To graze or not to graze, that's the question

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Abstract

Current trends in livestock farming in Europe are causing a decline in the popularity of grazing systems for dairy cows. This paper presents an overview of dairy cow grazing in northwest Europe. The grazing system affects various aspects such as grassland productivity, animal welfare, environment, economy, labour and even society. Grazing has advantages and disadvantages. The importance attached to the various effects of grazing is very personal. It is shown that grazing for a limited part of the day scores well on the whole. In the end, the personal motives of the farmer will answer the question 'to graze or not to graze'.

Keywords: animal welfare, dairy cattle, grass intake, grazing, grazing system, sustainability

Introduction

Throughout Europe, forage is the main feed for dairy cattle. Grass is fed either fresh – predominantly through grazing – or in a preserved form as silage or hay. There is a trend however towards less grazing in most European countries. The reasons for this vary but are mainly due to the different types of farm systems that typically occur in different regions.

Modern, large-scale farms with high yielding dairy cattle, such as those increasingly occurring around Europe, may reduce grazing in order to control the diet and optimise grassland utilization. Unquestionably, dry matter intake (DMI) and hence nutrient intake of dairy cattle fed grass only is limited. Van Vuuren and Van den Pol-van Dasselaar (2006) used data of Bruinenberg *et al.* (2002), Bargo *et al.* (2003), Butler *et al*. (2003), Ribeiro Filho *et al*. (2005) and Tas *et al.* (2005) to calculate that when fed a grass-only diet, a maximum DMI of 110 to 120 g (kg body weight)$^{-0.75}$ can be expected. This is enough to meet the requirements of maintenance and 22 to 28 kg of milk. Cows with higher milk production capacity require supplementary feeding to meet their relatively high energy and protein requirements. However, in situations where supplementation is offered grazing time decreases.

In addition, increased herd sizes make grazing more difficult. In general, when farms increase in size, the grazing area (i.e. land base) in the vicinity of the farm remains the same, which leads to an increase in grazing pressure through increased stocking rate. When additional land is incorporated into the grazing area, walking distance to the milking parlour may become a limiting factor.

Another reason for less grazing is the increasing use of automated milking systems. It is possible to combine both grazing and robotic milking systems (e.g. Wiktorsson and Spörndly, 2002), it can, however, be problematic (Parsons and Mottram, 2000). Information collected through a survey conducted in the Netherlands revealed that only half of the farms using robotic milking systems practised grazing (Van Dooren *et al*., 2002). However, on the other farms surveyed about 90% turned cows out to pasture to graze. Over the next ten years we expect a sharp increase in the number of European farms with robotic milking systems.

In some countries, grass growth has been reduced during the summer months over the last number of years, especially in July and August. The uncertainty regarding the availability of grass supply may be another reason for less grazing. Finally, the need to reduce mineral losses and increase labour efficiency may also be reasons to cease grazing. Especially the latter is an important factor for many farmers.

From the reasons outlined above it is clear that current trends in livestock farming in Europe are causing the decline in the popularity of grazing for dairy cows. Is this a matter of concern? Is grazing important and, if so, why? Grazing sends out a signal about dairy farming. The general public in Western European countries is increasingly calling for farm systems in which animals can display their natural behaviour, and grazing is an important aspect of such behaviour for dairy cattle. In addition to issues related to animal welfare, an open landscape with grazing cattle is highly appreciated by the general public. The use of systems that involve only restricted or no grazing opens up the opportunities for moving away from grass as the major feed, with possible large effects on production, economics, environment and landscape. In several countries large projects to stimulate grazing have already started or are being prepared at the moment, for example in Luxembourg (www.fill.lu), the Netherlands (www.koeenwij.nl), Switzerland, Austria, Germany and the UK. The aim of the FILL-pasture project in Luxemburg is to promote grazing. The aim of the Koe and Wij project in the Netherlands is to make farmers aware of the different aspects of grazing and let them decide for themselves using arguments with respect to economy, labour, environment and personal preference.

