Impact of potassium fertilisation on grassland production costs

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Abstract

Intensive potassium (K) fertilisation of grassland influences the increase of forage K content which may cause different diseases of dairy cows due to the large part of such forage in a ration. Too high levels of K fertilisation may negatively affect the yield and unnecessarily increase the forage production costs. On account of all that we decided to evaluate the height of grassland forage production costs at fertilisation with different K rate. Model calculations for farms made by Agricultural Institute of Slovenia were used as a tool for cost estimation. A model of hay production in the field (three cut use) was used with the variation of the quantity of K added and yield. The results have shown that the forage production costs at the fertilisation with 100 kg K2O/ha (rate with the optimum content of K in grassland forage for dairy cows) and by one tenth lower yield were lower by little more than 5% than the forage production costs of the initial model (8.5 ton DM/ha; 200 kg K2O/ha).

Key words: potassium, fertilisation, grassland feed, production cost

Introduction

Intensive grassland forage (intensive fertilisation, early cut…) often contains too high levels of potassium (K) (Babnik et al., 2008), which is the most critical point in the feeding ration of dry cows and due to which metabolic diseases appear after calving (Curtis et al., 1984, Oetzel et al., 1988). This results in an increase of production costs and, as a rule, in a decrease of milk produced, both of them decreasing the production economy. Also, Bewley and Amaral-Phillips (2009) report about K surplus in forage as being the key problem of metabolic disorders, so that the strategy of reduction of metabolic diseases in cows should be based on the decrease of K content in rations before calving. Since the production of basic forage is intended for feeding in the entire production period, reduction of K content in forage and not in the feeding ration should be considered.

In spite of the fact that the results of monitoring of the Slovene grassland soil fertility sometimes indicate a poor supply with K available to plants (Sušin, 2001), the results obtained by chemical analyses of grass silage samples (Verbič, 2006) indicate high K content in silage. The two opposite facts are probably the consequence of the so-called luxury consumption of K by plants (Verbič, 2006, Funderburg et al., 2009). In this case the grassland often utilises more K than estimated on the basis of AL analyses of K accessible in soil. Due to the reasons mentioned above Babnik et al. (2008, 2009) warn that the supply of meadows with K should be evaluated also through K concentration in forage. According to the expert recommendations valid in Slovenia (Leskošek and Mihelič, 1998) when determining fertilisation rates, K fertilisation with regard to desired yield and K supply in soil is considered.

Investigation carried out by Babnik et al. (2009) indicated that in the field experiment with soil poor in supply of K the highest hay yield was obtained at the fertilisation with 150 kg K2O/ha with the forage containing 4 g K in one kg of dry matter more than the recommended upper limit of 20 g K in one kg of dry matter. The yield was on the same level as if it had been reached following the currently valid recommendations using 200 kg K2O/ha (Leskošek, 1993). At the same time it was established that by increasing the fertilisation intensity above 150 kg K2O/ha, the content of K available in soil and in forage increases while the yield decreases. With the fertilisation rate of 100 kg K2O/ha, which is only half of the
quantity currently recommended for the grassland fertilisation at the optimum K supply of soil, the dry matter yield was by 10% lower than the maximum reached yield, but in this case the forage K content was optimal (15 g K in one kg of dry matter). Based on the investigation results, Babnik et al. (2009) found out that even if soil supply of K is poor grassland required lower K rates than recommended. At the same time they report that for the evaluation of the actual K supply of grassland, K content in forage was a more reliable criterion; all this considered, more accurate recommendations should be prepared in order to reach desired quantities and optimum quality of forage and optimum value of K.

The investigations mentioned above have proved that the currently valid fertilisation rates for grassland fertilisation with K are probably too high both from the viewpoint of reaching the highest yield as that of the forage K content. Due to the significant effect of the fertilisation on the grassland forage production costs (Zbirnik rastlinskih kalkulacij, Modelna kalkulacija za seno…, 2008) and of the great part of such a forage in the ration of dairy cows as well as in total milk production costs (Volk, 2001), these at the first sight small changes in feed costs are severely reflected in the economy of milk production. Therefore, in the current paper we want to show to what extent the consideration of different fertilisation rates for K fertilisation influences the grassland forage production costs.

