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Comparison of leys on conventional and organic farms

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Abstract. The objective of this research was to compare the potential production of conventional and organic leys depending on the nutritive status of the soil. Three pairs of dairy farms, located in different regions of Estonia, were selected: Lääne (west), Harju (north) and Võru (south-east) Counties. In this research work, the botanical composition of the sward, the dry matter (DM) and crude protein (CP) yield and concentration in grass were measured. The soil pH_{KCl} and the content of organic matter were determined, including the content of soluble plant nutrients P, K, Ca and Mg in the soil. The soil profiles were described and the soils were classified.

As the organic farms, with legume-rich swards, were quite similar to the conventional farms, the preliminary results did not show large differences between the two farming types studied. The average DM yield of the ley at the first cut and the total DM yield were higher on the conventional farms.

Key words: botanical composition, grassland, ley, organic farming, soil

INTRODUCTION

The high price of mineral fertilisers and concern about the soil fertility encouraged farmers to grow nowadays much more forage legumes for feeding livestock in Estonia (Older et al., 2000). Red clover (*Trifolium pratense* L.) is the most widely grown legume on conventional and organic farms. The productive age of ley can be prolonged by one year using tetraploid red clover varieties, which were introduced by Estonian forage producers in the 1990s. These varieties have higher yield and better quality than diploid red clover varieties, which were used earlier (Bender, 2000).

The interest in organic farming and food quality has increased rapidly in the last decade. In the 1990s, organic farming expanded very fast in many regions of Europe; numerous studies, projects and reviews of organic agriculture were carried out. However, in Estonia there has not been much research in the field of organic farming.

Organic ley farming systems in Estonia are traditionally based on ley/arable crop rotations, and farmers use mixed grass and legume leys. These leys offer a powerful mechanism for supplying nitrogen through their potential to accumulate biologically fixed nitrogen into the soil to support both animal production and the subsequent phase of arable cropping.

MATERIALS AND METHODS

The objective of this research was to compare the production potential of organic grasslands with that of conventional (more intensively used) ones. Three pairs of dairy farms, located in different regions of Estonia, were selected. Each pair included one organic farm and one conventional farm. The data on the organic farms were obtained from the Estonian Biodynamic Association. None of the conventional farms was located far from the corresponding organic farm. Field research was carried out in the regions in the west (Harju County), north (Lääne County) and south-east (Võru County) of Estonia in 2001.

On each of the farms, the fresh and DM yield and the botanical composition of the sward were measured on the 4 research plots of 5 m^2. The N content in the grass was measured by the Kjeltec Autoanalyser 1030. The content of soluble plant nutrients P, K, Mg and Ca in the soil was determined by AL (ammonium acetate extraction) method; the soil pH_{KCl} and the content of organic matter were also determined. The grass was harvested twice during the season, whereas the first cut was mostly done at the time of early heading (grasses) or full budding (legumes). For statistical analyses ANOVA was used.

RESULTS AND DISCUSSION

The dominant soil types on the farms of Western Estonia were Calcic Cambisols, on the farms of Northern Estonia Calcic Gleysols, and in the south-east Haplic Podzols. Several areas were degraded by water and tillage erosion. The content of organic matter was higher on the organic farms of Harju County, but the soils of Võru County were exceedingly poor in humus due to soil erosion. The soil pH, which depends on the soil type, was higher on the farms of Western Estonia. The content of lactate-soluble P and K mostly depended on the location of farms (Table 1). These are the problematic aspects of organic farming, which cannot have high productivity without a high level of plant nutrients in the soil, whereas nitrogen is the most important nutrient required for herbage growth. In the case of a legume plant, its green mass and the amount of roots are high also without industrial nitrogen fertilisers, and when it is ploughed into the soil, the content of soil organic matter will increase.

Table 1. Agrochemical properties of topsoil (0–20 cm) in 2001.

County in Estonia	Type of farm	pH_{KCl}	P	K	Ca	OM*	Type of soil
			AL- method				
A - Lääne	conventional	6.7	56	177	4,307	4.2	Calcic
	organic	6.9	82	143	3,644	3.9	Cambisols
B - Harju	conventional	6.4	102	151	3,002	4.7	Calcic
	organic	6.9	64	183	3,949	5.8	Gleysols
C - Võru	conventional	6.5	125	148	1,363	3.0	Haplic
	organic	6.6	59	77	1,151	2.2	Podzols

*Content of organic matter, %.

In temperate regions, the grass-clover systems are likely to be receiving about 200 kg N ha per year from nitrogen fixation (Newton, 1995). In relation to the maintenance of soil nutrient status, the main priority of grassland management concerns the removal of nutrients from a field cut for fodder. This can obviously have a major effect on soil P and K content. In farming systems compared in Germany, soil P content decreased by 39% over 5 years in the organic system (Younie, 2000), and in the Netherlands by 25% under cutting management (Younie, Baars, 1997). Regular soil analyses are recommended to ensure the balance of soil fertility. The low content of P and K in the soil are caused by their low content in the soil parent material, too. The FYM (farm-yard manure) is one of the major sources of nutrients in organic farming.