To graze or not to graze, that's the question! This paper provides information with regard to answering this question. We will describe the current situation and trends in Europe. We will examine some problems relating to grazing: the dilemma of a high herbage intake versus high utilization and the increasing walking distances for dairy cows when farm size increases. We will consider the effect of different grazing systems on aspects such as sustainability, the animal and the society. Finally, the determining factors for grazing will be discussed.

Grazing in Europe

There are few long-term data on grazing available in Europe. However, scientists of several countries in northwest Europe indicate that grazing is decreasing in importance. There is large variation both between and within countries. In Denmark, 16% of dairy cattle did not graze in 2001. By 2003 this number had increased to 30% and it is still increasing. The countries Norway, Sweden and Finland have welfare legislations stating that cattle must have access to pasture or alternative exercise areas outdoors for a minimum period of time during the summer (six weeks to four months depending on location). However, there are no requirements regarding the contribution of pasture to the total energy supply. In Norway, 10-25% of the yearly net energy supply comes from pasture. The grazing season in Norway and Finland varies from less than 100 days in the mountain areas and far north to approximately 180 days in the coastal areas in the south. In Finland grazing became less important from 1990 onwards until the introduction of aforementioned welfare legislation in 2006. In the Netherlands the number of grazing dairy cows has been monitored rather intensively from the early 1990s onwards (Figure 1). Especially in the last few years the number of dairy cows which are kept indoors for all or part of the summer has increased considerably. If grazing is practised, the average number of grazing hours cow^{-1} day^{-1} has reduced. In Germany there is a similar trend. In Luxembourg, it is estimated that up to 10% of the national herd does not have access to pasture; also the number of grazing animals is decreasing. A survey conducted in 2005-2006 in the west of Belgium revealed that at least 4% of the farms dairy cattle do not graze. When asked, 13% of the farmers said that in future dairy cattle will not graze on their farms. In the UK, it was estimated that less than 5% of the dairy cattle did not graze in 2005; this number is increasing. In Ireland, grass-based seasonal systems of milk production predominate. The length of the grass-growing season varies from about 8 months in the northeast to up to 11 months in the extreme southwest.

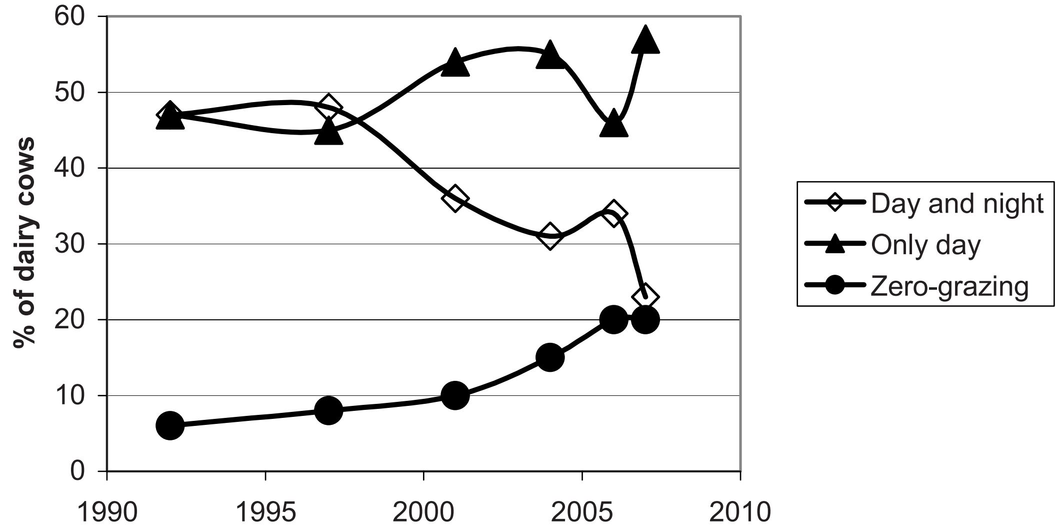

Figure 1. Grazing systems in the Netherlands in the period 1992 to 2007 (% dairy cows) (CBS StatLine databank, http://www.cbs.nl/nl/cijfers/statline/index.htm).

