Review paper

# SUPPLEMENTARY FEEDING OF GRAZING DAIRY COWS

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## Abstract

The objective of this paper was to consider the effect of supplementary feeding of grazing dairy cows on dry matter intake (DMI), milk production and milk composition. Accurate estimations of total DMI and pasture DMI are important to the management of dairy grazing systems. The intakes of dry matter (DM) and net energy-$NE_L$ are lower on the pasture-only diet compared with cows supplementary fed with concentrate. Many pasture factors affect DMI, including pregrazing pasture mass and pasture allowance. Milk production of high producing grazing dairy cows in early lactation increases linearly as the amount of concentrate increases to 10 kg DM/day with a milk response of 1 kg milk/kg concentrate. In late lactation, increases are with a lower milk response per kilogram of supplemented concentrate. With the amount of concentrate supplementation, milk fat and protein yield increase while milk fat percentage decreases. Supplementation with rumen undegradable protein (RUP) is important for meeting requirements of grazing dairy cows, because the pasture has high ruminal crude protein (CP) degradability. Corn silage supplementation to grazing cows may increase milk production if pasture offered is restricted, but if pasture is offered ad libitum milk production does not change or can decrease. Supplementation of ruminally inert fat could have positive effect on milk production with concentrate supplemented at a lower rate.

**Key words**: *cows, intake, pasture, performances*

## Introduction

The use of pasture for dairy cows is considered as lower-cost feeding system because grazed forage is the cheapest source of nutrients. Milk production per cow is usually lower on grazing-based than on confinement-based farms. Milk production of grazing cows is limited by the inability to consume enough pasture DM to meet the nutrient requirements for higher milk production, or an imbalance of rumen fermentable carbohydrate and rumen degradable protein-RDP (Stojanović et al., 2006a; Stojanović et al., 2009). The duodenal protein supply of a dairy cow grazing pasture is adequate to meet the production requirements of approximately 25 kg of milk per day (Reis and Combs, 2000). Supplementation-concentrate as a source of starch provides the energy for more efficient utilization of the RDP in pasture (Grubić and Adamović, 2003; Stojanović et al., 2007).

According to Clark and Kanneganti (1998) pasture used for dairy cows is characterized as high quality pasture with the content of 18 to 24% DM, 18 to 25% CP, 40 to 50% NDF, and 6.40 to 7.0 MJ/kg DM of $NE_L$. The main objective of supplementation of grazing dairy cows is to increase total DMI and energy intake relative to that achieved with pasture-only diets (Stojanović et al., 2004). Supplemental nutrition of grazing cows improves the use of pasture with the possible higher stocking rate per unit of land, increases milk production per cow, improves body condition score-BCS and reproduction performances of grazing cows (Kellaway and Porta, 1993).

Appropriate strategies for supplementation of high producing dairy cows require an understanding of the effect of different types of supplements on DMI, digestion and animal performance and imply providing nutrients that complement the nutrient content of pasture and meet the nutrient requirements of dairy cows (Stojanović et al., 2006).

The objective of this study was to consider the impact of supplemental concentrate and forage nutrition of grazing cows on production performances.

**Dry matter intake of grazing cows**

Low pasture DMI is identified as a major factor limiting milk production of high producing cows with a grazing system (Grubić et al., 2003). Mayne and Wright (1988) reported that pasture DMI of high yielding dairy cows might reach 3.25-3.5% of BW, with no pasture quantity and quality restrictions. The intake of DM and $NE_L$ is lower on the pasture-only diet compared with cows fed total mixed ration (TMR), (Kolver and Muller, 1998). Total DMI of high producing cows fed pasture-only diets is lower than for cows fed pasture diets plus concentrates. This may be explained by physical constraints, rate of forage removal from the rumen, and water consumption associated with pasture.

