.398**	15,0	3,37	2,98	13,4
26.8	Silage	14.400	**-2.894**	15,5	3,25	2,88	13,5

* Silage is wilted, traditional silage from 2000. Mixture A is fresh grass from the existing field. Mixture B+C is a blend of fresh grass from the experiment mixtures.

Table 8. Results of trials with Danish and local grass mixtures, Ruchyi Farm near Sct. Petersburg, Russia 2001.
Figures prepared by the DAAS, National Centre, International department.

The milk yield per cow (including dry cows) increased around 3 kg/day when the feed was changed from silage to fresh, highly digestible grass. However, the milk yield dropped back to the previous level with increasing age and decreasing quality of the fresh grass. The milk yield of the demo group of 55 cows is approximately 7000 kg 4 % milk per year.

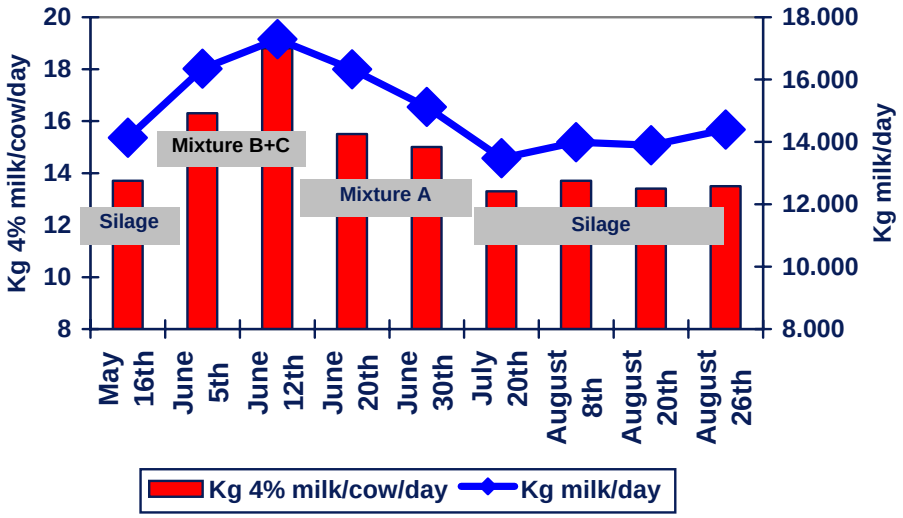

Figure 7. Results of trials with Danish and local grass mixtures, Ruchyi Farm near Sct. Petersburg, Russia 2001.
Figures prepared by the DAAS, National Centre, International department.

Conclusions:

- The milk yield increases when changing from silage to fresh grass
- The milk yield is higher when the fresh grass is young = more digestible and with higher feed intake per cow
- The milk yield increases when the feed consists of very leafy species of perennial ryegrass with high sugar content and white clover compared to older, more stemmed species and varieties
- If Ruchyi Farm had been able to keep the high milk production from the Danish grass for the whole 90 day period, the result would have been:

180.000 kg more milk = 900.000 Roubles in extra income
(If price for milk = 5 Roubles/kg)
This equals 10.000 Roubles pr. day

Søren Leerskov, Mission Report from the DAAS, August 2001.

Literature about forage quality

1. "Ensiling, - a craftsmanship". Languages: Danish, English, Russian and Polish. The Danish Agricultural Advisory Service, 2003. ISBN 87 7470 8457.

2. "Feed Stuff table", report no 91, 2000. The Danish Agricultural Advisory Service, National Centre

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

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

5. "Dyrkning af grovfoder". 3rd edition, The Danish Agricultural Advisory Service, 2000

6. "Bilag til Grovfoderdag, 2003". The Danish Agricultural Advisory Centre.

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