Material and methods

The effect of K fertilisation on grassland forage production costs was evaluated using model calculations made for farms by Agricultural Institute of Slovenia (Rednak, 1998, Splošna metodološka izhodišča …, 2008). It is a simulation model with functional dependencies built in, which, based on selected input technological parameters, allows estimation of input and work used, and along with that the total production costs of individual products. Production costs and values are evaluated according to prices valid in a certain period. For the needs of the current project, prices valid in 2009 were used for the calculation of production costs and value.

For the needs of the current project we made a model of hay production in the field, which envisages a three cut meadow with the expected yield of 8,500 kg of dry matter (DM) per hectare (basic model - M1) or - at 86% DM content in storage and losses at harvest (15%) - 8,400 kg net yield of hay per hectare. Models M2, M3 and M4 (Table 1) derive from the basic model. The difference between them exists in the quantity of fertilisers used and, in one case, in the size of yield expected (lower yield due to lower fertiliser rate). Similar to basic model, model M2 envisages fertilisation with slurry and fertilisation with mineral nitrogen (N) and phosphorous (P) fertilisers, but not fertilisation with mineral K. M2 is based on the presumption saying that in spite of the monitoring results of soil fertility of Slovene grassland indicating lack of K (Sušin, 2001), farmers decide to reduce the K fertilisation. Considering the farm management aspect they fertilise only with animal manure as they do not have the necessary land (mainly fields with field crops) for their application. In such a case, requirements for N and P are the only criterion for reaching the desired yield.

<table>
<thead>
<tr>
<th>Table 1: Fertilising rates and fertilising management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>Yield (kg SS/ha)</td>
</tr>
<tr>
<td>Net yield of hay (kg/ha)</td>
</tr>
<tr>
<td>Fertilising rate (kg of nutrient/ha):</td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>P2O5</td>
</tr>
<tr>
<td>K2O</td>
</tr>
<tr>
<td>Slurry (kg)</td>
</tr>
<tr>
<td>Fertilisers (kg)</td>
</tr>
</tbody>
</table>

*Real use of only 140 kg K2O/ha from animal manure without adding K via mineral fertilisers

Model M3 considers lower K requirements of grassland to reach the same yield as M1. The envisaged K requirements derive from the results of an investigation carried out by Babnik et al. (2009), in which the highest yield of 8.5 tons DM/ha and fertilisation with 150 kg K2O/ha was obtained on grassland poorly supplied with K. Based on investigation results concerning the impact of forage K content the optimal forage K content was determined. While data which could more accurately show the framework of fertilisation rates and yield with regard to optimal forage K content are fewer. In spite of that, M4 model considered the recommendation of Babnik et al. concerning the optimal K content in grassland forage. It was reached at one
half lower fertilisation rate (100 kg K₂O/ha) than the currently valid fertilisation recommendations. The quantity of K in this case allows 10% lower yield than that envisaged in the basic model M1.

In the basic M1 model, recommendations for grassland fertilisation are considered (Leskošek, 1993). In addition to that, the calculations take into account the quantity of fertilisers envisaged in frame of legal limits concerning the application of dangerous substances in the environment (Decree on the limit input concentration values …, 2005) and for animal fertilisers the limit at the rate of stocking for sustainable animal breeding, which is 1.9 LU/ha (Slovene Agriculture - Environmental Programme …, 2001). To reach the envisaged fertilisation rates in individual models, the quantities of mineral fertilisers required are calculated from the difference between the nutrient requirements of plants and nutrient quantities applied with slurry. Different quantities of slurry and mineral fertilisers result in differences of work generated from the preparation and application of all fertilisers while in the case of M4 model the use of work at harvest is different, too.

Changes occurring due to taking into account different fertilisation rates were evaluated on the basis of hay production costs. The height of costs in particular models and the changes between the basic model and other models (indexes of changes) are presented on the level of total costs. Fertiliser costs are indicated separately for mineral fertilisers and slurry. The results are also presented on the level of total costs reduced by subsidies (regional payment for grassland and repayment of part of the excise duty for fuels) and on the level of total costs per product unit reduced by subsidies (production price).

Results and Discussion

Planning of fertilisation results in a more rational utilisation of fertilisers and changes in production costs which is presented in table 2. The results indicate that the costs of grassland forage production are lower if the use of fertilisers is lower. This is also true in the M4 model which anticipates by one tenth lower yield due to a lower K dose.

