Forage botanical and chemical composition on dairy farms with different grassland systems and production systems

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Abstract

Thirty-two dairy farms in Middle-Norway with different grassland systems (short-term (<4 years) grassland (S) or long-term (>7 years) grassland (L)) and different production systems (organic (O) or conventional (C)) were compared in a field study in 2007. In a principal component analysis on variables including farm details, botanical composition and chemical forage composition, the farms were separated into organic and conventional farms with the exception of one farm. Amongst the organic farms most SO farms were distinguished from LO farms. Concentration of forage crude protein was positively correlated with proportion of grass. Concentration of non-fibrous carbohydrates, in vitro digestibility and net energy lactation was positively correlated with proportion of legumes. Species diversity and cutting time at first cut was positively correlated with proportion of non-legume herbs.

Keywords: Grassland system, production system, botanical composition, dairy farming, feed composition

Introduction

The choice of how grassland is managed on dairy farms affects the botanical composition and the herbage chemical composition. Besides choice of seed mixture, climatic conditions, soil-chemical conditions, grassland duration, harvesting time, frequency of cuts and fertilization affect the community of plant species. Wachendorf and Taube (2001) found higher proportion of white clover (*Trifolium repens* L.) and lower proportion of grass in the herbage of long-term organic grassland compared to long-term conventional grassland in Northern Germany. Herbage botanical composition can alter fatty acid composition in milk (Dewhurst *et al.*, 2003; Leiber *et al.*, 2005). In coastal or mountainous regions in Norway with high precipitation, soil tillage is often difficult and long-term grasslands are more common in contrast to regions where conditions are suitable for grain production and where short-term grassland typically is part of a crop rotation. Organic and conventional production systems are present in both regions, but with different adaptation according to specific conditions in each production system. The objective of the current field study was to examine the relationship between farming system, forage botanical composition and the herbage chemical properties.

Material and methods

Thirty-two dairy farms in Middle-Norway participated in 2007 in a field study with the objective to study effects of grassland system (short-term (<4 years) grassland (S) or long-term (>7 years) grassland (L)) and production system (organic (O) or conventional (C)) on milk quality. Nine SO farms were paired with nine SC farms and seven LO farms were paired with seven LC farms matched by proximity and calving pattern (Table 1). Every second month feed samples in addition to tanker milk samples were collected from each farm and analysed for chemical composition. Botanical composition on three fields per farm was

analysed before first cut by using the dry-weight-rank method (Mannetje and Haydock, 1963). A principal component analysis (PCA) included the variables harvesting time at first cut (CUT), altitude (ALT), timothy (*Phleum pratense* L., b_TIM), meadow fescue (*Festuca pratensis* L., b_MEA), perennial ryegrass (*Lolium perenne* L., b_RAI), common couch (*Elytrigia repens* L., b_COU), smooth meadow-grass (*Poa pratensis* L., b_SMO), sum of grasses (b_GRA), red clover (*Trifolium pratense* L., b_RED), white clover (b_WHI), sum of legumes (b_LEG), common dock (*Rumex longifolius* DC., b_DOC), dandelion (*Taraxacum* F. H. Wigg., b_DAN), creeping buttercup (*Ranunculus repens* L., b_CBU), meadow buttercup (*Ranunculus acris* L., b_MBU), sum non-legume herbs (b_HER), number of species (SPE), crude protein (CP), crude fat (CF), NDF (NDF), non-fibrous carbohydrates (NFC), organic matter (OM), *in vitro* true digestibility (IVT), NDF digestibility (dNDF), and net energy lactation (NEL).

Table 1. Farm details for organic (O) or conventional (C) dairy farms with short-term (S) or long-term (L) grassland management (standard deviation in brackets)

	SO	SC	LO	LC
n	9	9	7	7
Altitude, m a.s.l.	68 (39.2)	62 (38.2)	106 (71.6)	141 (125.1)
Herd size	24 (10.7)	24 (12.6)	14 (3.4)	19 (5.3)
Forage area proportion	0.9 (0.05)	0.8 (0.23)	1.0 (0.02)	1.0 (0.00)
Grassland age, years	3 (0.9)	3 (0.8)	11 (3.6)	10 (4.1)
Date first cut, date (days)	12 June (4.9)	11 June (6.0)	22 June (10.8)	18 June (7.9)
Manure, tons ha^{-1}	27 (8.3)	33 (14.4)	33 (16.0)	57 (30.6)
N fertiliser, kg ha^{-1}	0	145 (83.7)	0	119 (52.6)