Many pasture factors affect DMI, including pregrazing pasture mass (kgDM/ha) and pasture allowance - PA (amount of pasture offered per cow, kg DM/cow/day). Over a range of PA from 20 to 70 kg DM/cow/day, pasture DMI increased 0.19 kg/kg of increased PA (Bargo et al. 2003). In order to maximize pasture DMI of high producing dairy cows, unrestricted pasture quality and quantity must be ensured. Unrestricted pasture conditions (high PA) also imply low pasture utilization (pasture DMI/PA < 50%). The use of very high PA might result in deterioration of pasture quality because of the increase in residual pasture height. Even under unrestrictive pasture conditions, total DMI of high producing dairy cows is lower compared with cows consuming TMR or pasture plus supplements (Bargo et al., 2002). Because of low pasture utilization and deterioration of pasture quality at high PA, a practical recommendation is to provide a PA of 2 times the expected pasture DMI or 25 kg DM/cow/day when cows are fed supplements (Bargo et al., 2002). Grazing cows are characterized by low grazing efficiencies - 45.5% of the pasture allowance (Vazquez and Smith, 2000).

Regression equations for prediction of pasture DMI (PDMI) for grazing dairy cows:

PDMI, kg/day = 4.47 + 0.14 * FCM + 0.024 * BW + 2.00 * CBW + 0.04 * PA + 0.022 * PASUP − 0.90* SUP − 0.13* NDFp − 0.037 * LEG, (Vazquez and Smith 2000)

FCM - 4% fat corrected milk (kg/day), BW – body weight (kg), CBW - change in BW (kg/day), PA – pasture allowance (kgDM/cow/day), PASUP - pasture allowance and total supplementation interaction (PA * SUP), SUP - total supplementation (kg DM), NDFp - NDF in pasture available (% DM), LEG - percentage of legumes in pasture (%);

PDMI = –0.61 + 0.981 * PA + 0.479 * CI – 0.039 * (PA * CI) – 0.014 * $PA^2$, (Meijs and Hoesktra, 1984)

PA – pasture allowance (kg DM/cow/day), CI – intake of concentrates (kg/day);

For low pasture allowance, NDF intake as a percentage of the BW is 1.2%, whereas for high PA, intake of NDF is significantly higher than 1.3% (1.5% of BW in grazing dairy cows consuming only pasture), (Kolver and Muller, 1998).

Arriaga-Jordan and Holmes (1986) reported that concentrate supplementation of dairy cows reduced grazing time 11 min/kg of concentrate in continuous grazing and 8 min/kg of concentrate in rotational grazing. When the amount of concentrate was increased from 5 to 10 kg/day, grazing time decreased 16 and 20 min/kg of fiber-based or starch-based concentrate, respectively (Sayers, 1999). Bargo et al. (2002) reported that supplementation with 7.9 kg/day of a corn-based concentrate reduced grazing time by 75 min/day at low PA and by 104 min/day at high PA.

**Effect of supplementation on production performances of grazing dairy cows**

Supplementary feeding of grazing cows decreases pasture DMI while increases total DMI. Decreasing of pasture DMI is indicated by value of substitution rate – SR. Substitution rate is defined as the decrease in pasture intake per kilogram of supplemental feed.

SR (kg pasture DM/kg supplement DM) = (pasture DMI in unsupplemented grazing cows, kg - pasture DMI in supplemented grazing cows, kg) / supplement DM, kg

A substitution rate < 1 kg/kg means that total DMI of the supplemented grazing cows is higher than total DMI of the unsupplemented grazing cows. Bargo et al. (2003) reported that decreasing of pasture DMI was 13%, when pasture was supplemented with 1.8 to 10.4 kgDM of concentrate, while the increasing of total DMI was 24%. Milk response – MR (kg of additional milk/kg supplement) is one of the main indicators that determine whether supplementation is profitable.

The type of supplement influences substitution rate and milk yield and response. Supplementation with forages, such as hay or corn silage, decreases pasture DMI more than concentrates and results in higher SR than supplementation with concentrates. Mayne and Wright (1988) found SR ranged from 0.84 to 1.02 kg/kg for grass silage supplementation and from 0.11 to 0.50 kg/kg for concentrate supplementation. Meijs (1984) reported that SR was reduced from 0.45 kg pasture/kg high-starch concentrate to 0.21 kg pasture/kg fiber-based concentrate when cows grazed a ryegrass pasture.

