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Effect of supplementing crossbred lactating dairy cows fed elephant grass based diets with lablab hay and a concentrate

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Abstract

Lablab (Lablab purpureus [Sweet]) cv Rongai as a supplementary forage legume for lactating dairy cows (Friesian x Zebu) fed elephant grass (Pennisetum purpureum) based diets with and without a concentrate was evaluated. Crossbred (Friesian x Zebu) lactating dairy cows with live-weights of 405.5 (SD ±15) and 385.5 (SD ±15) and mean milk yields of 9.5 and 8.5 litres respectively were used in two experiments at Namulonge Agricultural and Animal Production Research Institute. Effect of supplementing lactating crossbred dairy cows fed on elephant grass based diets with lablab hay supplement on milk yield was assessed in experiment I. Addition of lablab hay significantly increased elephant grass dry matter intake (DMI). The optimum supplement level was 3 kg day^{-1} (as fed), beyond which there was a substitution effect. Sole feeding on elephant grass resulted in lower ($P \leq 0.05$) total dry matter intake (TDMI) than when lablab hay supplement was included. Daily milk yield was significantly ($P \leq 0.05$) increased by lablab hay supplementation up to 3 kg day^{-1}. Butterfat content was not affected by supplementation. The effect of supplementing elephant grass fodder and 3 kg day^{-1} of lablab hay as basal diets with a concentrate on the performance of lactating crossbred dairy cows was assessed in Experiment II. Concentrate supplementation impaired DMI of elephant grass but TDMI increased significantly ($P \leq 0.05$). Daily milk yield was increased ($P \leq 0.05$) by supplementing up 2 kg day^{-1} of a concentrate but there was no further increase ($P \leq 0.05$) with the level of 3 kg day^{-1}. Butterfat content was not affected by conceutrate supplementation. Satisfactory performance of lactating crossbred dairy cows fed elephant grass fodder based diets can be obtained by supplementing with lablab hay and a concentrate.

Key words: Lablab, milk yield, supplement.

Introduction

The use of elephant grass (*Pennisetum purpureum*) as a basal diet for lactating dairy cows is a well-established on most smallholder dairy farms in Uganda. The major problem associated with it is, it matures rapidly, becomes coarse and stemmy, and therefore has a low crude protein value for a greater part of the year resulting in low apparent digestibility (Bredon and Horrel, 1962; Ogwang, 1974). Animals subsisting solely on it during the dry season are pften on a diet almost void of digestible crude protein and in many cases may even show a negative nitrogen balance (Crowder and Chheda, 1982). Low protein content also causes a reduction in overall digestibility of herbage dry matter. The end result of reduced voluntary intake and lower digestibility is a shsrp decline in the total intake of digestible energy.

Lablab purpureus cv Rongai provides a cheap source of protein for livestock in Uganda. Over 80% of smallholder dairy farmers in Uganda use *Lablab purpureus* cv Rongai (lablab) fodder as a protein supplement to elephant grass (Kabirizi, 1996). The forage legume produces higher dry matter yield compared to other sister forage legumes used by the smallholder dairy farmers in Uganda (Sabiiti, 1993). Herbage availability during the growing seasons often exceeds animal requirements; however the accumulated forage loses its nutritive value with maturity (Kabirizi, 1996). The excess herbage harvested at optimum nutritive value could be conserved and used as a protein supplement to elephant grass based diets during the dry seasons.

Protein and energy contents of forages are the major factors affecting optimum milk yield (Muinga *et al.* (1993). Forage which forms the bulk of the feed may be available in sufficient quantity but of inadequate quality to support optimum milk production. It therefore becomes necessary to supplement the diet with concentrates to ensure optimal milk. To reduce competition between man and animals for cereal grains, it is important to determine the optimal rate of concentrate supplementation for lactating cows in accordance with efficient utilization of available forages.

In view of the above constraints, a study was conducted at Namulonge Agricultural and Animal Production Research Institute (NAARI) with a broad objective of assessing the potential of lablab hay as a dry season protein supplement to elephant grass based diets with and without a concentrate supplement for lactating dairy cows. The specific objectives of the study were to determine:

a) The optimal level of lablab hay supplement for crossbred lactating dairy cows fed a basal diet of elephant grass (*Pennisetum purpureum*) and its effect on milk yield and milk composition.

b) The optimal level of a concentrate supplement for crossbred lactating dairy cows fed elephant grass-lablab hay as a basal diets and its effects on milk yield and milk composition.

