Forage Production, Utilization and Environmental Conservation in Sweden

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Abstract

There are totally 1.5 million ha of grassland in Sweden of which 70 percent is temporary in rotations on arable land. Temporary grassland is the dominating crop with 40 percent of the arable cropping area. The climate is cold temperate and winter damages are common in the grasslands. In the North, where farming is done up to 66˚N latitude, light conditions are extreme, which gives higher energy content in the forage. Timothy (*Phleum pratense* L.), meadow fescue (*Festuca pratensis* L.) and red clover (*Trifolium pratense* L.) are the dominating species. Contrary to the intensive grasslands in Europe, it is very common to use a mixture with grasses and legumes. Silage maize can only be grown in very south where the temperature sum is high enough. The area of silage maize is rapidly increasing due to new varieties. Larger milk yield per cow has increased the requirement for herbage with higher nutrient quality. This has lead to earlier cuts and increasing number of cuts. Due to the long winter season a large part of the forage is conserved as silage. In 2009, Sweden had about 350 000 dairy cows on nearly 6 000 farms. About ten percent of the milk farms have organic production. Efforts to reduce N-losses to the environment are done by developing grazing systems and total feeding rations that increase N utilization. Also slurry injection into grassland has advantages over slurry spreading as it decreases ammonia losses and odour and improves forage hygiene.

Climate

Sweden is situated between the latitudes 55˚N and 69˚N and the climate is cold temperate and winter damages are common in the grasslands, especially in red clover. In the North, light conditions are extreme, which gives higher energy content in the forage. Due to the long winter season a large part of the forage is conserved as silage.

The forage production in Sweden

There are totally 1.5 million ha of grassland in Sweden of which 70 percent is temporary in rotations on arable land (Table 1). This proportion is much higher than in many other European countries (Søegaard *et al.*, 2007). Temporary grassland is the dominating

Table 1. Arable grassland permanent grassland and other arable crops in Sweden 2005-2010 in million ha. Source Swedish Agricultural Board (2010).

Crop	2005	2006	2007	2008	2009	2010*
Cereals	1.01	0.96	0.97	1.09	1.05	0.97
Arable grassland	1.03	1.06	1.08	1.11	1.18	1.21
Permanent grassland	0.51	0.51	0.49	0.46	0.44	0.45
Others	0.67	0.64	0.59	0.43	0.42	0.44
Total area	*3.22*	*3.17*	*3.14*	*3.09*	*3.08*	*3.08*
Permanent grassland, percent	16	16	16	15	14	15

*Preliminary values

crop with about 40 percent of the arable cropping area (Table 2). Interestingly this percentage has steadily increased the last six years. The temporary grasslands in Sweden are mainly established in the spring and cut two-three times during two-four years (Søegaard, 2007). Larger milk yield per cow has increased the requirement for herbage with higher nutrient quality. This has lead to earlier cuts and increasing number of cuts.

Silage maize has been a very minor crop in Sweden so far in area compared to the temporary grassland. The silage maize can only be grown in very south where the temperature sum is high enough. But the last ten years the area under silage maize has increased more than five times as seen in Table 2. An important factor in this change has been new released varieties, which are better adapted to the climate.

Table 2. Arable grassland and other arable crops in Sweden 2001-2010 in million ha. Source Swedish Agricultural Board (2010).

Crop	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*
Cereals	1.15	1.11	1.13	1.11	1.01	0.96	0.97	1.09	1.05	0.97
Arable grassland	0.93	0.94	0.93	0.93	1.03	1.06	1.08	1.11	1.18	1.21
Others	0.62	0.63	0.61	0.62	0.67	0.64	0.59	0.43	0.42	0.44
Total arable land	*2.69*	*2.68*	*2.67*	*2.66*	*2.70*	*2.66*	*2.65*	*2.63*	*2.64*	*2.63*
Arable grassland, percent	35	35	35	35	38	40	41	42	44	46
Silage maize, thousand ha	3.0	3.9	4.0	5.3	5.8	7.5	10.8	13.1	16.1	16.5

*Preliminary values

The number of species used in the Swedish grasslands are high, especially the number of grass species (Table 3). Species marked with M are main species in Sweden according to Søegaard (2007). These species are also dominating in Norway and Finland. When moving more south in Europe, perennial ryegrass and white clover then becomes the main species. Among the grasses, there is an increasing use of perennial ryegrass and festulolium in Sweden, especially in more favourable locations.

The type of farming varies a lot in Sweden, which is illustrated by Figure 1. Most grassland on arable land (28 %) is found is on the high lands in the south Sweden, indicated by animal production dominating symbol on the map. This area, which goes across Sweden, is popular called the Animal belt.