Throughout northwest Europe there are not only considerable differences in the length of the growing season, but also in dry matter yield. Compared to these large differences, the differences in nutritive value of herbage are smaller. The net energy is high in spring, with more than 7 MJ kg DM^{-1}, this decreases during the summer period and tends to increase slightly during late summer and autumn (Table 1). The crude protein level follows mainly the same pattern as the net energy. It is high in early spring and again in late summer and autumn. The data of Table 1 are partly from extensive surveys and partly from experiments. It is therefore not possible to draw conclusions about the differences between countries.

Table 1. Net energy and crude protein content of herbage for dairy cows during the growing season in Ireland (Horan and Shalloo, 2007), the Netherlands (Van Vuuren and Van den Pol-van Dasselaar, 2006) and Norway (Johansen, unpublished data).

	Mar	Apr	May	June	July	Aug	Sept	Oct/Nov
Net energy for lactation (MJ kg DM^{-1})								
Ireland	7.1	7.1	7.0	6.9	6.6	6.4	6.7	6.7
The Netherlands		7.2	7.0	6.9	6.8	6.8	6.9	
Norway			8.8	7.2	6.9	6.9		
Crude protein (g kg DM^{-1})								
Ireland	223	222	166	176	169	189	203	228
The Netherlands		237	214	223	227	237	261	
Norway			264	207	193	227		

The dilemma of a high herbage intake versus high utilization

The productivity of dairy cattle is influenced by herbage intake and by nutritive value of the herbage. Several management factors affect dry matter intake (DMI) (e.g. Dillon, 2006). A very effective way to increase herbage DMI is to increase herbage allowance. Data from Johansen and Höglind (2007) illustrate this. When 12 to 24 kg DM allowance was offered, DMI increased by 0.24 kg for each extra kg DM of herbage allowance. Sward utilization decreased, however, from 72% at 12 kg DM herbage allowance to 51% at 24 kg DM allowance. This decrease in herbage utilization is a matter of concern.

Although herbage intake can be increased by offering larger allowances, the negative effect of higher residuals in subsequent grazings is also clear (Taweel, 2006). Research at Moorepark in Ireland showed that pastures grazed to a post-grazing sward surface height of 5.5 to 6.5 cm in the May to June period compared to a post-grazing sward surface height of 8.0 to 8.5 cm achieved a higher DMI (+ 0.8 kg day^{-1}) and higher milk production (+ 1.2 kg day^{-1}) in the July to September period, due to a higher proportion of green leaf and lower proportion of grass stem and dead material.

Allocating herbage in early spring may positively affect herbage intake. Kennedy *et al.* (2005) showed that dairy cows in early lactation, that were turned out to pasture full-time post calving, produced the same amount of milk as cows that remained indoors until early April, but with a lower fat content (38.6 versus 41.6 g kg^{-1}) and higher protein content (33.6 versus 30.7 g kg^{-1}). The cows on the early spring grazing system continued to maintain a higher milk protein content and higher grass DMI than their indoor counterparts for 12 weeks after the experimental treatments were no longer imposed. O'Donovan *et al*. (2004), in an experiment carried out in France, also showed that early spring turnout to pasture has positive effects in subsequent grazings. During the mid-April to early July period pastures initially grazed in early spring (February and March) produced swards of higher quality and higher milk production potential than swards initially grazed in mid-April. The positive effects of early grazing are due to a higher leaf proportion and hence greater digestibility compared to later grazed swards.

Kristensen *et al*. (2007) showed that restricting grazing time forces the cow to graze more efficiently, although the reduction in herbage intake and animal performance cannot be fully compensated. Comparison of animal production in a system of restricted grazing with supplementary feeding and a system of full-time housing showed that a high milk production of 9000 kg cow^{-1} yr^{-1} can be realized in both systems (Beeker *et al*., 2006).