One of the most important aims in grassland husbandry in Estonia is the use of legume plants as the source of nitrogen for grasslands as well as for increasing the protein content in the forage. The legumes are very important because conventional farmers usually cannot afford to apply mineral nitrogen fertilisers to grassland. Thus no clear difference between the botanical composition of swards of the conventional and organic farms was found in the research. The investigated grasslands had mostly more than 50% of legumes and 20–40% of grasses in the botanical composition of the swards. But grass swards on the organic farms have often much more herbs in their botanical composition (Fig. 1).

The disadvantage of red clover is its short age and its sensitivity to unfavourable growing and overwintering conditions. In order to decrease the influence of the disadvantages mentioned above, also mixed sowings with grasses were cultivated in addition to the pure sowings of red clover. Among grasses, timothy was, and is, up to now the most widely used one. Conventional farmers also need grassland with good production and without expensive mineral nitrogen.

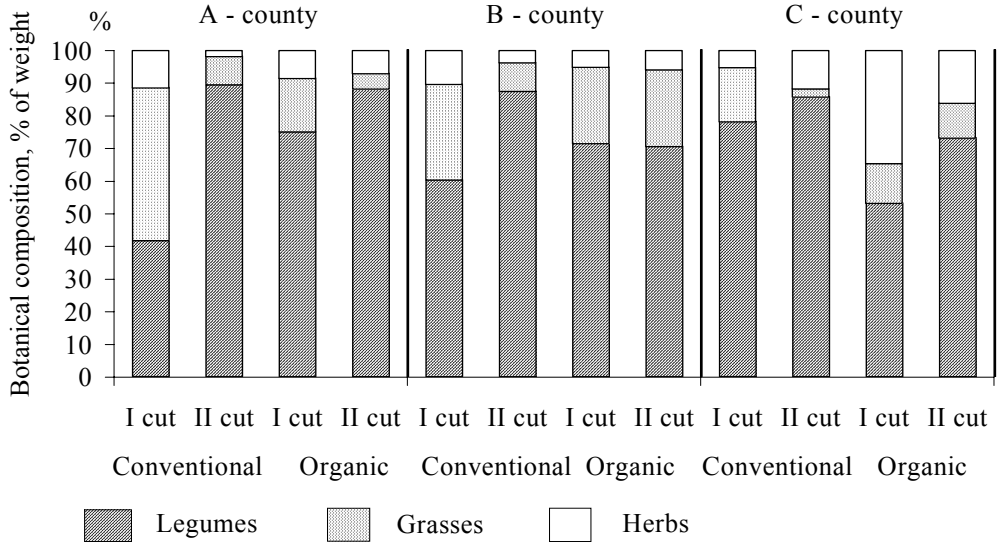

Fig. 1. Botanical composition of conventional and organic leys in different counties in 2001.

A typical ley on an organic farm will include a range of different species and varieties of grasses, clovers, or other forage legumes and herbs. Herbs are deep-rooting plants and bring mineral nutrients into the upper part of the soil, thereby contributing to soil fertility (Lampkin, 1999). A number of organic and conventional comparisons of grassland have shown that an organic sward generally contains more plant species than a conventional sward (Newton, 1999).

Conventional farms, that have legume-rich grasslands, are quite similar to organic farms – they both use grass-legume mixtures, like leys in field crop rotation, and conventional farms also apply few mineral fertilisers.

It is a well-known fact that mineral fertilisation is one of the main factors of grassland productivity. But for many farmers milk production is not profitable enough, and they do not want to spend extra money on grassland fertilisation. On the other hand, the low level of grassland fertilisation fosters its richness in different plant species. The grass from species-rich grassland has better palatability for grazing animals due to its high biodiversity.

The DM yield of ley was estimated at the beginning of legume budding. The study showed that the DM content was lower in the both compared farming types in the first cut (average 17%) than in that of the aftermath (20%). The average DM yield of the first cut, 2.7 Mg ha^{-1}, and that of the aftermath 2.3 Mg ha^{-1}, was obtained on a conventional farm, the lower DM yield values (by 27 % in the first cut and 34% in the aftermath) were obtained on organic farms. The highest annual DM yields (5.5–6.0 Mg ha^{-1}) were measured in conventional B and C counties (Fig. 2).