There is usually a negative relationship between substitution rate and milk response, indicating that the lower SR the higher MR is expected. At high producing grazing dairy cows with increasing of pasture allowance, substitution rate also increased and milk response decreased. Bargo et al. (2002) in study with dairy cows (101 days in milk – DIM, milk yield of 45.8 kg/day) grazed orchardgrass (*Dactylis glomerata*) with corn as supplement (7.9 kg/day), with pasture allowance 25 and 40 kg DM/cow/day, reported SR as 0.26 and 0.55 kg pasture/kg concentrate, and MR as 1.36 and 0.96 kg milk/kg concentrate, respectively. Robaina et al. (1998) in the research on grazing dairy cows (pasture: perennial ryegrass - *Lolium perenne* and white clover - *Trifolium repens*) 180 DIM and yielding 20.5 kg milk/day, with 4.3 kg/day concentrate (barley/lupin) and pasture allowance 21.1 and 42.3 kg DM/cow/day, found that SR was 0.31 and 0.57 kg pasture/kg concentrate, and MR was 0.98 and 0.54 kg milk/kg concentrate, respectively. Higher substitution rate found with higher pasture allowance may be partially explained by the higher quality of pasture actually consumed, because cows have the opportunity to be more selective.

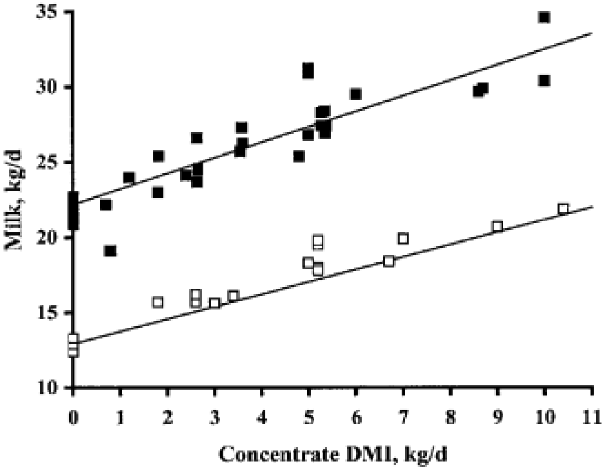


**Figure 1.** *Relationship between milk production and concentrate DMI by grazing dairy cows supplemented with different amounts of concentrate: ■-studies with cows < 90 DIM or > 28 kg milk/day; □-studies with cows > 160 DIM or < 23 kg milk/day (Bargo et al., 2003).*

Milk production of high producing grazing dairy cows in early lactation increases linearly as the amount of concentrate increases from 1.8 to 10 kg DM/day with milk response of 1 kg milk/kg concentrate, whereas in late lactation, milk response is lower. In early lactation, cows partition more nutrients toward milk production thus MR to supplementation may be higher than in late lactation, when more nutrients are directed to BW. To avoid metabolic health problems such as subclinical acidosis, it is not recommended to supplement more than about 10 kg DM/day or >50% of DMI. The high fiber intake (pasture NDF >50% DM) may allow for feeding high amounts of concentrate (Bargo et al., 2003).

Milk production increases with the amount of concentrate supplementation, as well as the milk fat and protein yield, while milk fat percentage decreases. Supplementation of 8.7 kg of corn for the grazing dairy cows (orchardgrass - *Dactylis glomerata*) with pasture DMI of 19 kg/day, decreased pasture DMI – 15.8 kg/day while increased total DMI – 24.5 kg/day, increased milk yield (20.7 to 29.8 kg/day) and milk fat yield (0.79 to 0.97 kg/day) and milk protein yield (0.60 to 0.90 kg/day), while milk fat percentage was decreased (3.81 to 3.31%) with increased milk protein percentage (2.96 to 3.10%), (Bargo et al., 2002). Supplementing grazing dairy cows (perennial ryegrass - *Lolium perenne*) with 1.8 or 3.6 kg/day of concentrate (corn/dry beet pulp), decreased pasture DMI (17.1 to 16.5 and 16.8 kg/day) while total DMI was increased (17.1 to 18.3 and 20.4 kg/day), as well as milk yield (24.0 to 25.0 and 26.6 kg/day), milk fat yield (0.88 to 0.90 and 0.93 kg/day) and milk protein yield (0.77 to 0.82 and 0.86 kg/day), while milk fat content was decreased (3.71 to 3.68 and 3.55%) with increased milk protein content (3.25 to 3.28 and 3.26%), (Dillon et al., 1997). Reis and Combs (2000) found that using 5.0 and 10.0 kg of corn in diets for grazing cows (alfalfa - *Medicago sativa*, red clover - *Trifolium pratense*, perennial ryegrass - *Lolium perenne*) decreased pasture DMI (13.9 to 12.7 and 9.8 kg/day) increasing at the same time total DMI (13.9 to 17.7 and 19.8 kg/day) with increase in milk production (21.8 to 26.8 and 30.4 kg/day) and decrease in milk fat yield (0.88 to 0.83 and 0.75 kg/day) while milk protein yield was increased (0.62 to 0.79 and 0.93 kg/day), content of milk fat was reduced (3.89 to 3.50 and 3.08%) whereas higher values for milk protein were determined (2.85 to 2.95 and 3.05%).