The study comprised of two feeding experiments.

Experiment 1. Effect of supplementing elephant grass (*Pennisetum purpureum*) with *Lablab purpureus* hay on milk yield and milk composition of lactating dairy cows

Objective

To determine the effect of supplementing crossbred lactating dairy cows fed on elephant grass based diets with lablab hay on milk yield and milk composition.

Materials and methods

Fodder establishment, harvesting and hay production

Two hectares of land were planted to lablab forage (cv. Rongai) at NAARI six months before the experiment started. Lablab seeds were sown at a spacing of 1.0 m by 1.0 m, a sowing depth of 2.5 cm and a seed rate of 7.5 kg ha^{-1}. Two seeds per hill were planted. All plots received a blanket application of 50 kg of P_2O_5 ha^{-1} before sowing to improve the P content of the soils. Planting and crop management was done according to Ogwang (1974).

The herbage was harvested by cutting whole plants (stems and leaves) at a height of 30 cm above ground as recommended by Favoretto and Costa (1978). This was done when 50% of the plants had flowered (Kabirizi, 1996). Hand-shears were used to harvest the herbage. The harvested material was chopped into pieces of 1.5-3.0 cm long using a hand shear and later dried in a shade. The material was consistently turned using a rake to enhance drying. The dried material was baled in wooden baling boxes with dimensions of 60 cm x 75 cm x 60 cm. The bales were tied using sisal strings. The bales were tied using sisal strings. The baled hay was stored in a well-ventilated store on wooden racks

Four hectares of land were planted to elephant grass fodder two months before the experiment started. The elephant grass variety used in this experiment was *Pennisetum 99* which is a hybrid between *P. purpureum* and bulrush millet (*P. typhoides)*. Ogwang (1974) reported higher dry matter (24 t/ha) and crude protein values per unit area (CP 12%) in *P. 99* than the commonly used elephant grass hybrid, Kawanda (*KW) with* 18 t/ha, dry matter yield and CP 8%), a hybrid between the local hairy elephant grass variety found along the roadsides and Bulrush millet, P. *typhoides*. *P. 99* is therefore the currently recommended elephant grass variety for feeding dairy cattle in Uganda. Ogwang (1974) reported that although yield results and energy concentration were found to be high in *P. 99*, it is too mature to meet the nutritional requirements of a mature dairy cow if it is harvested at 10 weeks

The dried material was baled in wooden baling boxes with dimensions of 60 cm x 75 cm x 60 cm. The bales were tied using sisal strings. The baled hay was stored in a well-ventilated store on wooden racks

Experimental design and animal management

Crossbred (Zebu x Friesian) lactating cows used were in their third month of lactation which had previously lactated 1-2 times. Mean milk yield was 9.5 and 8.5 kg day^{-1} (1 kg of milk = 1.3 litres) and average live weight of 405.5 (S.D=±15 kg). The animals were selected from the NAARI dairy herd. The experimental design was a 4 x 4 Switch-over Latin Square design was used.

The cows were housed individually in well-ventilated stall-feeding units. They were drenched with Levamisole hydrochloride or oxychlozanide (Nilzan) once every three months and dipped in Delnav acaricide twice a week to control ticks. Routine vaccinations and the necessary veterinary services were applied.

Diets and feeding management

Animals were fed on freshly harvested, chopped elephant grass fodder, *ad libitum* which was harvested twice a day (morning and evening) at an average height of 1.0 m as described by Ogwang (1974). It was chopped using a forage chopper. The feeder-troughs which were 90cm x 60cm x 60cm, were fodder-filled twice a day at 7.30 a.m. and at 5.00 p.m. to ensure *ad libitum* feed supply to the animals.

Four levels (treatments) of lablab hay, *viz* 0, 2, 3 and 4kg day^{-1} $animal^{-1}$ were additionally randomly assigned to the animals on "as fed basis". The hay was offered to the animals in the morning before offering elephant grass fodder. All the diets were maintained for a period of 28 days; this included 14 days of adjustment to the diets and 14 days for data collection.