Results and discussion

The PCA principal component (PC) 1 explained 23.2% of the total variation and distinguished O farms from C farms with the exception of one extensively managed C farm (Figure 1). O farms had lower proportions of grasses and higher proportions of dicotyledons than C farms in their grassland. PC 2 explained 17.0% of the total variation and divided most LO farms from SO farms. The dicotyledon proportion was dominated by legume species on SO farms and non-legume species on LO farms. All non-legume herb species were clustered in the PCA score plot and positively correlated with species diversity and cutting time at first cut (Figure 2). Red clover was positively correlated with white clover and concentration of non-fibrous carbohydrates, *in vitro* digestibility and NEL. Grass species showed more variation than legumes or non-legume herbs. Timothy was positively correlated with C farms and perennial ryegrass was positively correlated with S farms, while other species like meadow fescue and smooth meadow grass were not correlated with any of the farm types. Concentration of herbage crude protein was positively correlated with proportion of grasses indicating that both grass proportion and grass N concentration increased with N-fertilisation on C farms compared to O farms.

Conclusions

Differences between organic and conventional herbage in botanical and chemical composition seemed to be larger than differences between grassland systems. These differences indicate that conventional farms had forage qualities different from organic farms, which may affect milk quality. The effect of legumes vs. non-legume herbs in the herbage may be studied on organic farms with different grassland systems.
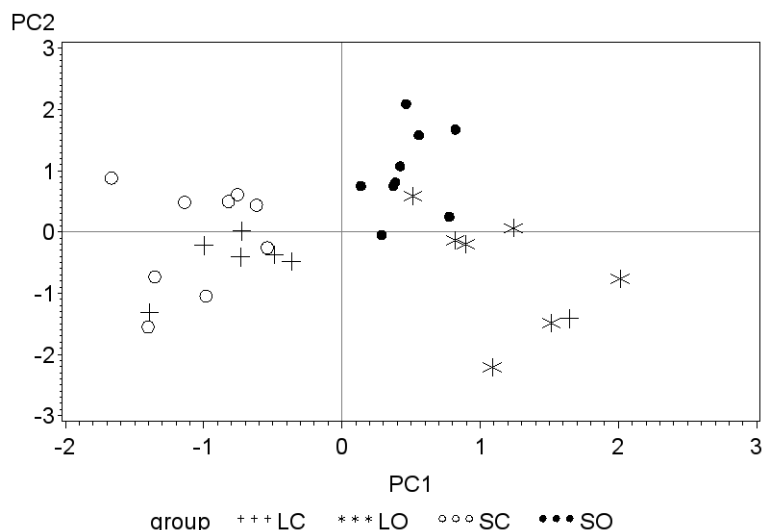
Figure 1. Component scores of principal component analysis of thirty-two farms with short-term (S) or long-term (L) grassland system and organic (O) or conventional (C) production system.
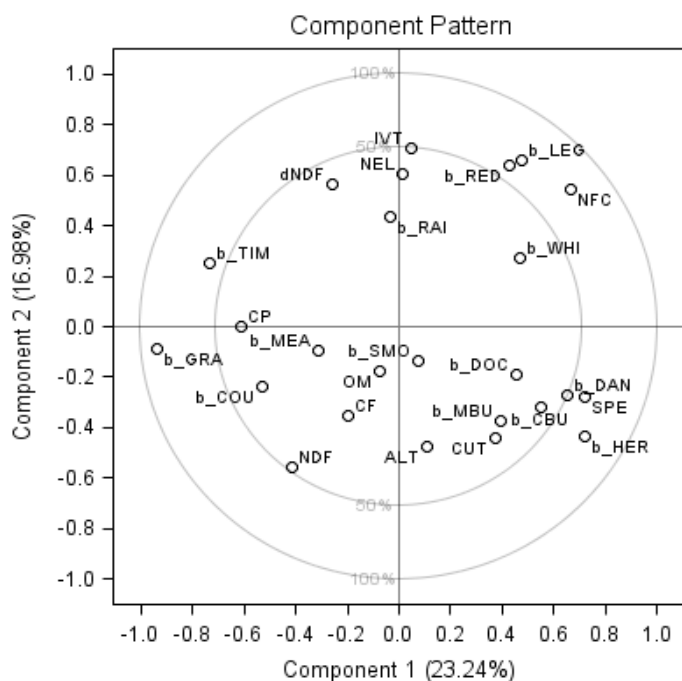

Figure 2. Score plot of principal component analysis (variable names explained in material and methods).

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