Also other strategies have been developed to realize a low post-grazing height. Mayne *et al*. (1988) used a leader follower system, with high and low yielding groups of dairy cows. Also systems with heifers and sheep as followers have been used. Furthermore, topping has been advocated (Stakelum and Dillon, 1990) to maintain sward quality mid-season. Recent experiments on peat soils did not, however, show a positive effect of topping (Holshof *et al*., 2006).

We conclude that there are opportunities to increase the DMI of grazing dairy cows; however, stringent management factors need to be put in place. The main objective is to find the balance between a high herbage intake, little residual herbage and little negative side effects later in the growing season.

Walking distance

Grazing becomes more complicated with increasing herd size. The area that is needed for grazing increases proportionally with the herd size (Figure 2). With increasing herd size, the average distance between paddock and milking parlour increases too. To calculate the average walking distance, we simply assumed a square farm area with farm buildings in the corner and with square paddocks at a depth: width ratio of 2: 1. Walking speed of dairy cows was assumed to be 4 km hr^{-1}. This implies that it takes 15 minutes to walk 1000 m. In farmers' questionnaires in the Netherlands, 1000 m is seen as an acceptable maximum walking distance for dairy cows. Figure 2 shows that under these conditions 30 ha is the maximum area that can be grazed. A dairy herd of 150 cows can graze on 30 ha during the whole growing season with 8 kg DM of maize supplementation during the night period. With larger herds, e.g. with 250 dairy cows, grazing during the whole growing season is not possible on an area of 30 ha. A different position of the farm buildings, e.g. in the centre of the farm area, can provide much more grazing opportunities. For example a dairy herd of 600 cows can in that situation graze on 120 ha during the whole growing season with 8 kg DM of maize supplementation during the night period. However, in several countries it is not easy to realize farm buildings in the centre of the farm area.

The possibility of milking dairy cows at pasture is reconsidered again. Oudshoorn (pers. comm.) tested a system of an in-field milking robot in Denmark in 2007. Experiments with a mobile robot or an easy transportable milking parlour will probably start in the Netherlands in 2008.