Supplementation with rumen undegradable protein-RUP could be important for meeting requirements of grazing dairy cows, because the pasture has a high ruminal CP degradability (>70%), and therefore provides smaller amounts of RUP compared with cows on TMR diets (Grubić et al., 2003a; Stojanović et al., 2010). Providing necessary dietary content of RUP is possible by using high-quality protein feeds - sources of undegradable (protected) protein: heat-treated soybean and soybean meal (extruded, toasted), soybean expeller, corn gluten meal, heat or chemical treated rapeseed expeller and meal (Stojanović et al., 2010a). Ruminal ammonia concentration of grazing Holstein cows decreased linearly with the inclusion of supplement (corn-based concentrate 5 and 10 kg DM/day) in the diet. Reduction in ruminal ammonia (from 13.2 to 10.4 and 8.13 mmol) is most likely due to the ability of the ruminal bacteria to utilize larger amounts of ammonia because of an increased supply of ruminally fermented organic matter (Reis and Combs, 2000). The pasture species have a large impact on the RUP concentration in consumed pasture. A winter oats pasture contains 18.4% CP and 19.3% RUP in CP, while an orchardgrass pasture contains 24.8% CP and 39.1% RUP in CP. An increase in milk yield (6 to 18%) with supplementation of high RUP concentrates is reported in the study by Schor and Gagliostro (2001).

Corn silage supplementation to grazing cows may increase milk production if pasture offered is restricted - low pasture allowance, but if pasture is offered ad libitum - high PA, milk production does not change or can decrease. Different forms and amounts of hay supplementation reduced pasture DMI, whereas the effect on total DMI depended on the substitution rate values: with lower SR (0.33) total DMI was increased, and higher SR (0.81-0.97) resulted in similar total DMI (Bargo et al., 2003).

Supplementation of rumen-protected fat positively affects milk production with concentrate supplemented at a rate lower than 4 kg DM/day (milk production less than 30 kg/d). Milk fat percentage was higher (4.02 to 4.36%) when 0.5 kg/day of ruminally inert fat was added to 3.3 kg DM/day of concentrate-barley for grazing cows (King et al., 1990).

## Conclusion

Low pasture DMI is a major factor which can limit the milk production of high producing grazing cows. The pasture factors that mostly affect DMI are pregrazing pasture mass and pasture allowance. Supplementary feeding of grazing cows decreases pasture DMI while increases total DMI. Increasing in milk yield, milk response, is one of the main positive effects of supplementary feeding, followed with improvement in pasture utilization, possible increase in stocking rates on the pasture and positive effects on BCS and reproduction. Milk production increases with the amount of concentrate supplementation (up to 10 kg DM/day), as well as milk fat and protein yield, while milk fat percentage decreases. Dietary crude protein utilization is improved by inclusion of concentrate in diets for grazing cows. Corn silage supplementation to grazing cows may increase milk production if pasture offered is restricted.

**Acknowledgments**

This study is realized by financial support of the Ministry of Education, Science and Technological Development of the Republic of Serbia, through the Technological Development Project TR-31086.

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