**Bhutan Journal of Animal Science (BJAS)**
**Volume 6, Issue 1, Page 40-45, March 2022**

# EFFECT OF FEEDING GLIRICIDIA AND STYLO MEAL ON THE MILK YIELD AND COMPOSITION OF DAIRY COWS

**WANGCHUK[1], GANGA MAYA RIZAL[2], JAMBAY GYELTSHEN[1], CHIMI RINZIN[1] AND DORJI RINCHEN[3]**

[1] National Research and Development Center for Animal Nutrition, Department of Livestock, MoAF, Bumthang, Bhutan
[2] Department of Livestock, MoAF, Thimphu, Bhutan
[3] Dzongkhag Livestock Sector, Sarpang Dzongkhag, Bhutan

*Author for correspondence: wangchuk@moaf.gov.bt



**ABSTRACT**: Optimizing the productivity of livestock under smallholder farming system remains a challenge due to inability to feed adequate quantity of concentrate feed to express the genetic potentials. The high cost of concentrate feed for smallholder farmers hinders the optimization of productivity of the livestock. There is an urgent need to support smallholder farmers in Bhutan to augment livestock productivity through cheaper yet nutritious feeding resources. This study examined the effect on milk yield and its constituents by substituting home based cattle concentrate feed with legume meal (*Glyricidia sepium* and *Stylosanthes guianensis*). The feeding experiment was conducted at Dekiling Geog in Sarpang Dzongkhag. Three Jersey cross cows in mid lactation, weighing in average about 248.66 kg (live body weight), were assigned to a 3 x 3 Latin Squares. The dietary treatments consisted of 30 %, 20 % and 0 % legume meal in the daily diets of the experimental cows. The replacement of home-based concentrate with legume meal did not significantly affect the milk yield and its composition. The study finding suggests that home-based concentrates can be safely replaced by feeding legume forage meals. As legume meals can be made available year-round, it could be a good alternative feeding resource to sustain milk production throughout the production cycle in smallholder dairy farming system.

**Keywords:** legume meal; milk constituents; milk yield; smallholder dairy

## 1. INTRODUCTION

Feeding nutritionally balanced feed is the paramount important for livestock farmers to optimize productivity. An adequate feeding will ensure the energy and protein requirement of dairy cows to maintain optimum milk production, good health and reproductive efficiency (Orjales et al. 2018). In any livestock farming system, feed constitutes the highest variable cost, and lowering the cost of production at the smallholder dairy farms is reported vital (Heins et al. 2019). Promoting and feeding locally available legume meals or fodder at the smallholder farming system is expected to meet the nutritional requirement of dairy cows, while expenses on the feeding of limited and expensive protein rich concentrate could be reduced.

In Bhutan, concentrate feed is expensive as all raw materials are imported and feeding it is not common amongst the smallholder dairy farmers resulting in low productivity. This issue could be addressed by upscaling production and utilization of legumes such as Gliricidia and Stylo since legumes are the cheapest source of plant-based protein for animal feeding.

Gliricidia is a multi-purpose legume tree with the ability to provide high quality forage all year round (Odunsi et al. 2002). It is widely used as a protein source for ruminants during dry season and fed as a fresh diet or as leaf meal (Somasiri et al. 2010). While Stylo is promoted as a subtropical fodder legume in the country, Gliricidia is mostly used as a live fence by farmers in the subtropical region. To encourage green forage production at the entrepreneurial level, a contract fodder production

program on a pilot basis was initiated at Yangchenphu village under Dekiling Geog in Sarpang Dzongkhag. The green forage production is managed by a contract fodder production farmers' group that has been producing and supplying green forage silage to peri-urban private dairy and government farms. Recently, the group has set up a mini-forage legume processing plant and initiated the production of subtropical fodder legume meal from Glyricidia and Stylo on a trial basis. However, there is no local data on the level of substitution of home-based concentrate by legume meals in the diets of dairy cows. Therefore, on a pilot scale, the feeding trial was conducted with Jersey cross cows at the smallholder dairy farming level. The objectives were to evaluate the effect of substituting home based concentrate by feeding legume meal on milk production and its composition and initiate organic based livestock feeding.