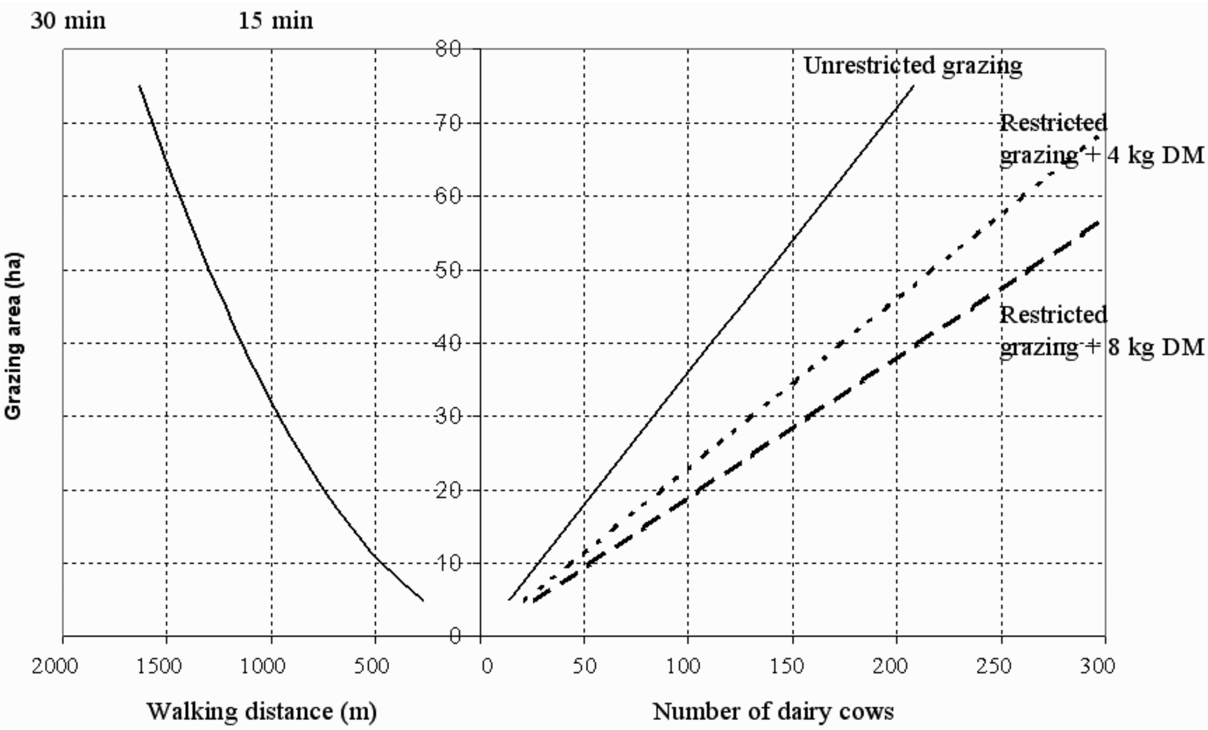

Figure 2. Left: The relationship between the area needed for grazing and the maximum walking distance from paddock to farm buildings. Right: The relationship between herd size and minimum area needed for dairy cows producing 9,000 kg milk yr^{-1} and grazing from April till the beginning of October for three systems: unrestricted grazing, restricted grazing (8 hours access) and 4 kg DM d^{-1} supplementary feeding and restricted grazing with 8 kg DM d^{-1} supplementary feeding.

Various aspects of grazing

In this paper, systems of grazing and feeding management during the summer are distinguished using the number of grazing hours, since this number determines to what extent the general public notices grazing:

– Unrestricted grazing, grazing day and night
– Restricted grazing, usually only grazing during the day
– No grazing, the animals do not graze

Feed supplementation, with for example concentrates, grass silage or hay, forms an important part of the systems with limited or no access to pasture. When grazing is practised, there are different options to optimize the use of grassland, e.g. variations in paddock size and stocking rate. The choice for a certain system has large effects on grassland production, the animal, the environment, economy and labour and even society. The impact of this choice on various aspects is summarized in Table 2 and explained in this paper.

Table 2. The effect of grazing on various aspects. The score ranges from - - to ++, with ++ signifying that the system concerned scores positive for the point in question, e.g. high health, low losses (Van den Pol-van Dasselaar, 2005).

Viewpoint	Unrestricted grazing	Restricted grazing	No grazing
Grass yield and grass use	-	+	+
Balanced diet	-	+/-	++
Natural behaviour	++	++	+
Animal health	++	+	+/-
Nitrate leaching, N_2O emission, N losses	-	+	++
P losses	-	+/-	+
Ammonia volatilization	++	+	+/-
Energy use, CH_4 emission	+	-	- -
Fatty acid composition of milk	++	+	+/-
Labour	++	+	+
Economics	+	+	-
Image of dairy farming	++	+	-

Effect of grazing system on grass production

Grazing affects both grass yield and grass utilization. Grazing has a relatively low gross dry matter production compared to cutting only. This is a result of grass being harvested at a much younger stage. More regeneration periods are needed per year. During grazing losses are incurred due to trampling and deposition of faeces and urine. Conversely, conserving grass gives harvest losses, preservation losses and feeding losses. Unrestricted grazing results in the lowest intake of net energy available for lactation, due to the combination of a relatively low production and relatively large grazing losses.

With a rising milk yield potential, the technical requirements of a properly balanced diet become increasingly important. Because grazing produces relatively large fluctuations in the composition of the diet, the attractiveness of unrestricted grazing declines as the dietary requirements become more demanding.

Effect of grazing system on animal welfare

Animal health and welfare are important items throughout the entire year and for all animals. Welfare includes aspects that are relatively easy to measure, such as health, and also intangible aspects such as emotions and feelings. Grazing has disadvantages as well as advantages. One important aspect of animal welfare is natural behaviour. This involves the requirements for food, water and rest, and also behavioural needs such as movement, social behaviour, foraging and play. Grazing gives much more scope for natural behaviour compared to conventional cubicle sheds.