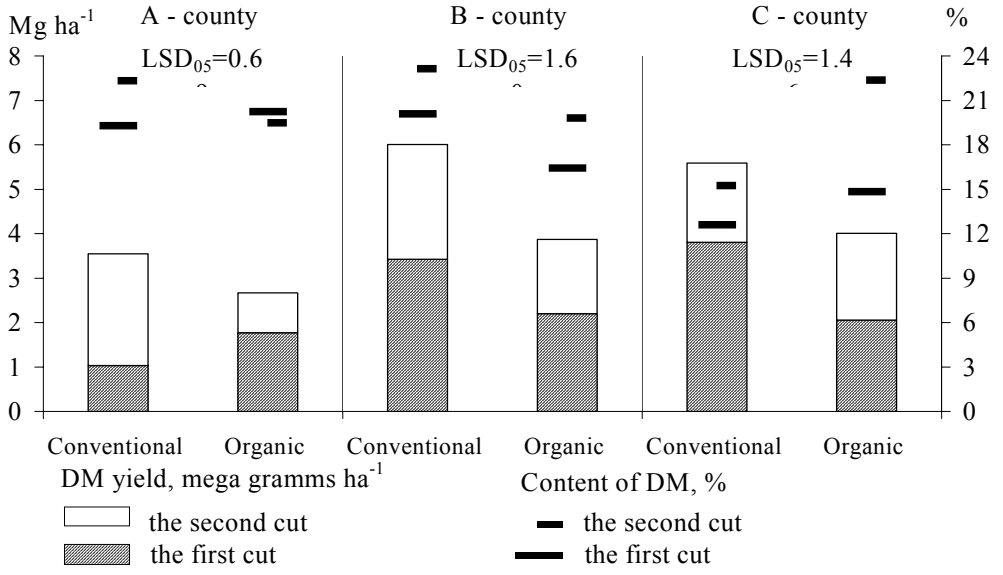

Fig. 2. The grass DM yield and DM content on the conventional and organic farms in 2001.

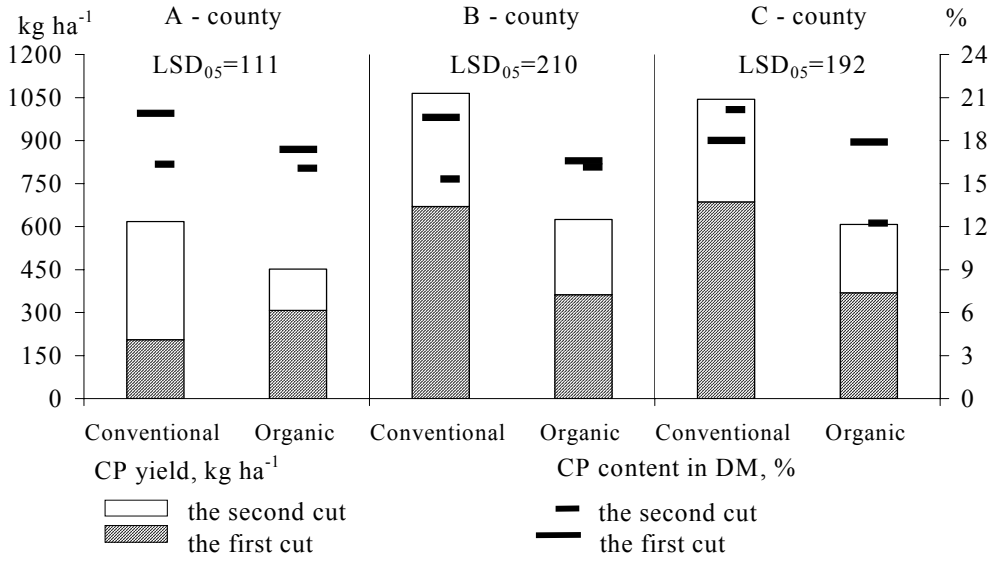

Fig. 3. Yield and content of CP in DM in the compared farms in 2001.

In order to achieve acceptable nutrient concentrations in herbage, especially that of protein, the optimal time for the first cut should be used. The timing of the first cut affects the yield and grass quality of subsequent cuts used, and the total number of cuts per season. The cutting time for grass conservation involves a compromise between the maximum grass yield and its maximum feeding value. The stage of plant development at the time of cutting influences the quality of the conserved product. Young fresh forage is usually rich in protein (Viiralt, Kabanen 2000).

It was found that the average CP concentration in the most cuttings of the grass of the conventional-type farms was much higher. Also the CP yield (kg ha^{-1}) values of 33% in the first cut and 45% in the aftermath were higher than these obtained on the organic farms (Fig. 3).

CONCLUSIONS

As the prices of mineral nitrogen fertilisers are relatively high in Estonia, the use of legumes is very important both for conventional and organic farms. The grass-clover leys can be managed in a similar way as N-fertilised grass swards for cutting, and they should be utilised at a young stage.

The soils of the researched C-county (Võru) are exceedingly poor in organic matter and soil nutrients.

The botanical compositions of swards did not strongly differ between the observed farming types. The common ley contained 50–90% of legumes; the leys on the organic farms contained often more herbs.

The results of this experiment showed that for obtaining a high quality feed, the optimal time of the first cut is relevant. The CP concentration was highest in the grass of earlier cutting, where the CP content was 16–19%.

The quantity and content of DM increased rapidly during the prolonged pre-cut growing period, and the highest annual DM yields were 6 Mg ha^{-1} in the case of a 2-cut system on a conventional farm.

The results showed the importance of growing the legumes and the use of mineral fertilisers. It was proved that the fertilisation is one of the main factors influencing the yielding ability of leys.

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