## 2. MATERIALS AND METHOD

### 2.1 Study area

The experiment was conducted at Yangchenphu village. It is located at an altitude of 400 meters above sea level (masl) and administratively falls under Dekiling Gewog in Sarpang Dzongkhag. The integrated crop-livestock farming system dominates the agriculture farming system in the study area. The Dzongkhag has an improved breed cattle population of 9722 (DoL 2019). The dairy farm having the provision of separate feeding pan was selected for the study.

### 2.2 Animal Management

The animals used in this experiment were managed in a normal housing system practiced for cattle in the subtropical region of the country. The animals were adequately fed ensuring animal welfare.

### 2.3 Selection of animal

The dairy backyard farm with three lactating Jersey cross cows (248.66 ± 40.06 kg of BW) was selected for the experiment. The animals were of similar age and lactation stage. Prior to the feeding trial, the animals were observed for physical health status. The live body weight of all experimental animals was measured/estimated using rondo tape before and after the experiment. The minimum of two meters distance was maintained between the experimental animals to avoid error in feeding.

### 2.4 Experimental design and treatments

The experimental design was a 3×3 Latin squares design. The feed treatments and their compositions are presented in Table 1. Three Jersey crossbred cows in their mid-lactation stage were selected for the experiment. Each cow was subjected to three 21-day periods (Table 2). During each period, animals were offered one of three diets. The 21-day period included 14 days as a dietary adaption period and seven days for data collection. The amount of feed allocated for each animal was based on total dry matter requirement. The total DM requirement was estimated at 3% of the live body weight. Feeding was carried out for 63 days from 28th April to 27th June 20.

**Table 1**: Composition of experimental diet

| Feed type | Treatments (feed composition%) | | |
|---|---|---|---|
| | T1 | T2 | T3 |
| Fodder grass (basal diet) | 77 | 77 | 67 |
| Dried Legume meal (50% Glyricidia+50% Stylo) | 0 | 20 | 30 |
| Concentrate (Crushed maize) | 20 | 0 | 0 |
| Molasses | 3 | 3 | 3 |

**Table 2**: Arrangement of treatments in 3 x 3 Latin squares design

| Period | Cow No. | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| I | T2 | T1 | T3 |
| II | T1 | T3 | T2 |
| II | T3 | T2 | T1 |

### 2.5 Preparation of legume meal

The green Glyricidia leaves with twig and Stylo forage were harvested from field and transported to mini-forage processing unit. The green legume forage was chopped by fodder chaff cutter to required size and spread over the sun drying shed for minimum of one week. The dried legume chaff was ground into legume meal by grinding machine.

### 2.6 Chemical analysis

The forage legume meal used in the feeding experiment was analyzed at Animal Nutrition Laboratory, NRDCAN, Bumthang. Proximate analysis was performed for crude protein, crude fat, crude fiber, and total ash content following the AOAC methods (AOAC 1990).

### 2.7 Data collection

Feed offered and feed refused were measured on a daily basis and feed intake was calculated as feed offered minus feed refused. The milk production was measured and recorded daily from the 15$^{th}$ to 21$^{st}$ days of each period for three consecutive experimental periods. The fresh milk samples were collected and analyzed weekly in a milko tester to determine the milk composition.

### 2.8 Statistical analysis

Statistical analysis was conducted using results from the final week of each experimental period. The data collected were processed in Microsoft excel spread sheet and exported to IBM SPSS version 26. The data sets were arranged in rows and columns and checked for outliers followed by Shapiro Wilk's and Leven's tests for normality and homogeneity of variance. The data on DM intake and lactation performance was averaged per period. The data were analyzed for descriptive statistics such as mean and standard deviation. The statistical inference test was performed through General Linear Model and Univariate with Post Hoc tests to compare the means of different treatments on milk quantity and quality parameters.

## 3. RESULTS AND DISCUSSION

### 3.1 Chemical composition of feed ingredients

The nutritive value of forage is dependent on chemical composition, dry matter digestibility and dry matter intake. The chemical composition of the legume meal is presented in Table 3. The concentration of crude protein (CP) in Glyricidia and Stylo meal were 16.53 and 9.71 percent respectively. The CP content for Glyricidia and Stylo meal in present study was observed lower than the values reported elsewhere. Several authors have reported the average CP content of Stylo varieties in the range of 10 to 12% (Bamikole and Babayemi 2004; Liu et al. 2012; Li et al. 2014) whereas the CP content in *Glyricidia sepium* was reported in the range of 20-26% (Anis et al. 2016; Silva et al. 2017). This could be due to the variation in the harvesting stage, soil fertility and environmental conditions including rainfall. In the present study, the crude fiber content in a legume meal was observed higher than those reported by Aye and Adegun (2013). The difference could be due to variation in harvesting stage and inclusion level of leaf component and plant parts while processing for legume meal. The crude fiber content in legume meal rises if a higher ratio of plant stem and twigs are included.

