The effect of decreased N and P applications on herbage quality in the Netherlands

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Abstract

In the Netherlands, the amounts per ha of nitrogen (N) and phosphorus (P) applied have been reduced by approximately 40% since 1996, due to legislative restrictions. However, as the reductions in N and P fertiliser application have not resulted in a reduction in the dry matter (DM) yield of grassland, we hypothesise that herbage quality is changing. We used a large database (n>350,000) with results of spring forage analyses from dairy farms in the Netherlands. In the period studied (1996-2013), crude protein (CP), crude ash, P, K, Fe, Zn, Mo, Cu and Co content all decreased. In the same period, an increasing content of energy, water-soluble carbohydrate (WSC) and selenium was found. The decreasing CP levels probably induced the increase in the WSC content of herbage. The increase in Se content can be explained by the increased use of Se containing fertilizers. In conclusion, almost all mineral contents in herbage seem to decrease because of the legislative restriction on N and P input. In order to maintain high animal production levels, farmers need to purchase high-protein feed and minerals for their rations to compensate for the decreasing CP and mineral contents in silage.

Keywords: herbage quality, nitrogen, yield

Introduction

In the Netherlands the applications of N and P have been reduced due to legislative restrictions. These restrictions are intended to minimize losses of N and P and thus improve ground- and surface-water quality. Application of N and P has declined by approximately 40% since 1996 (CBS, 2014). However, as the reduction in N and P fertiliser application has not resulted in the DM yield of grassland has not yet significantly changed (CBS, 2014). So the reduction of N and P applications has led to increased fertiliser-use efficiency in the Netherlands. However, since N application directly influences herbage quality (Tremblay, 2005), it is expected that there will be consequences for the herbage quality and animal performance. This paper summarises the changes in herbage quality in the Netherlands in relation to the reduced N and P applications. The results can indicate if the reduced N and P application might eventually affect animal performance in the near future.

Materials and methods

A huge database of commercial feed analyses from BLGG (www.blgg.nl) was used to perform this study. The database contains over 350,000 spring-cut forage analyses (grass silage) from Dutch dairy farms in the period 1996-2013. To evaluate the development of herbage quality, annual averages have been used. Besides the commercial analyses, the national mineral balances established by Statistics Netherlands (CBS, 2014) are used to correlate the changes to the reduced applications of N and P. The statistical analyses were performed with PSAW statistics 2013 using a simple linear regression model.

Results and discussion

Table 1 shows the development of the silage quality in the Netherlands over the years 1996 to 2013. The contents of ash, CP, K, P, Mn, Zn, Fe, Cu, Mo, and Co all decreased significantly. The decline in CP contents has a strong direct correlation with the reduced N input. However, the data from the CBS contain the average national N input by manure and fertilizer is for the Netherlands overall. Therefore, it

Table 1. Mean values (3 periods) of herbage quality characteristics and mineral input and DM yield in the Netherlands. Annual change (indicated by slope) and the regression coefficient indicates the mean change per year for the period 1996-2013.

Characteristics[a]		1996-2001	2002-2007	2008-2013	Slope[b]	R^2
DM	g kg^{-1}	448	448	455	n.s.	n.s.
VEM [c]	g kg DM^{-1}	886	888	912	2.3 *	0.51
Crude Ash	g kg DM^{-1}	119	108	102	-1,6 ***	0.58
CP [d]	g kg DM^{-1}	202	180	168	-2.9 ***	0.75
CF	g kg DM^{-1}	246	263	252	n.s.	n.s.
WSC	g kg DM^{-1}	79	84	99	1.8 #	0.19
Na	g kg DM^{-1}	2.4	2.5	2.4	n.s.	n.s.
K	g kg DM^{-1}	36	34	33	-0.3 ***	0.57
Mg	g kg DM^{-1}	2.3	2.3	2.3	n.s.	n.s.
Ca	g kg DM^{-1}	5.1	4.9	4.9	-0.0 *	0.23
P	g kg DM^{-1}	4,2	4.1	3.9	-0.0 *	0.32
S	g kg DM^{-1}	2,7	2,8	2.9	n.s.	n.s.
Mn	mg kg DM^{-1}	97	90	88	-0.7 *	0.23
Zn	mg kg DM^{-1}	44	40	40	-0.4 *	0.26
Fe	mg kg DM^{-1}	497	398	349	-13.4**	0.47
Cu	mg kg DM^{-1}	8.1	7.6	7.5	-0.1*	0.34
Mo	mg kg DM^{-1}	2.2	1.9	1.7	-0.0 **	0.53
Co	µg kg DM^{-1}	212	151	131	-7.0 ***	0.68
Se	µg kg DM^{-1}	46	75	95	3.6 ***	0.64
DM yield	kg ha^{-1}	10,540	10,408	10,928	n.s.	n.s.