The diets were maintained for a period of 28 days; this included 14 days of adjustment to the diets and 14 days for data collection. Fresh, clean tap water and mineral lick were availed to the animals all the time.

Laboratory analysis

Samples of feed offered or refusals were analysed for contents of dry matter (DM) according to AOAC (1980). Crude protein (CP) was analysed using micro-Kjeldahl procedure (AOAC, 1980). NDF, ADL and ADF were determined as outlined by Goering and Van Soest (1970). *In vitro* organic matter digestibility (IVOMD) was determined using Tilley and Terry (1963) method. Metabolizable energy (ME) was calculated using a formula by Close and Menke, (1986) where ME = 0.15 IVOMD.

Data collection

Dry matter intake (DMI) was calculated as the difference between the feed offers and refusals corrected for DM content of the respective feed components. Milk yields per animal were taken every day at 7.00 am and 4.00p.m. The values were converted to 4 % Fat Corrected Milk (FCM) yield (FCM yield = [0.4MY + 15 BFY]. Milk samples were collected simultaneously at the end of each feeding period. The corresponding morning and evening samples were bulked into one sample and preserved under freezer conditions at -1°C for butterfat content analysis. Butterfat content was determined using The Gerber Method as described by Kiwuwa (1974).

Analytical methods

Data was analysed using a computer soft-ware package, MSTATC for a Latin square design. In each case, mean separation was done using the least significant difference (LSD), at 5% confidence interval.

Experiment 11. Effect of feeding elephant grass lablab hay based diets with or without a oncentrate supplement on milk yield and milk composition of lactating dairy cows

Objective

To determine the effect of supplementing lactating dairy cows fed elephant grass fodder and 3 kg day^{-1} of lablab hay with and without a concentrate on milk yield and milk composition.

Materials and methods

Crossbred (Zebu x Friesian) lactating dairy cows used were

Table 1. Percentage (%) chemical composition (DM basis) of diets used

	Diets	
Parameter	Lablab hay	Elephant grass fodder
DM	85.4	21.0
CP	15.1	8.4
NDF	58.3	62.7
ADF	41.5	36.1
ADL	11.3	13.8
OMD	58.2	53.1
#ME (Mcal kg^{-1}) DM	2.1	1.9

It was assumed according to Close and M enke (1986) that ME =0.15IVOMD

Utilization of elephant grass with lablab hay supplement by crossbred lactating dairy cows

Lablab hay significantly increased elephant grass dry matter intake (DMI) (Table 2), however, increasing lablab hay levels in the diets resulted in no significant differences in intake of elephant grass. Feeding lablab hay levels at

in their third month of lactating and had previously lactated 1-2 times. They had a mean milk yield of 9.5 kg day^{-1} and an average liveweight of 405.5 (SD = $\pm$15 kg). The experimental design and animal management were similar to those in experiment I.

Diets and feeding management

Lablab hay was supplied at a fixed rate of 3 kg day^{-1} per animal using results derived from feeding experiment I. In addition, a concentrate (Ugachick dairy meal brand) was randomly assigned to the animals, at rates of 0, 1, 2 and 3kg animal^{-1} day^{-1} on "as fed basis". The choice of the concentrate levels was based on the levels used by the smallholder dairy farmers in Uganda. The choice of a brand was based on the ease of accessibility of the feed from the factory. Half of the concentrate ration was provided to the animals at 7.00 a.m. and the other half at 4.00 p.m. at milking times.

Data, laboratory analysis and analytical methods

Data collection, laboratory analysis and analytical methods were similar to those used in experiment I.

