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Effect of feeding rice straw and supplements on the performance of cattle under small farmer conditions

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ABSTRACT

Evenly matched pairs of heifers owned by small dairy farmers grazing under coconut under their own conditions were used. They were either fed rice straw *ad libitum* (S) or S supplemented (SS) with low levels of urea, molasses, rice bran, vitamin/minerals (24, 90, 70 and 16 g/ head/ d, respectively) up to first oestrus and then doubled and trebled during pregnancy and lactation, respectively. Botanical and proximate composition plus dry matter yields of herbage/weeds at each location were recorded. In order of dominance (0 ± SD for all locations), species composition (%) was: pasture grasses (42.6 ± 18.2), fodder grasses (24.8 ± 21.4) with leguminous and other species (16.2± 3.8 and 16.4 ± 8.8, respectively). Proximate composition (%) for pooled (spp., locations overtime) herbage samples (0 ±SD) were: DM (20.6 ± 1.9) CP (10.9± 1.0) and CF (29.3 ± 2.9) indicating an acceptable CP level. Similarly the yield was 1414 ± 263 kg/ha/yr, but pointing to a restricted supply of quantity. Supplementation significantly (P< 0.05) improved the age at first oestrus (11.3 vs 10.5 mo), average live weight gain (ADG, 162 vs 252 g/head/d)) and the live weight at which first oestrus(135.1 vs 154.6 kg/head). The corresponding data which also differed (P<0.05) in favor of SS compared to S were, 33.3 vs 30.5 mo, 233 Vs 322 g/head/d and 208.1 vs 253.4 kg/head), respectively. The weight of calves at birth and the yield of milk were also significantly (P < 0.05) higher due to feeding of supplements. It is recommended that the resource poor small dairy farmers should move away from more extensive to a more intensive stall feeding system of management, based on cheaply available feed resources such as straw, tree legume forage and critical supplements to balance the ration.

Key words: *:* Concentrate, cross-bred cattle, supplement, oestrus, legume forage

INTRODUCTION

The small farm is a major feature of land tenure systems in developing countries e.g.: Sri Lanka. The land area of a small holder appears to vary from < 1 ha to approximately 5 ha. (Reynolds 1985). In the humid tropics of Asia, land use is strongly oriented towards rice cultivation with small area available for cultivation of fodder to raise livestock. Where land is a limiting factor, 0.5 million ha of coconut plantation represents a potential grazing resource allowing crop and stock integration

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as well. According to Camoens *et al.*, (1985) over 60% of food production in Asia is provided by small farmer, keeping livestock in mixed crop/livestock farming systems, especially under coconut / cattle systems. Coconut lands used for grazing contain natural herbage which includes mostly palatable weeds. Rice straw could be introduced to overcome seasonal variations in herbage production. However, straw is deficient in many nutrients. P is the most expensive mineral to supplement, and its identified deficiencies under Sri Lankan conditions can be less expensively supplied through rice bran. (Ranawana, 1981) Jayasuriya (1981) reviewed the difficulties involved in treating rice straw under Sri Lankan village conditions, implying appropriate supplementation to be more feasible up to that time. Attempts to introduce critical supplements to improve the reproductive and productive performance of indigenous cattle grazed under coconut in a six year continuous study have been well documented (Pathirana *et al.*, 1996).

Therefore, the primary objective of this study was to evaluate and demonstrate the beneficial effects of introducing straw and a supplement based on previous research findings to the feeding system of cross bred cattle of small scale dairy farmers.

MATERIALS AND METHODS

Selection of farmers

Farmers were selected, based on a household survey, using a structured questionnaire in four AGA divisions (Kamburupitiya, Akuressa, Devinuwara and Weligama). An important criterion for selection was the possession of a comparable pair of heifers for testing of two methods of feeding (control and treatment). The experiment was carried out with 15 farmers each having matched pair of animals (30 animals).

The heifers were crosses of indigenous Zebu with Indian Zebu or Jersey. The initial age and live weights were 10.9 ±1.7mo. and 76.1± 1.6 kg (0 ±SD), respectively. In addition to two main genetic make up of heifers (indigenous x Indian and indigenous x Jersey), the management system was also broadly divided into extensive (grazing only for the supply of feed) and semi – intensive (cut and fed in addition to grazing). However, the genetic make up and the system of management were evenly balanced between the two heifers of a given farmer. The initial age and live weight of two experimental groups viz. straw only and straw plus supplements fed groups were 11.3 ± 1.5 mo. and 76.4 kg ± 10.5 and 10.5 mo ± 1.3 and 75.9 ± 8.9 kg, respectively.

