

Species-rich grasslands for a higher biodiversity on highly productive dairy farms

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Abstract

During the past decade trials have shown the value of species-rich grasslands for farmland biodiversity. On four highly productive dairy farms, where farming was combined with management of species-rich grasslands and habitat creation for meadow birds, we analysed the value of these species-diverse swards with respect to grass production and quality, farm management and biodiversity. Compared with grass, herbs and legumes generally contained higher levels of minerals and their herbage offered more structure in the cattle diet. Speeding up the creation of species-diverse swards is possible by reseeding with species-rich mixtures. On these farms a species richness of 17-30 species per 100 m² was obtained. Previous research showed that replacement of 25-30% *Lolium perenne* silage by silage from comparable species-rich swards is possible without a decline in milk production. When highly productive dairy farms create species-diverse swards on part of their acreage, it will be possible to produce healthy forage while also providing a good habitat for meadow birds.

Keywords: species-rich grassland, dry matter production, mineral composition, dairy farming, biodiversity

Introduction

The appreciation of herbs and legumes in grassland swards is increasing. Herbs and legumes support animal health and contribute to increasing farmland biodiversity. Many highly productive dairy farms are working on the edge, which causes extra costs due to health problems. Acidification of the rumen is a problem on one third of Dutch farms, caused by a biased ration of grass, maize and concentrates with high levels of energy and protein. Roughage that is rich in structure (fibres) can reduce the acidification considerably (Bruinenberg *et al.*, 2006). Moreover, various herbs and legumes contain high levels of healthy components, which, for instance, have a positive effect on the fatty acid composition of milk (Moloney *et al.*, 2014). In general, herbs and legumes contain higher levels of minerals and trace elements than grass species (Fisher *et al.*, 1996; Pirhofer *et al.*, 2011).

We performed a number of experiments to re-introduce species-rich grassland by sowing species-rich seed mixtures (Korevaar and Geerts, 2009, 2012). The experiments showed that many of the re-introduced species were relatively persistent in the swards, and under low-fertilized conditions these species-rich grasslands can compete with *Lolium perenne* swards for production. Next, we tested the value of species-rich grasslands on dairy and beef farms (Geerts *et al.*, 2014). In this paper we present the results obtained on four dairy farms that combined a highly productive dairy herd with species-rich grasslands on part of their fields.

Materials and methods

In 2012 a farm network was established in the Netherlands. The network consisted of 10 dairy and beef farms, a bird protection agency, research and advisory organisations, agricultural colleges, a province, and a seed company. On some farms species-rich grasslands had already been sown before the start of the network which made it possible to analyse the value of well-established swards for dairy production, farm management and biodiversity.

Species-rich seed mixtures were collected from an *Arrhenatheretum elatioris* community and sown in autumn 2002 on fields of two farms (Tervoert and Esselink) in Winterswijk (Province of Gelderland). Cattle slurry (18 Mg ha⁻¹) was applied annually to the swards. The swards were cut two or three times per year. On the farm De Kleijne, on a dry sandy soil in Landhorst (Province of Noord-Brabant), three different seed mixtures were sown in October 2005: a seed mixture of 9 grass species, 3 legumes and 4 herbs; a seed mixture collected from an *A. elatioris* community; and a seed mixture of 4 grass species dominated by *L. perenne*. Cattle slurry (20 Mg ha⁻¹) was applied annually to these swards. On the farm Agema, on a fertile clay soil in Kollumerpomp (Province of Friesland), the *A. elatioris* mixture was sown in 2011. In 2013 the established sward received farmyard manure (15 Mg ha⁻¹) and was harvested twice. Species composition and dry matter production were monitored on all farms. On the farms in Winterswijk and Landhorst the feeding value and mineral content were measured in fresh grass samples. On the farm in Kollumerpomp the samples were taken from wilted silage.

In addition to the monitoring programme we performed a literature survey to compare the mineral content of a number of legume and herb species with the minerals in grass species.

Results

The four farms studied produced more milk cow⁻¹ than the Dutch average of 8,000 kg year⁻¹ and there was also a lower concentrate consumption per cow on three of the farms (Dutch average: 2,110 kg cow⁻¹ year⁻¹). On three farms the milk production ha⁻¹ was lower than the Dutch average of 14,670 kg ha⁻¹ year⁻¹ (Table 1).