Furthermore, grazing reduces the risk of mastitis because the infection pressure of ambient bacteria is lower and there is less probability of the teats being trampled (undamaged teats are less prone to bacterial infection). On the other hand, the sheep head fly (*Hydrotea irritans*) occurs exclusively outdoors, which means that permanent confinement indoors can avert summer mastitis. But on balance, grazing generally has a positive influence on udder health. Grazing also benefits the claw health of dairy cows. Infectious diseases like foot rot and the disease of Mortellaro are more common in the cowshed, because the infection pressure is higher (Smits *et al.*, 1992; Somers *et al.*, 2005). The relatively hard floor in conventional cubicles can result in wounds and pressure sores on knee and heel joints (Wechsler *et al.*, 2000). The frictional force required for unrestrained locomotion of dairy cattle is minimal 0.6 (Van der Tol *et al.*, 2005). While the frictional force of pasture is higher than 0.8 (Telezhenko *et al.*, 2004), the frictional force of floors in conventional cubicle sheds is in general less than 0.6.

Conversely, grazing results in large fluctuations in the composition of the diet and it makes frequent milking difficult. Both these aspects negatively influence welfare, especially if the cows are very productive. Furthermore, in the field the cows are exposed to the rain and sun and if the temperature exceeds 25 °C, heat stress can occur (Dantzer and Mormède, 1983; Shearer and Beede, 1990). In addition, in the field there is an increased risk of being infected by specific pathogens such as intestinal worms, lungworms and liver fluke. Across-the-fence contact with cows from other farms increases the risk of the transmission of infectious diseases such as infectious bovine rhinotracheitis and bovine virus diarrhoea. However, in practice these risks rarely lead to major problems of animal health.
In general, it is easier to prevent the disadvantages of grazing than to remedy the welfare disadvantages of current cubicle stalls.

Effect of grazing system on the environment

Grazing has several effects on the environment, the most obvious being nutrient loss. Less grazing results in reduced mineral losses and thus reduces the imbalance between a farm's mineral inputs and mineral emissions. This is particularly true for nitrogen, but is also important for phosphate. The most important difference between grazing and keeping cows indoors all year is the place where the dung and urine land: some in the pasture, or all in the cowshed. When dung and urine are deposited in the field, a large amount is deposited on a small area where the minerals cannot be used – at least, not in the short term – and thus losses are more likely. Dung and urine collected from the cowshed can be used as fertilizer. This improves the nutrient use efficiency and reduces the need to buy fertilizer, while yields remain the same. Keeping cows indoors all year can reduce a farm's imports of nitrogen by about 50 kg ha^{-1} yr^{-1} compared to grazing (Van de Ven, 1996). In addition, grazing affects the type of nitrogen loss. During grazing, relatively large amounts of nitrate may be leached (Ryden *et al.*, 1984) and there may be considerable denitrification (Ryden, 1985). Furthermore, there may be relatively large emissions of nitrous oxide (N_2O) (Velthof and Oenema, 1997). By contrast, collecting dung and urine from the stall and spreading it on the land, as is the case when keeping cows indoor all year, results in more ammonia volatilization. This ammonia volatilization may be partly reduced by adapting the feed strategy (less protein in the ration) (Van Duinkerken *et al.*, 2005). When keeping cows indoors all year, the energy use and hence the CO_2 emissions may also be larger because there is much more use of machinery. The grazing system does not affect methane emissions from grasslands themselves (Van den Pol-van Dasselaar *et al.*, 1999). The larger amount of manure in the slurry pits when keeping cows indoors all year, however, may lead to more methane emissions.

Effect of grazing on fatty acid composition of milk

The grazing system affects the fatty acid composition of milk. Due to grazing, the content of unsaturated fatty acids in milk increases (Elgersma *et al.*, 2003a, 2003b, 2004). Unsaturated fatty acids are believed to be better for human health.

