Spezielle Futterqualität von Grünland

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Introduction

Forage production in Germany faced new challenges in the last decades. The increasing pressure from the EU to reduce the contribution of agricultural practices to eutrophication of water resources resulted in several guidelines to the member States. In consequence, member States formulated their needs from the perspective of individual country agricultural practices, driven by soil and environment conditions, and historical agricultural practices, resulting in national legislation to be executed by farmers. Currently, the production of arable land may be split between the supply of food, feed and energy crops, and grassland areas in Germany become more attractive for grazing and forage conservation, and biogas production. In addition, crop rotations including arable grassland are alternatives to maize monoculture and should be supported further also in biogas producing farms. Depending on the proportion of permanent grassland and its use in dairy farming, farmers are shifting to temporary grassland especially in less favoured crop areas and its proportion is increasing continuously over the last years. Temporary grassland is characterized by a grass phase of one to three years. It has its origin in the positive response to residual effects of the grass phase in the subsequent arable crop, especially on soil fertility, reduced crop diseases and weeds. This kind of grass-arable system is important for some regions, to obtain adequate succeeding crop yields. The establishment of temporary grassland may be advantageous to overcome feed shortages observed in permanent grassland, to increase the variability of feed sources and to promote crop rotation (SØEGAARD ET AL., 2007).

As the main task for the majority of specialized dairy farms is to increase the N use efficiency at the farm level, a forage production system towards cultivation of temporary grassland combines the increasing genetic potential for high yielding dairy cows with the utilization of new released cultivars of forage species or the utilization of those with high nutritive value. Temporary grassland is used as alternative to optimize nutrient fluxes in the farming system, allowing the exchange between crop and livestock production to obtain higher efficiency.

The main objective herein was to integrate the knowledge about evaluation of feed quality (mainly protein) with that of grassland science in order to optimize nutrient fluxes in the plant-animal system. In this way, it should be possible to obtain a better understanding of processes influencing the forage quality variation in the forage crop and related them to possible relevant aspects in animal nutrition.

Breeding progress on protein quality for perennial ryegrass

Plant breeding has contributed with 4-5% per decade to the increase in dry matter production, in addition to an increase of 10 g kg^{-1} DM digestibility per decade in North Western Europe since the 1950's (WILKINS AND HUMPHREYS, 2003). However, one of the main problems in grassland based systems is the inefficiency of ruminants to convert plant biomass into animal product. Especially N is poorly utilized. Taking into account that only 20-30% of the ingested N can be converted to meat or milk (DEWHURST ET AL., 1996), ruminant feeding contributes to environmental N pollution. Assuming forages as important sources of proteins for high yielding dairy cows, the determination of protein quality should necessarily represent the estimation of the escape protein content of a specific forage species or mixture to reduce excessive losses of intraruminal degraded protein. Different literature reports on positive influence of non-ammonia N content in the small intestines resulting in efficient dietary N utilization when increasing amounts of escape protein available in the diet is present (SANTOS ET AL., 1998; VOLDEN, 1999). However, purchased concentrate with high amounts of escape protein is fed to correct for undegradable protein requirement of high yielding cows lacking in grass silage based diets, increasing the N load in the dairy farm. The possibility to improve protein quality of perennial ryegrass by breeding to save concentrate imports to the farm is not often considered. For those concentrates like soybean meal and rape seed meal the amount of escape protein is increased artificially through physical (heat) or chemical (formaldehyde) treatments. Also in silages there are possibilities to influence positively the protein quality, or at least avoid extensive losses on protein quality by wilting, application of lactic acid producing bacteria, or chemicals (e.g. organic acids). Although in fresh forage the proportion of true protein is higher compared to forage conserved as silage (MESSMAN ET AL., 1994; CASTILLO ET AL., 2001), in grazed forages the possibilities to manipulate protein quality are limited. Therefore, breeding for protein quality in perennial ryegrass needs to consider also grazing systems. An attempt to reduce the initial degradation rate obtained was tested for alfalfa (*Medicago sativa*), resulting in the LIRD-cultivars (low initial rate of degradation), which is a breeding target using measurements very close to the protein degradation processes in the rumen. COULMAN ET AL. (1999) used 4 hour incubation