Data on the grass or silage composition are presented in Table 2. The results of the farm in Landhorst show that under conditions of low inputs of manure, the species-rich swards can compete with *L. perenne* swards in terms of productivity, content of minerals and trace elements and the feeding-value parameters of the herbage. The overall production on this farm was low due to the limitations of the dry sandy soil. In Winterswijk and Kollumerpomp soil fertility and moisture conditions were more favourable. From the literature survey (results not shown here) we concluded that, in general, the content of minerals and trace elements in herbs and legumes is significantly higher than in grasses.

Discussion and conclusions

Compared to grass species, herbs and legumes generally contain higher levels of minerals and offer more structure in the diet, whereas their digestibility is only slightly lower. Earlier research showed that replacement of 25-30% of *L. perenne* silage by silage from species-rich swards showed no negative impact on milk production (Bruinenberg *et al.*, 2006). In addition to this, farmers are able to contribute to the meadow bird biodiversity, as the plant species mixture attracted a range of insects, which are main component in the diet of young birds (Kentie *et al.*, 2013).

Table 1. Some characteristics of the four dairy farms (year 2013).

Farm	De Kleijne (Landhorst)	Tervoert (Winterswijk)	Esselink (Winterswijk)	Agema (Kollumerpomp)
Soil type	sand	sand	sand	clay
Total grassland (ha)	32	44	31	70
Silage maize (ha)	14	16	9	10
Other crops (ha)		4	1	10
Dairy cows (number)	83	66	48	95-100
Milk (kg cow ⁻¹ year ⁻¹)	8,500	9,185	9,300	12,000
Milk (kg ha ⁻¹ year ⁻¹)	15,400	10,072	11,250	13,000
Concentrates (kg cow ⁻¹ year ⁻¹)	1,870	1,956	2,190	ca. 2,050
Species-rich grassland (ha)	15	4.5	3.5	15

Table 2. Species numbers, dry matter (DM) production, net energy content and mineral and trace element composition of species-rich grass compared to a *Lolium perenne* sward at low manure applications.

	Farm					
	De Kleine			Tervoert and Esselink		Agema
Soil type	Dry sandy soil			Sand		Clay
Experimental details	Fresh grass, average of 2 cuts a year			Fresh grass, 2 or 3 cuts a year		Silage from 1 st and 2 nd cut of one field
Years	2006-2010			2005-2010		2013
Fertilisation	20 Mg cattle slurry ha ⁻¹ year ⁻¹			18 Mg cattle slurry ha ⁻¹ year ⁻¹		15 Mg farm yard manure ha ⁻¹ year ⁻¹
Seed mixture	Species-rich	<i>A. elatioris</i>	<i>L. perenne</i>	<i>A. elatioris</i>		<i>A. elatioris</i>
Species (numbers 100 m ⁻²)	17 b ¹	22 c	13 a	28		30
DM yield (t ha ⁻¹)	4.9 a	4.7 a	4.4 a	8.0		7.8
Net energy (MJ kg ⁻¹ DM)	5.08 a	4.87 a	5.26 a	5.04		5.09 5.42
Sugar (g kg ⁻¹)	90.5 a	100.6 ab	109.9 b	107.0		123 96
Crude protein (g kg ⁻¹)	107.7 b	90.2 a	99.4 ab	100.2		85 154
P (g kg ⁻¹)	3.7 a	3.6 a	3.6 a	3.6		2.9 3.8
K (g kg ⁻¹)	23.8 a	21.2 a	22.4 a	19.1		24.7 27.5
S (g kg ⁻¹)	2.1 a	2.1 a	2.3 a	2.0		12 3
Na (g kg ⁻¹)	0.6 a	0.7 a	0.5 a	2.4		0.9 2.4
Ca (g kg ⁻¹)	6.4 b	4.7 a	4.7 a	7.8		8.0 13.1
Mg (g kg ⁻¹)	2.6 b	2.0 a	2.1 a	2.5		1.9 2.9
Fe (mg kg ⁻¹)	93 a	85 a	79 a	195		571 272
Zn (mg kg ⁻¹)	94 b	65 a	71 a	66		25 3.8
Mn (mg kg ⁻¹)	228 a	316 b	220 a	230		65 130

¹ Different letters in a row: parameters are different $P \leq 0.05$.

Speeding up the creation of species-diverse swards is possible by reseeding with species-rich seed mixtures. The persistence of these swards is good, if there are adaptations in the management and fertilization level. When highly productive dairy farms create species-rich swards on part of their acreage, it will be possible to produce healthy forage while providing a good habitat for meadow birds.

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