Table 3. Forage species used in Swedish grasslands

	Perennial forage legume species		**Perennial forage grass species**
M	Red clover (*Trifolium pratense* L.)	M	Timothy (*Phleum pratense* L.)
M	White clover (*Trifolium repens* L.)	M	Meadow fescue (*Festuca pratensis* Hudson.)
	Lucerne (*Medicago sativa* L.)		Perennial ryegrass (*Lolium perenne* L.)
	Alsike clover (*Trifolium hybridum* L.)		Festulolium (*Festulolium*)
	Bird's foot trefoil (*Lotus corniculatus* L.)		Hybrid ryegrass (*Lolium x boucheanum*)
			Italian ryegrass (*Lolium multiflorum* Lam.)
			Cocksfoot (*Dactylis glomerata* L.)
			Kentucky bluegrass (*Poa pratensis* L.)
			Red fescue (*Festuca rubra* L.)

M= main species

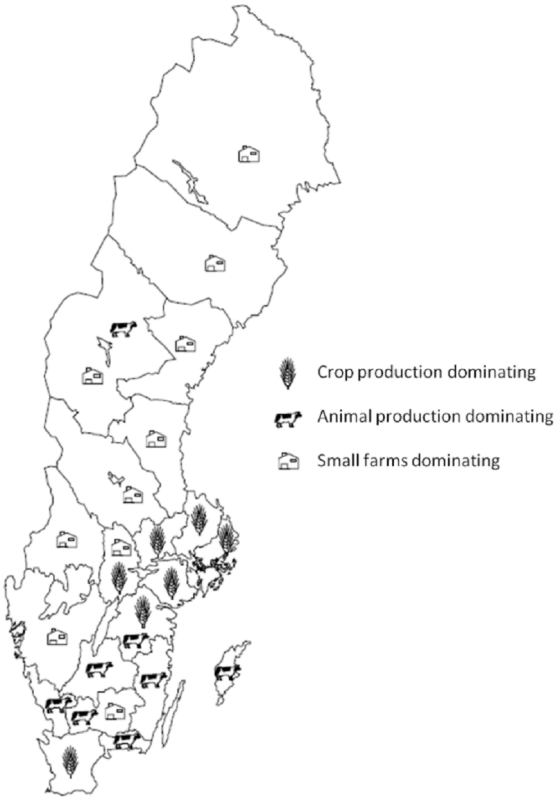

Fig. 1. Dominating type of farms in different regions in Sweden. From Statistics Sweden (2010) page 44.

The dairy and animal production in Sweden

In 2009, Sweden had 357 000 dairy cows on 5 883 farms (Table 4), which means that an average farm had about 60 dairy cows in 2009. There has been for a long time a change to larger farms. The amount of organic produced milk is increasing and in January 2010 about ten percent of the milk farms have organic production (Table 4).

In Table 5, the number of bovine animals, sheep's and lambs in 2007 are reported. Note the decrease in number of dairy cows between 2009 and 2007 (Table 4 and 5).

Seed mixtures in grasslands

Contrary to the intensive grasslands in Europe, it is very common to use a mixture with grasses and legumes in Sweden. In Table 6, two examples are given of mixtures from a seed company in Sweden (SW Seed, 2008). SW 932 in this example is robust mixture for cutting leys with 2-3 harvests per year. SW Ares is a new sustainable variety bread for southern Sweden. SW 843 on the contrary, is a mixture for an intensive and high production meaning 3-4 harvests per year ore combined with grazing. It has two varieties of perennial ryegrass, two of timothy and two of meadow fescue, which are of different types and make the mixture more flexible. Diversity of clover species in grass-clover swards can contribute in first hand to the stability of yield, but does not always mean greater herbage yields (Frankow-Lindberg *et al.*, 2009).

Natural grasslands

The area of semi-natural grasslands in Sweden has been decreasing for a long time in Sweden. In a survey, based on old maps, it was calculated that dur-

Table 4. Structure of dairy sector in Sweden in January 2010. Source: The Swedish Dairy Association (2010).

Description	Value
Number of dairy companies	21
Number of processing plants	36
Number of livestock cooperatives	7
Number of semen-producing companies	2
Number of breed societies	9
Number of dairy farmers	5 883
of which organic	512
Number of dairy cows (June 2009, thousands)	357
Average of cows per herd	59
Total milk delivered Mkg (2009)	2926

Table 5. Livestock numbers in 1 000 head in year 2007

Description	1 000 head
Dairy cows	370
Suckler cows	186
Total cows	*556*
Heifers, bulls and steers older than one year	516
Calves younger than one year	489
Total bovine animals	*1 560*
Ewes and rams	242
Lambs	267
Total sheep and lambs	*509*

Table 6. Example of two seed mixtures from a seed company in Sweden. The percent is the seed weight in the mixture. The variety name is before the name of the species

SW 843 Intensive South	**SW 932 All round Basic**
3 % Sara red clover	5 % SW Ares red clover
3 % SW Ares red clover	5 % Sara red clover
4 % Ramona white clover	65 % Ragnar timothy
20 % Ragnar timothy	25 % Sigmund meadow fescue
15 % Grindstad timothy	
15 % Sigmund meadow fescue	
10 % Tyko meadow fescue	
10 % Malta perennial ryegrass	
10 % Leia perennial ryegrass	
10 % Storm hybrid ryegrass	

ing the last 200 years in 12 landscapes in South-east Sweden, the land-cover of semi-natural grasslands has decreased from 83% to 17% (Cousins, 2009). In a field survey, the semi-natural grasslands in these 12 landscapes had a species richness of 9-29 species m^2.