**Table 3**: Chemical composition of the legume meal

| Parameters (%) | Legume meals | |
|---|---|---|
| | Glyricidia | Stylo |
| Crude protein | 16.53 | 9.71 |
| Crude fat | 2.5 | 1.25 |
| Crude fiber | 14.5 | 35.5 |
| Total ash | 6.54 | 2.78 |

### 3.2 Average dry matter intake

Table 4 presents the average dry matter intake (DMI), milk production and milk composition of three treatment groups. The dry matter intake is one of the important parameters to determine the performance of dairy cows (Vazquez and Smith 2000). The average DMI of cows among the three treatments did not differ significantly. This finding is in line with the result of Pailan et al. (2010) who reported similar DMI when supplemented with legume meal. Thang et al. (2008) also observed similar results for total feed intake in growing cattle with increasing levels of replacement with legume foliage. The different inclusion levels of legume meal in this experiment did not increase average DMI. This could be due to feeding of the same type of basal diet to the cows. However, Das et al. (2012) reported improvement in DMI for growing heifers when the concentrate was replaced with Stylo meal. On the contrary, DMI was reduced when concentrate was replaced with Glyricidia leaves (Richards et al. 1994). The variable response observed in different feeding

**Table 4:** Total DMI, milk yield and composition for three treatment groups (Mean ± SD)

| Parameters | Treatment | | | Significance level |
|---|---|---|---|---|
| | T1 | T2 | T3 | |
| Total DMI (Kg) | 7.45 ± 1.20 | 7.46 ± 1.20 | 7.46 ± 1.20 | ns |
| Milk yield (L per day) | 4.50 ± 2.79 | 4.61 ± 0.89 | 3.59 ± 2.17 | Ns |
| Milk fat (%) | 3.99 ± 1.22 | 4.32 ± 1.14 | 4.09 ± 0.54 | ns |
| Milk protein (%) | 3.03 ± 0.12 | 3.00 ± 0.15 | 3.00 ± 0.17 | Ns |
| SNF (%) | 8.33 ± 0.33 | 8.29 ± 0.45 | 8.27 ± 0.53 | Ns |
| Lactose (%) | 4.58 ± 0.20 | 4.58 ± 0.22 | 4.56 ± 0.27 | ns |

*$p \leq 0.05$; ns: nonsignificant*

experiments could be due to variation in the stage of animal, form of supplemental feeding, the type of basal diet inclusion and the presence of antinutritional factors.

### 3.3 Milk yield and composition

The average milk yield recorded were 4.50, 4.61 and 3.59 L for T1, T2, T3, respectively. Although there were no significant differences in daily milk yield among the three treatment groups, the milk production for T2 was higher than T1 and T3. A similar result was reported by Widiawati et al. (2019) when the concentrate was replaced with Glyricidia meal for feeding dairy cows. This indicates that the inclusion of forage legume meal in dairy ration does not affect milk production at small holder farm level. Pailan et al. (2010) stated that on dry matter basis 25% of concentrate mixture could be replaced by stylo meal without affecting milk yield and its composition in lactating buffaloes under on-farm condition. However, some authors have reported an increase in milk yield when feeding forage legumes (Dewhurst, 2013; Phelan et al. 2015). Sehested et al. (2003) concluded that the omission of concentrate supplementation to high merit cows could reduce milk production by 24%. The increase in milk yield potential for high yielding cows has been correlated with the corresponding increase in concentrate feeding but the greater cost of concentrate compared to the cost of forage demands efficient use of concentrate (Purcell et al. 2016).

According to Krailas and Wanapat (2003), the replacement of concentrate with stylo and cassava does not affect the milk yield but increases the milk protein percentage of cross bred dairy cows. The higher level of milk protein from feeding with a forage diet could be attributed to high tannin content. The major benefits associated with the presence of tannin in the feed are the protection of plant protein from digestion in the rumen and availability of protein for utilization in the small intestine (Wanapat et al. 2002). In this experiment, milk protein content across the three treatments was similar. The milk fat content for T2 (20% LM) and T3 (30% LM) were higher than T1 (20 % concentrate) even though the difference was not significant. This could be due to the complete replacement of concentrate by forage based legume meal in the present feeding experiment. The milk from the cow fed with forage-based diet would contain a higher ratio of fatty acids and affect the fatty acid profile (Kalac and Samkova 2010). Sutton et al. (2003) mentioned that the reduction of milk fat content in dairy cow may be due to changing the conventional diet to low roughage diet.