[a] DM = dry matter; CF = crude fibre; CP = crude protein; WSC = water-soluble carbohydrate.

[b] # $P<0.1$; * $P<0.05$; ** $P<0.01$; *** $P<0.001$; n.s. = not significant.

[c] VEM = Dutch energy unit. 1 VEM= 6,9 kJ net energy for lactation

[d] Crude Protein including NH_3-fraction.

includes more than just the dairy farmers. Nevertheless, over 50% of Dutch agricultural land consisted of grassland during the studied period (CBS, 2014). Figure 1 shows this correlation between the average N input ha^{-1} and the CP contents in silage. The decreasing CP content can be a challenge for the Dutch dairy sector since sufficient CP in the ration is necessary to maintain high milk yields (Broderick, 2003). The decreasing CP content in herbage will force dairy farmers to buy more high-protein feed. However, the

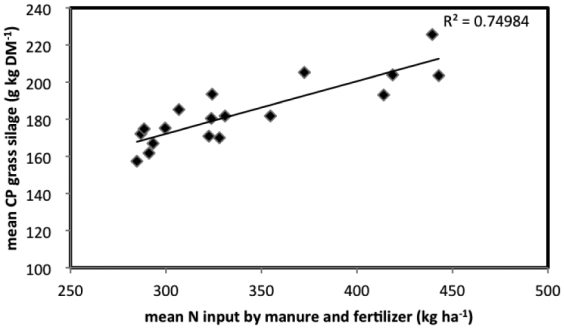

Figure 1. The relationship between the average N input ha^{-1} by animal manure and fertilizer and the mean CP content of spring-cut grass-silage in the Netherlands during 1996-2013.

content of VEM, WSC and Se tend to increase. The decreasing CP levels probably induced the increase in the WSC content of herbage (Tremblay, 2005; King, 2012). Silages with a higher WSC content will also contain more VEM which can be used for milk production. The increasing Se concentrations are possibly an effect of the increased use of fertilizers containing Se. This was also noted by Reijneveld (Reijneveld, 2014).

Conclusions

The reduced N and P inputs and the maintenance of the DM yield on grassland have resulted in a higher efficiency in terms of fertilisation. However, the lowering of manure and fertilizer inputs are resulting in a change of silage quality in the Netherlands. The decreasing CP and mineral contents are directly correlated to the reduced N input. In order to maintain high animal performance, dairy farmers will need to buy more high-protein feeds and minerals. Therefore, at farm level, the lower N input by fertilizers will be partly replaced by higher inputs of N present in the feed.

References

Broderick G.A. (2003). Effects of varying dietary protein and energy levels on the production of lactating dairy cows. *Journal of Dairy Science* 86, 1370-1381.

CBS (2014). Statistics. Available at: www.cbs.nl.

King C., McEniry J., Richardson M. and O'Kiely P. (2012). Yield and chemical composition of five common grassland species in response to nitrogen fertiliser application and phenological growth stage. *Acta Agriculturae Scandinavica Section B: Soil and Plant Science* 62, 644-658.

Reijneveld J., Abbink G.W., Termoshuizen A.J. and Oenema O. (2014). Relationships between soil fertility, herbage quality and manure composition on grassland-based dairy farms. *European Journal of Agronomy* 56, 9-18.

Tremblay G., Bélanger G. and Drapeau R. (2005). Nitrogen fertilizer application and developmental stage affect silage quality of timothy (*Phleum pratense* L.). *Grass and Forage Science* 60, 337-355.