Results and discussion

Experiment I. Effect of supplementing lactating dairy cows fed elephant grass fodder based diets with lablab hay supplement

Chemical composition of fresh feeds used

Data on the chemical composition of diets used hay is shown in Table 1.

levels higher than 3 kg day^{-1} reduced elephant grass DMI. The reduction in DMI though not significant ($P \leq 0.05$) could be attributed to the palatability and chemical composition of lablab hay as compared to elephant grass (Table 1). Total dry matter intake (TDMI) and TDMI expressed as metabolic body weight (TDMI kg$^{0.75}$ day^{-1}) significantly ($P \leq 0.05$) increased with increasing levels of lablab hay supplement. TDMI expressed as percent body weight (% BW) responded similarly to elephant grass when supplemented with Lablab and was above 2.5 % for all animals fed on supplemented diets. The highest % BW was obtained at a supplementation level of 3kg day^{-1} of lablab hay.

The high DMI of elephant grass in supplemented diets might have been due to several reasons. Lablab hay might have provided essential nutrients, particularly CP (Table 1), which might have been lacking in the elephant grass for the animals to maintain optimal rumen activity. Lablab hay might also have been degraded more rapidly in the rumen. This is because of the positive effects of Nitrogen (N) in increasing microbial population and efficiency thus enabling them to increase the rate of breakdown of the digesta. As the rate of breakdown and passage of the digesta increases, feed intake is accordingly increased (Muinga *et al.* (1992). Increased DMI attributed to the addition of legume hay to roughage diets has been reported by Kimambo *et al.* (1992). However, the results from this trial depart from those of Boitumelo and Mahabile (1992) who observed no differences in DMI of elephant grass fed lactating cows and supplemented with Lablab hay in Botswana. In another study, Kiflewahid and Mosimanyana (1992), reported a depressing effect in DMI of maize stover when lactating dairy cows were supplemented with *Dolichos Lablab (L. purpureus)* in Botswana. It can therefore be concluded that Lablab hay supplement can only suffice to maintain minimal milk production levels. However, for the high yielding animals to reach their genetic production ceiling, these unenriched forages would be certainly inadequate.

Table 2. Utilization of elephant grass supplemented with Lablab hay

Parameter	Lablab hay levels (kg day^{-1})				
	0	2	3	4	*SEM
Elephant grass DMI (kg day^{-1})	8.8^{a}	9.4^{b}	9.7^{b}	9.4^{b}	$\pm$0.10
Lablab hay DMI kg day^{-1})	0.0^{a}	1.4^{b}	2.3^{c}	2.9^{d}	$\pm$0.05
TDMI (kg day^{-1})	8.8^{a}	10.8^{b}	12.0^{c}	12.3^{c}	$\pm$0.37
TDMI (% BW)	2.2^{a}	2.7^{b}	2.9^{c}	2.9^{c}	$\pm$0.09
TDMI g/kg$^{0.75}$/ day)	98.5^{a}	118.7^{b}	129.5^{c}	131.1^{c}	$\pm$4.10
Total CP intake (g day^{-1})	747.8^{c}	997.3^{b}	1129.5^{a}	1186.1^{a}	$\pm$6.40
Total ME intake (Mcal day^{-1})	17.8^{a}	21.6^{b}	23.6^{c}	24.0^{c}	$\pm$0.75

^{abc} Means within the same row with different superscripts differ ($P \leq 0.05$).
*SEM: Standard error

Milk yields and milk composition for crossbred lactating dairy cows fed on elephant grass with and without lablab hay supplement

Supplementing lactating dairy cows fed elephant grass based diets with lablab hay increased milk yield and Fat corrected (FCM) milk yields significantly ($P \leq 0.05$) (Table 3) but had no effect on the butterfat content of the milk. Butterfat yield increased significantly ($P \leq 0.05$) but only beyond a level of 3 kg day^{-1} of lablab hay. Increasing Lablab hay levels beyond 3kg day^{-1}, did not result in a further significant rise in milk yield.

The low milk yield from unsupplemented diets could be attributed to the low intakes of ME and CP values observed in this diet (Table 2). According to A.O.A.C. (1980), the cows used in this experiment, based on body weight and milk production required about 11.2 Mcal. day^{-1} for their maintenance. The amount provided by the unsupplemented diets was approximately 17.8 Mcal. day^{-1} (Table 2) which implies a difference of about 6.6 Mcal. day^{-1} over its maintenance requirements. Therefore, this ME in excess of maintenance was insufficient and generated only 5.8 kg FCM day^{-1}. The cows, therefore, received sub-optimal amounts of ME and were unable to lactate to their genetic capacities.