## 4. CONCLUSION

Considering the findings from the current study, the replacement of home-based concentrate with mixed legume meal (*Glyricidia sepium and Stylosanthes guianensis*) does not affect milk production and its composition. The strategic supplementation of legume meal has the potential to reduce concentrate use in smallholder dairy farms and result in higher economic returns through a lower concentrate to milk yield ratio. It also has the potential to promote organic dairy farming by feeding organic based forage and legume feed resources. The present study thus concludes that legume meal can safely replace the home-based concentrate feed. Replacing home-based concentrate feed with legume meals can be a valuable strategy to generate income from smallholder dairy farming system in Bhutan. The

use of non-conventional feed stuffs such as legume meals could be an alternative that can be adopted to reduce the feed cost. The legume meal can be also fed to meet the requirement of livestock particularly during lean season when availability of other protein rich forage is scarce. However, further investigation is needed in organized large scale dairy farms to understand the value of mixing legume meal as a protein source. The inclusion levels of legume meals in the Total Mixed Ration can also be experimented to understand the economic benefit returns from the plant protein source for livestock feeding.

## COMPETING INTERESTS

All authors named in this study declare that there were no financial and non-financial competing interests in conducting this study. The study was mainly conducted to understand the effect of substituting home based concentrate with the legume meals in dairy cattle performance so that smallholder farmers could benefit from the study.

## ACKNOWLEDGEMENT

The authors would like to express sincere gratitude to the Program Director of the National Research and Development Centre for Animal Nutrition for his continuous support in meeting the research demands of the center. All authors acknowledge the continuous support provided by the Sarpang Dzongkhag Livestock Sector, Mr. Tashi Dendup (CLPO) LPD, Mr. Towchu Rabgay (CRO) LRED, Mr. Jigme Wangdi (ES), DoL, and all the staff of NRDCAN, Bumthang. We highly acknowledged their support in completing this experiment. We extend our heartiest appreciation to Mrs. Dechen Yeshi from Dekiling Geog, Sarpang Dzongkhag for allowing us to conduct a feeding trial on her dairy farm.

## REFERENCES

AOAC. (1990). Association of Official Analytical Chemists. 15th edition. Published by Association of Official Analytical Chemists, inc. Suite 400. 2200 Wilson Boulevard, Arlington, Virginia 22201 USA.

Aye PA and Adegun MK. (2013). Chemical composition and some functional properties of Moringa, Leucaena and Glyricidia leaf meals. Agriculture and Biology Journal of America, 4 (1): 71 – 77.

Anis SD, Kaligis DA, Talung G and Aryanto. (2016). Leaf quality and yield Glyricidia sepium under different population density and cutting interval in coconut plantation. Journal of the Indonesian Tropical Animal Agriculture, 41 (2): 91 – 98.

Bamikole MA and Babayemi OJ. (2004). Feeding goats with Guinea grass - Verano Stylo grass nitrogen fertilized grass with energy concentrate. Arch Zootec, 53: 13 – 23.

Das MM, Mahanta SK and Mojumdar AB. (2012). Effect of replacement of concentrate mixture protein with stylo meal on intake, nutrient utilization and growth performance of crossbred heifers. Indian Journal of Animal Science, 82 (10): 1217 – 1220.

Dewhurst R. (2013). Milk production from silage: comparison of grass, legume and maize silage and their mixtures. Agriculture Food Science, 22:57-69.

DoL (2019). Livestock Statistics, Department of Livestock, Thimphu, Bhutan.

Heins BJ, Sjostrom LS, Endres MI, Carillo MR, King R, Moon RD and Sorge US. (2019). Effects of winter housing systems on production, economics, body weight, body condition score and bedding cultures for organic dairy cows. Journal of Dairy Science, 102(1):706-714.

Kalac P and Samkova E. (2010). The effects of feeding various forages on fatty acid composition of bovine milk fat: A review. Czech Journal of Animal Science, 55(12): 521-537.