<table>
<thead>
<tr>
<th>Model</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
<th>Index M2 M1</th>
<th>Index M3 M1</th>
<th>Index M4 M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (kg DM/ha)</td>
<td>8,500</td>
<td>8,500</td>
<td>8,500</td>
<td>7,650</td>
<td>100,0</td>
<td>100,0</td>
<td>90,0</td>
</tr>
<tr>
<td>Total costs</td>
<td>2,039</td>
<td>1,923</td>
<td>1,946</td>
<td>1,796</td>
<td>94,3</td>
<td>95,4</td>
<td>88,1</td>
</tr>
<tr>
<td>of this: total fertilisers</td>
<td>572</td>
<td>472</td>
<td>487</td>
<td>413</td>
<td>82,6</td>
<td>85,1</td>
<td>72,1</td>
</tr>
<tr>
<td>mineral fertilisers</td>
<td>157</td>
<td>57</td>
<td>72</td>
<td>116</td>
<td>36,4</td>
<td>45,8</td>
<td>74,0</td>
</tr>
<tr>
<td>slurry</td>
<td>415</td>
<td>415</td>
<td>415</td>
<td>296</td>
<td>100,0</td>
<td>100,0</td>
<td>71,4</td>
</tr>
<tr>
<td>Subsidies</td>
<td>393</td>
<td>392</td>
<td>393</td>
<td>390</td>
<td>99,9</td>
<td>100,0</td>
<td>99,2</td>
</tr>
<tr>
<td>Costs, reduced by subsidies</td>
<td>1,647</td>
<td>1,531</td>
<td>1,553</td>
<td>1,407</td>
<td>93,0</td>
<td>94,3</td>
<td>85,4</td>
</tr>
<tr>
<td>Costs, reduced by subsidies/kg</td>
<td>0,196</td>
<td>0,182</td>
<td>0,185</td>
<td>0,186</td>
<td>93,0</td>
<td>94,3</td>
<td>94,9</td>
</tr>
</tbody>
</table>

Source: Model calculations by Agricultural Institute of Slovenia

The highest fertilisation costs as well as the highest production price of produced forage was evaluated for the initial model M1 (fertilisation with 200 kg K₂O/ha). The fertilisation costs in the model M1 are by 15%, 17% and 28% higher than in models M3, M2 and M4 while the costs reduced by subsidies per production unit in models M3, M2 and M4 are lower by 7%, less than 6% and more than 5%.

The costs of hay production are the lowest in the model M2 in which only fertilisation with K from animal fertilisers was expected. Further estimates indicate that the production price of hay in the case of the lowest fertilisation dose (100 kg K₂O/ha) and at the yield lower by one tenth are on the similar level as at the fertilisation norm of 150 kg K₂O/ha.

According to the estimations of grassland forage production the differences in the production price between models M2, M3 and M4 are small. Due to important share of grassland forage in feeding ration in the total costs of milk and meat production even the small differences between production prices importantly affect the economy of production.
Conclusions

Excessive K content in the forage of dairy cows during lactation is not problematic, but feeding such forage in the dry off time may lead to health problems of dairy cows after calving. Since in the practice we are often confronted with difficulties in the separation of grassland forage (later harvested forage contains less K), beside lower production costs, this is an additional reason for taking into account recommendations indicating that for cows the optimal forage K content is reached at half lower fertilisation rates than the currently valid recommendations (100 kg K₂O/ha). Fertilisation with 100 kg K₂O/ha does not allow reaching the highest yields (10% lower yield), but the costs of grassland forage production decrease faster (lower fertilisation costs) than the yield decreases. At the fertilisation rate which still allows the highest yield of grassland forage (150 kg K₂O/ha) as also at fertilisation rate of 100 kg K₂O/ha, the calculated forage price is significantly lower than the price calculated according to the current recommendations for K fertilisation.

References


http://www.uky.edu/Ag/AnimalSciences/dairy/extension/nut00046.pdf


Decre on the limit input concentration values of dangerous substances and fertilisers in soil. Ur. l. RS št. 84/2005

http://www.noble.org/Ag/Soils/FertilizingBermudagrass/CDIndex.pdf


Splošna metodološka izhodišča in pojasnila k modelnim kalkulacijam. (2008).

Sušin J. (2001). Oskrbljenost tal s fosforjem in kalijem na travnikih in vrtovih. Sodobno kmetijstvo. Letn. 34. Št. 10. 455-458


http://www.kis.si/datoteke/file/kis/SLO/EKON/ZBIRNIKrastlinska.xls

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