The FCM yield values in the unsupplemented diets used in this experiment, though very low, were well within the expected range for elephant grass diets as reported by Sabiiti and Mwebaze (1989) in Uganda. Higher milk yields in the animals fed on higher ME and CP rations confirms the suggestion made earlier that lower productivity of the unsupplemented diets was due to the correspondingly low magnitudes of these nutritional attributes. Butter fat yield only increased significantly ($P \leq 0.05$) beyond a level of 3 kg day^{-1} of lablab hay (Table 3).

Table 3. Milk yield and Milk Composition for lactating dairy cows fed on a basal diet of elephant grass fodder with lablab hay supplement

Parameter	Lablab hay (kg day^{-1})				
	0	2	3	4	SEM
Mean milk yield (kg day^{-1})	9.1^{a}	9.8^{b}	10.8^{c}	10.7^{c}	$\pm$0.15
Butterfat (%)	3.3	3.4	3.5	3.6	$\pm$0.09
FCM yield (kg day^{-1})	9.0^{a}	8.9^{a}	10.0^{b}	10.0^{b}	$\pm$0.11
Butterfat yield (g day^{-1})	300.3^{a}	333.2^{a}	378.0^{b}	385.2^{b}	$\pm$38.9

^{abc}Means within the same row with different superscripts differ ($P \leq 0.05$).

Experiment 11. The effect of supple menting lactating dairy cows fed elephant grass fodder-lablab hay based diets with and without a concentrate

Chemical composition of fresh feeds used

Data on the chemical composition of diets used hay is shown in Table 4.

Table 4. Percentage (%) chemical composition (DM basis) of diets used

Parameter (%)	Diets		
	*Lablab hay	Elephant grass	Concentrate
DM	85.4	17.0	98.5
CP	15.1	9.5	17.5
NDF	51.3	58.1	23.1
ADF	41.5	34.9	17.4
ADL	11.3	13.1	9.0
OMD	58.2	56.2	71.3
Gross energy (Mcal kg^{-1} DM)	4.1	3.9	4.2
ME (Mcal kg^{-1} DM)	2.2	2.1	2.6

It was assumed according to Close and Menke (1986) that ME = 0.15 OMD

Utilization of elephant grass fodder and lablab hay with and without a concentrate supplement by crossbred lactating dairy cows

Inclusion of a concentrate in the diets significantly ($P \leq 0.05$) reduced elephant grass DMI (Table 5) but there was no significant difference between grass DMI for the various concentrate levels. In contrast, the intake of lablab hay increased with increasing concentrate rates but dropped when the rate exceeded 2 kg day^{-1}. The concentrate substitution effect on grass and Lablab hay might have been partly caused by the digestion of the starch in the concentrate which has been reported to depress rumen pH to as low as 6.0 thus reducing the population of the cellulolytic bacteria (Muinga *et.al.* 1993). This might have led to a reduction in fibre digestion and extended the retention time of the particulate matter in the rumen causing a decrease in feed intake. TDMI and TDMI kg $^{0.75}$ g/day^{-1} increased only when the level of the concentrate in the diet was above 1 kg day^{-1}. Beyond this level the increase was not significant. TDMI as % BW increased with supplementation in a similar manner.

Total ME energy and CP intake significantly ($P \leq 0.05$) increased with increasing levels of concentrate supplementation (Table 5).

Table 5. Utilization of elephant grass and lablab hay diets with concentrate supplementation

Parameter	Concentrate levels (kg day^{-1})				
	0	1	2	3	SEM
Elephant Grass DMI (kg day^{-1})	7.8^{a}	7.2^{b}	6.9^{b}	6.7^{b}	±0.31
Lablab hay DMI (kg day^{-1})	2.8^{a}	2.6^{ab}	2.7^{b}	2.4^{b}	±0.06
Concentrate* DMI (kg day^{-1})	0.0	0.9	1.8	2.7	-
TDMI (kg day^{-1})	10.6^{a}	10.7^{a}	11.4^{b}	11.8^{b}	±0.35
TDMI (g/$kg^{0.75}$/day)	122.4^{a}	122.4^{a}	130.9^{b}	136.1^{b}	±4.00
TDMI (as % BW)	2.8^{a}	2.8^{a}	3.0^{b}	3.2^{b}	±0.08
Total CP intake (g day^{-1})	1163.0^{a}	1225.3^{a}	1371.4^{b}	1471.1^{c}	±35.13
Total ME Intake (Mcals day^{-1})	21.5^{a}	22.0^{a}	23.9^{b}	25.2^{c}	±0.70

^{abc} Means within rows with different superscripts differ ($P \leq 0.05$).