Environmental conservation

The ecological value and the food production possibilities of the agricultural landscape and the agricultural land are protected in Sweden. In 1999, the Swedish Parliament adopted 15 national environmental quality objectives, and one more has been added since then. These objectives describe what characteristics the natural and cultural environment must have for a more sustainable development of the society. Among the 15 goals, these three objectives apply to the agriculture:

- a varied agricultural landscape
- zero eutrophication
- a non-toxic environment.

These three objectives include the following:

– Existing biodiversity must be preserved by long-term management strategies.

– Small biotopes are to be preserved and also created in the plain districts.

– Nutrient leaching and use of chemical plant protection products shall be reduced.

The objectives shall be reached through legislation, financial instruments, information, extension services, and training.

Efforts to reduce N-losses to the environment are done by develop grazing systems and total feeding rations that increase N utilization. To improve the technique of spreading the manure is also important. Slurry injection into grassland has advantages over slurry spreading as it decreases ammonia losses and odour and improves forage hygiene, but it can increase the nitrous oxide (N_2O) production. However, in spite of the reduction in ammonia emissions, Rodhe et al. (2006) reported little or no effect on yield from the injection technique compared with surface spreading. The most common explanation given for this is that damage to the grass sward caused by injector tools balances out the larger amount of ammonium nitrogen left after slurry injection. If the injection equipment as shown in Fig. 2 is used without slurry, a yield reduction up to 3-9% can occur (Rodhe and Halling, 2010).

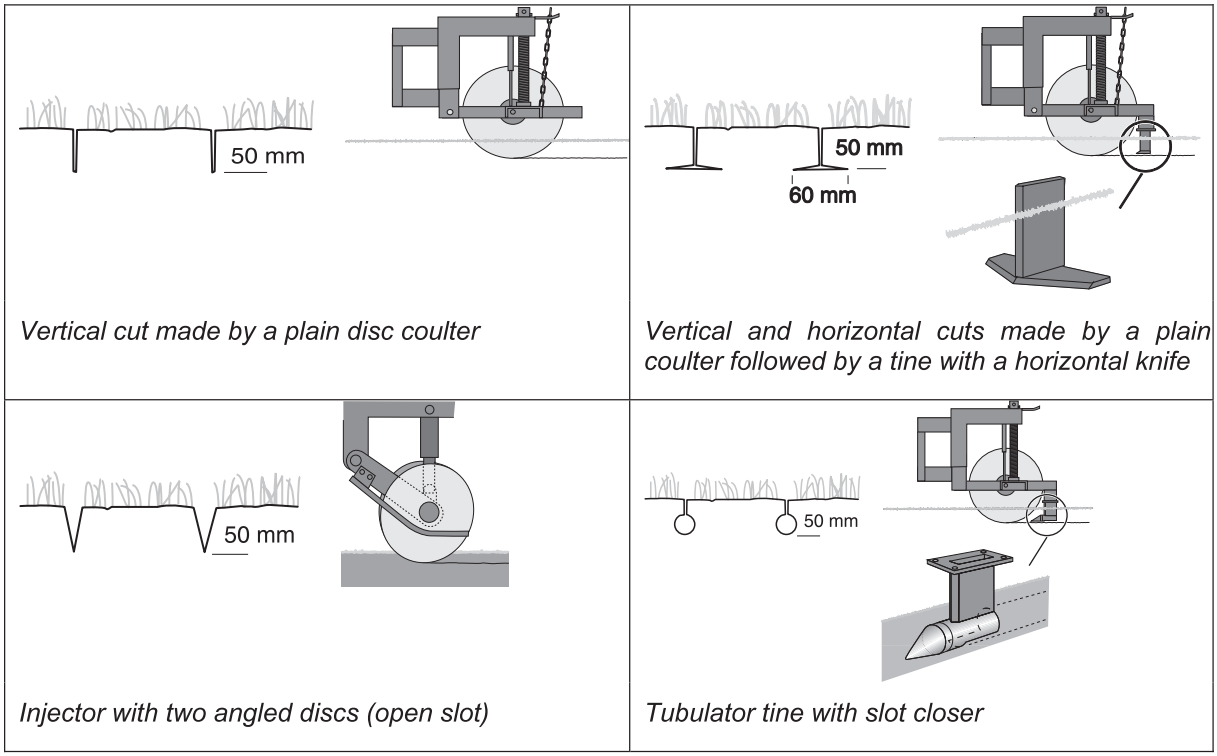

Fig. 2. Different techniques for injecting manure into a grassland sward.

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