Krailas K and Wanapat M. (2003). Cassava hay and Stylo 184 to replace concentrates in diets for lactating dairy cows. Livestock Resources Rural Development, 15 (11): 1-9.

Li M, Zi X, Zhou H, Hou G and Cai Y. (2014). Chemical composition and in vitro digestibility of Stylosanthes guianensis varieties.

Lui Q, Chen M, Zhang J, Shi S and Cai Y. (2012). Characteristics of isolated lactic acid bacteria and their effectiveness to improve stylo silage quality at various temperature, Animal Science Journal, 83: 128 – 135. Grassland Science, 60: 125 – 129.

Odunsi AA, Ogunleke MO, Alagbe OS and Ajani TO. (2002). Effect of feeding Glyricidia sepium leaf meal on the performance and egg quality of layers. International Journal of Poultry Science, 1(1): 26 – 28.

Orjales I, Alonso ML, Miranda M, Moreton HA, Resch C and Lopez S. (2018). Dairy cow Nutrition in organic farming system. Comparison with conventional system. The Animal Consortium.

Pailan GH, Gupta JN, Sharma P and Mahanta SK. (2010). Effect of Stylo supplementation in lactating buffaloes. Indian Journal of Animal Science, 80 (10): 1031-1033.

Phelan P, Moloney AP, Geough EJM, Humphreys J, Bertilsson EG, Riordan O and Kiely PO. (2015). Forage legumes for grazing and conserving in ruminant production systems. Critical Reviews in Plant Sciences, 34: 281-32

Purcell PJ, Law RA, Gordon AW, Gettrick SAM and Ferris CP. (2016). Effect of concentrate feeding method on the performance of dairy cows in early to mid-lactation. Journal of Dairy Science, 99: 2811 – 2824.

Richards DE, Brown WF, Ruegsegger G and Bates DB. (1994). Replacement value of tree legumes for concentrate in forage-based diets. II. Replacement value of *Leucaena leucocephala* and *Gliricidia sepium* for lactating goats. Animal Feed Science and Technology, 43: 53 – 65.

Sehested J, Kristensen T and Soegaard K. (2003). Effect of concentration supplementation level on production, health and efficiency in an organic dairy herd. Livestock Production Science, 80: 153 – 165.

Silva SF, Carneiro MSS, Edvan RL, Pereira ES, Neto LBM, Pinto AP and Camilo DA. (2017). Agronomics characteristics and chemical composition of Glyricidia sepium grown under .

different residual heights in different seasons. Ciencia Investigation Agraria, 44 (1): 35 –42.

Somasiri SC, Premaratne S, Gunathilake HAJ, Abeysoma HA, Dematawewa CMB, and Satsara JHMN. (2010). Effect of Glyricidia (*Glyricidia sepium*) leaf meal blocks on intake, live weight and milk yield of dairy cows. Tropical Agriculture Research, 22(1):76-83.

Sorge US, Moon R, Wolff LG, Michels L, Schroth S, Kelton DF and Heins B. (2016). Management practices on organic and conventional dairy herds in Minnesota. Journal of Dairy Science, 99: 3183-3192.

Sutton JD, Dhanoa MS, Morant SV, France J, Napper DJ and Schuller E. (2003). Rate of production of acetate, propionate and butyrate in the rumen of lactating dairy cows given normal and low roughage diets. Journal of Dairy Science, 86:3620 – 3633.

Thang CM, Sanh MV and Wiktorsson H. (2008). Effects of supplementation of mixed cassava (*Manihot esculenta*) and legume (*Phaseolus calcaratus*) fodder on the rumen degradability and performance of growing cattle. Asian Australian Journal of Animal Science, 21 (1): 66-74.

Wanapat MA, Polthanee S, Wanapat and Wachirapakorn C. (2002). Feasibility study on cassava leaf/hay as animal feeds. Department of Animal Science, Faculty of Agriculture, Khon Kean University, Thailand.

Widiawati Y, Purwantari ND, Sajimin and Herliatika A. (2019). The utilization of Arachis pintoi and Gliricidia sepium as protein sources substitute for dairy cattle. IOP Conference Series: Earth and Environmental Science.

Vazquez OP and Smith TR. (2000). Factors affecting pasture intake and total dry matter intake in grazing dairy cows. Journal of Dairy Science, 83:2301-2309.