Management and feeding of animals

The management of animals varied between farmers, as expected and also as confirmed by the survey. However, each and every pair of animals belonging to different farmers was carefully selected so that two animals belonging to a particular farmer were uniform as far as possible in breed, weight, age and the physiological stage. Farmers were also advised to manage and care for the two animals in exactly the same manner in all respects, except for the two different methods of feeding, so that between two animals within each pair, the unconfounded effects of the two method of feeding could be reasonably detected. The adherence of farmers to these requirements was continuously and carefully monitored.

Table 1. Ingredients, composition and amounts of supplementary feed

Ingredient	Composition (g/100g supplement)	Amount fed (g/head/d)		
		To 1st heat	In pregnancy	In lactation
Urea	12	24	48	72
Molasses	45	90	180	270
Rice bran	35	70	140	210
Vit./salt, min.mix	8	16	32	48
Total	100	200	400	600

Table 2. Yield, proximate and botanical composition of grazed natural herbage and proximate composition of straw.

Location[1] /Pair No.	DMY[2] (kg/ha/ yr)	Proximate composition (%)[3]			Botanical Composition (%)			
		DM	CP	CF	FdGr[4]	PsGr[5]	Lgm[6]	Other spp
1	1346	21	10.2	30.8	6	51	15	28
3	1652	18	9.1	32.0	19	46	21	14
5	1012	22	11.4	31.2	8	45	19	28
6	921	18	12.5	26.7	5	48	16	31
7	1514	19	10.0	32.1	5	65	10	20
8	1453	22	9.6	30.3	3	71	18	8
10	1214	21	11.4	28.6	21	58	9	12
11	1694	24	10.8	29.5	41	31	16	12
12	1380	19	12.3	29.1	49	14	21	16
13	1782	23	11.4	30.2	54	22	19	5
14	1586	20	10.9	31.4	62	18	14	6
X ± SD	1414 ± 263	20.6 ± 1.9	10.9 ± 1.0	29.3 ± 2.9	24.8± 21.4	42.6± 18.2	16.2± 3.8	16.4± 8.8
Straw	-	87.7	4.9	34.7	-	-	-	-

[1]Data from only 11 locations. [2]DMY=dry matter yield [3]g/100gDM. [4]FdGr=Fodder grasses. [5]PsGr=Pasture grasses. [6]Lgm=Legumes.

Therefore, the farmers were allowed to practice their normal methods of management and feeding with animals, except for the following two different methods of feeding:

Straw as it is, offered *ad libitum* (S)
Straw as it is, offered *ad libitum* + supplements (SS)

Hence, in addition to the normal grazing, both animals in each pair were offered rice straw as it is, *ad libitum* while only one animal received the supplement(Table 1). Animals within each pair were randomly assigned to the two feeding methods. Water was offered *ad libitum.*

Supplements were based on the findings from the previous study (Pathirana *et al.*, 1996), in which a highly significant response with straw based rations was obtained. Ingredients used in making the supplement and the amounts fed during different physiological stages of animals are given in Table 2. Total amount g/head/d were fed in two equal quantities in the morning and evening. Supplements were mixed with the upper layers of straw to avoid wastage and to ensure its total intake.

Observations and recording of data

Live weight

A livestock scale was taken to 28 farmers initially earmarked for the study for accurate recording of live weight of 56 heifers. Weigh band weights of the animals were also recorded simultaneously. There was a highly positive correlation (r=0.98) between the two sets of weights. Therefore, the weigh band was conveniently used to obtain monthly live weights of animals using the regression procedure thereafter. However, the initial and final weights were obtained with the livestock scale. Details of the regression are given below.

$Y = -6.4288 + 0.8641x$, where Y is the livestock scale weight, x is the weigh band weight (n = 56 for 28 pairs of heifers selected from among 407 dairy farmers).

Yield, proximate and botanical composition of grazed herbage

For the estimation of pasture yield and botanical composition of the natural herbage grazed by experimental cattle, 15 samples from each location were obtained using a quadrat (I m x 1m) thrown randomly on three occasions per year. After recording the botanical composition using the dry weight rank method (Mannetje and Haydock 1963); dried samples were kept for dry matter yield estimation and proximate analysis.

Straw intake

Straw intake was recorded during 3 weekly periods of animals from each of the treatments mentioned above. Representative samples of straw offered were collected for analyses.

Heat detection

This was based on the external characters and the behavior of heifers on which the farmers were trained. Date of first heat was recorded.

Calving

Date and live weight of the calf at birth were recorded.

Lactation records

Records were kept on daily milk yields and duration.

Proximate analysis

Samples of herbage, straw and supplements were analyzed according to AOAC (1990).

Statistical analysis

Statistical analysis was done using the SAS software package.