Effect of grazing system on economy and labour

Grazing is, in general, more economically attractive than cutting only. Models indicate that in Ireland early grazing will generate an increased profitability of € 2.70 cow^{-1} day^{-1} for each extra day at grass, through higher animal performance and lower feed costs (Kennedy *et al.*, 2005). In the Netherlands, the difference between grazing and cutting-only is on average throughout the year € 0.5-€ 2 for every 100 kg milk produced (de Haan *et al.*, 2005). After all, the grazing cow selects, harvests and transports the grass herself and at the same time ensures that manure and urine are distributed over the field – albeit unevenly. On very intensive farms (≥ 20 000 kg milk ha^{-1}), cutting-only may be economically attractive. The benefits of cutting only on these farms are reduced somewhat by the additional labour needed compared to grazing. The labour input is lowest for unrestricted grazing. Situations of restricted access and no access to pasture require approximately the same labour input. Calculations showed that grazing yields the best returns hr^{-1} worked (Van den Pol-van Dasselaar and De Boer, 2007). However, it is not only the number of hours that counts, but also the quality of the labour needed (easy – difficult, light – heavy).

Grazing system and society

The choice for a certain grazing system even has an effect on society. In several regions of Europe, the general public appreciates grazing animals in the landscape. In the Netherlands for example, grazing dairy cows are seen as a national feature. Also, due to grazing, the biodiversity of the landscape increases which is valued by society. Finally, society also associates grazing with animal welfare. Therefore, grazing creates a positive image. The extent to which the general public notices grazing depends on:

- The number of animals
- The area grazed
- The time the animals spend grazing (hours per day, days per year)
- The place of the pasture (next to the motorway or deep in the countryside)
- The moment of grazing (day, night)

To graze or not to graze, determining factors

Farmers have various reasons for choosing a grazing system. In their choice they may incorporate the effect of grazing on grass yield and grass use, but also many other factors like sustainability (economy and environment), animal welfare, and society (Table 2). In some countries legislation is the determining factor.

The importance attached to the various effects of grazing is very personal. For example, what is more important: image of dairy farming or nutrient losses? Moreover, there seems to be conflicting views: grazing has advantages and disadvantages. For most factors the greater the number of hours at pasture, the greater the effect. For some factors the effect is site-specific, e.g. for nitrate leaching. The farm layout is another important site-specific factor which has a big impact on feasibility of alternative systems. It should also be remembered that farm management is an important factor. An individual farmer can have an effect on most of the relevant aspects via his or her management strategy and can thereby reduce or remove the negative effects of a certain grazing system. Table 2 shows that grazing for a limited part of the day scores well on the whole.

However, the question 'to graze or not to graze?' is not that easy to answer. There is another important influencing factor next to the elements already described in this paper. The project 'Koe & Wij' in the Netherlands (www.koeenwij.nl) showed clearly that the individual farmer is the main influencing factor. In the end, the personal preference of the farmer determines the grazing system used. Knowledge on the effect of grazing on labour, economy, environment and society is important, but the opinion of the farmer on the effect of grazing on these aspects is affected by personal preferences and experiences. Some farmers have negative experiences with grazing and therefore value all aspects like economy and labour negatively while others with positive experiences do exactly the opposite. Preferences may change with time or during major life events such as expansion of the farm or handover of the farm from parent to child. It may also change as a result of communication with society.

Knowledge transfer to farmers remains necessary. However, since personal preference is an important influencing factor, knowledge transfer alone is not enough to influence the choice of farmers and stop the decline in grazing. Projects to stimulate grazing should focus on personal preferences too. Furthermore, these projects should focus on grazing at large farms since the farm size in northwest Europe will continue to increase. As mentioned before, increased herd size makes grazing management more difficult. Therefore, relatively simple grazing systems should be developed and tested in practice. These systems may not reach the optimum herbage intake, but they will be easy to manage and therefore useful for large farms.

In conclusion

We expect the trend of decreasing percentages of dairy cattle with unrestricted grazing in Europe to continue. There are economical, practical and personal motives behind the decline in the popularity of grazing. The number of dairy cattle with no access to pasture may be influenced by legislation, knowledge transfer or development of relatively simple grazing systems. In the end, the personal motives of the farmer will answer the question 'to graze or not to graze'.

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