period with the in situ technique to determine the initial rate of dry matter disappearance in fresh leaf alfalfa material. Cultivars which were characterized as LIRD were selected for subsequent breeding programs. The initial rate of degradation during the vegetative phase of the selected cultivars could be reduced by approximately 15%. However, this difference was only possible in the early vegetation stage, and disappeared with increasing plant maturity.
Based on such observation, it is important to address that breeding of new genotypes for improved feed quality should be based on animal responses (CASLER AND VOGEL, 1999; WILKINS AND HUMPREYS, 2003). In this regard the Cornell Net Carbohydrate and Protein System (CNCPS) represents one of several mechanistic models developed to predict the nutritional value of diets by taking into consideration the degradation processes of carbohydrates and proteins in the rumen (BALDWIN ET AL., 1977; DIJKSTRA ET AL., 1992; LESCOAT AND SAUVANT, 1995). Hence, the CNCPS could be used as a tool to gain information whether and to which extent differences in carbohydrate and protein composition might enhance animal performance.

Forage legume based systems

Due to its biological N fixation capacity, forage legumes present generally a higher protein content compared to grasses and therefore its proportion and persistence under grazing determine the crude protein content of the mixture (KLEEN ET AL., 2011). In contrast, the available energy is lower in proportion to the protein content. Consequently, in forage legume based production systems, the protein is poorly utilised due to energy deficiency and extensive degradation of protein in the rumen. Different studies demonstrated that with fast degradation rate and high losses of N in urine, the absorption of amino acids in the small intestine may limit the performance of lambs, lactating ewes and dairy cattle (ROGERS ET AL., 1980; BARRY, 1981). In contrast, lambs grazing forage legumes with condensed tannins showed significant higher average daily gains compared to ryegrass (Speijers et al., 2004). However, tannin containing forage legumes like birdsfoot trefoil (*Lotus corniculatus* L.), greater birdsfoot trefoil (*Lotus pedunculatus* Cav.) or sainfoin (*Onobrychis viciifolia* L.) have less agronomic performance and therefore not yet competitive with traditionally grown forage legumes like white clover, red clover or lucerne.
In forage legume based production systems, the nutritive value of forages can be improved by increasing the amount of escape protein. In this case, forage legumes with secondary plant compound like tannins or polyphenol oxidase may be advantageous in contributing to increase the amount of escape protein of forages. The determination of protein fractions as part of the definition of protein quality indicated as well higher quality for red clover and

birdsfoot trefoil (KLEEN ET AL., 2011). Higher proportions of fraction A (non-protein N) are linked to low escape protein contents and therefore suggests poor utilization of the protein, which will be excreted mainly in urine. Although the productivity and increase in nutritive value has received attention in several studies, the protein quality of white clover and lucerne is rather poor. Compared to birdsfoot trefoil and red clover, white clover and lucerne showed higher protein degradation rates (BRODERICK UND ALBRECHT, 1997) and higher contents of fraction A under cutting systems (KLEEN ET AL., 2011). In vivo trials comparing white clover with ryegrass show higher N losses with white clover in the diet of grazing cattle (BEEVER ET AL., 1986a) and cattle fed indoors fresh forage (BEEVER ET AL., 1986b). Differences between digestion processes, either biologically (enzymes, microbial activity) or physically driven (particle breakdown, passage rate) influence N losses (DEWHURST ET AL., 2003) and most in vivo works need to formulate isonitrogenous and isoenergetic diets for comparison purposes between forage species (BRODERICK ET AL., 2001). Therefore, forage legumes are determining the forage quality in legume based systems. The choice of one or another forage legume species is based on its adaptation to the management system, the climate and soil conditions, its biological N_2 fixation or a combination of these factors. Tannin-containing legumes may be favorable to increase the N use efficiency of the ruminant, but up to now the yield performance make species like birdsfoot trefoil less attractive. Getting knowledge about the protein quality of different forage crops, i.e. the degradation rate, protein content and protein fractions as influenced by the forage species and grassland management are important to derive feeding strategies to enhance nutrient utilization and N use efficiency of the grazing animal, and to contribute for the modelling of N loss routes in the soil-plant-animal system.

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