* All the concentrate offered was consumed by the animals

Milk yields and milk composition for lactating dairy cows fed elephant grass and lablab hay based diets with a concentrate supplement

Inclusion of a concentrate in the diets significantly ($P \geq 0.05$) increased milk and FCM yields (Table 6). Supplementation with 1.0 kg of a concentrate per day resulted in FCM yield of 5.2%. Addition of an extra kilogram of a concentrate raised FCM yield by 9%, which is just less than twice the original increase. Overall, application of 2 kg day^{-1} of a concentrate proved to be superior to other dietary combinations.

The superior milk yield recorded with concentrate supplemented diets was probably due to extra ME and CP intake (Table 4). ME intake for the concentrate enriched diets was consistently greater than for the control diets. Despite the rise in ME intake, milk yield peaked at a supplement level of 2 kg day^{-1}. Beyond this level, there was a slight drop in milk yield although the decrease was not significant ($P \leq 0.05$). This experiment demonstrated similar milk responses to concentrate supplementation (Muinga *et al.*, 1993), though not to the same magnitudes. Milk composition was not affected by supplementation with concentrate (Table 6).

Conclusion

Elephant grass utilization, milk and FCM yield of lactating dairy cows could be improved by supplementing with small quantities, up to 3 kg day^{-1} of lablab hay for animals similar to those used in this study. However, it is important to note that was observed that the total CP and ME values in elephant grass fodder and lablab hay are insufficient for optimum milk production. It is therefore important to provide the animals with extra energy through concentrate supplementation.

When the animals were further supplemented with a concentrate, elephant grass DMI progressively reduced but lablab hay DMI increased. Inclusion of a concentrate in the diets improved milk yield. Overall, a rate of 2 kg day^{-1} of concentrate proved to be sufficient.

Butterfat content was not affected by either lablab hay or concentrate supplements.

This type of feeding is important for areas which experience long dry seasons during which a cheap source of protein for dairy cattle is scarce. In Uganda, however, utilization of elephant grass fodder supplemented with lablab hay and a concentrate by lactating dairy cows, in the dry season is a new intervention which has not yet been adopted by the smallhoder dairy farmers. This practice certainly needs to be tested on-farm in the light of the results of this study. In the context of the smallholder dairy farmer, besides improved animal production, the legume-rhizomal symbiosis is expected to provide farmers with an inexpensive source of nitrogen whose production is environmentally "clean".

What remains to be addressed from this type of feeding, is to establish appropriate technologies for harvesting lablab that could minimize harvest losses, reduce manpower requirement preserve nutritional qualities and ensure an acceptable final product for the animals. The effects of feeding higher levels of lablab hay to lactating dairy cows for longer periods need to be fully investigated as well. Social economic aspects such as adoption rate and the benefits of using lablab hay with elephant grass versus elephant grass alone or elephant grass-lablab hay- with agro-industrial by-products need also to be addressed.

Table 6. Mean daily milk yields and milk composition of lactating dairy cows fed elephant grass-lablab hay diets with and without a concentrate supplement

Parameter	Concentrate levels (kg day^{-1})				
	0	1	2	3	SEM
Mean milk yield (kg day^{-1})	9.8^{a}	10.4^{b}	11.3^{c}	11.0^{c}	±0.15
Butterfat (%)	3.9a	3.8^{a}	3.9^{a}	3.8^{a}	±0.09
FCM yield (kg day^{-1})	9.5a	10.0^{b}	10.9^{c}	11.1^{c}	±0.11
Butterfat yield (g day^{-1})	382.2	395.2	440.1	418.0^{b}	±44.3

^{abc} Means within rows with different superscripts differ ($P \leq 0.05$)

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