RESULTS AND DISCUSSION

Yield, botanical and proximate composition of grazed pasture

Yield, botanical and proximate composition of natural herbage grazed by experimental cattle are presented in Table 2. According to the experimental design, both animals of each farmers had to be managed the same way and had to graze in the same area. Hence, only the variations between grazing locations of animals managed by different farmers rather than the effects due to treatments could be recorded by these observations.

Dry matter yield (DMY) of different locations varied from 921 to 1782 kg/ha/yr with a (0 ±SD) of 1414 ± 263 kg/ha/yr. Indications are that even the maximum yield does not support the annual DM requirement of two cows, even at 2% live weight intake. This also explains the significant performance criteria responses to the introduction of supplemented straw. Ibrahim *et al.*, (1983) emphasized that improved natural pastures grown under coconut in low and highlands of Matara district were less productive and of poor quality, especially during dry periods. This leaves no alternative other than to use straw based diets with farmers willing to accept innovations concerned improving straw quality. The yields were less than half of those reported by Pathirana *et al.*, (1996) with cattle grazing natural herbage in coconut land under more controlled experimental conditions indicating a greater degree of overgrazing under practical situations than experimentally simulated. Proximate composition the quality of natural herbage grazed by cattle was of an acceptable quality when compared with cultivated grasses in general.

There was a fairly wide variation in the botanical composition between different grazing locations, particularly with fodder types with pasture type grasses predominant in most locations (42.6 ± 18.2%) followed by fodder grasses, while occurrence of other species and legumes was least and more or less equally distributed at 16.4 ± 3.8% and 16.2 ± 3.8%, respectively.

Some of the individual species identified are listed in Table 3. Many of the species identified in the present study are in common with those species found growing also as natural herbage under coconut (Tissera and Pathirana 1988). *A. affinis* and *A. compresses* have been reported to be the most abundant species under coconut (Steel *et al.*, 1980 and Whiteman 1980). Most of the grazing locations in the present study were also under coconut and the finding in this experiment are in agreement with those reported earlier. More over, Seresinhe and Pathirana (2000) reported that feeding of natural herbage collected from inundated paddy lands to indigenous cross bred cattle could only maintain a subsistence level of production.

Table 3. Grasses, legumes and other species/ weeds identified from experimental grazing areas.

Scientific Name	Vernacular Name	Scientific Name	Vernacular Name
Grasses		Other spp/Weeds	
Axonopus affinis A Chase	Narrow leaf carpet Grass	*Aerva lanata* (L)	Pob kudu pola
		Boerhavia repens (L)	Pitawakka
compressus	Tropical carpet grass	*Borreria hispida* (L)	
(SW) Beauv		*Centella asiatica*	Gotukola
Brachiaria dystachia (L.)			
		Comelia spp.	Atawara
		Comelina	Diyaberaliya
B. mutica (Forsk.)	Para or water grass	*Bengalensis* (L)	
B. paspaloides		*Cyprus spp.*	Kalanduru
B. subquadripara		*Dipteracanthus*	Gadupuruk
	Bermuda, African	*Ringens* (L)	
Crytococum trigonum	Couch, or star grass		
Cynodon dactylon	Pututana	*Eupatorium odoratum* (L)	Podisingnomaran
(L.) pers		*Hedyotis*	
		auricularia (L)	
Dactyloctenium	Delhi grass		
aegyptium (L.)Beauv.		*Hemidesmus indicus* (L)	Eramusu
Dichanthium	Creeping grass	*Ichnocarpus*	Kiriwell
annulatum (Forsk)	Spear or pili grass	*frutescens* (L)	
Digitaria adscendens			
Heteropogon	Congo grass	*Ipomea cymosa*	
contours (L)		*Ipomea pestigridis* (L)	Divipahuru
Imperata cylindrical (L)		*Lantana camera*	
Panicum brevifolium		*Leucas zeylanica*	Gatatumba
P. maximum Jacq.	Guinea A & B (Local)	*Merremia tridentate* (L)	
P. repens (L)	Etora, Panic rampant	*Michenia scandense* (L)	Watupalu
Perotis indica (L)		*Miriscus squarrosus* (L)	
Sacciolepis curvata		*Mitracarpus hirtus* (L)	
(L)		*Ocimum sanctum* (L)	Maduruthala
Setaria geniculata	Squirrel tail	*Osbekia aspera* (L)	
		Srachytorpheta	
		indica	
Legumes		*Urena lobata* (L)	Patta-Epala
		Vernonia cinerea (L)	
Alysicarpus	Aswenna	*V. zeylonica*	
vaginalis (L)			
Cajanus scarabaeoides	Thora, vill senna		
Cassia tora (L)	Centro		
Centrosema			
pubescens Benth	Guar or Cluster		
Cyamopsis	beans		
tetragonolobata (L)	Maha undupiyaliya		
Desmodium			
heterophyllum DC.	Heen undupiyaliya		
D. triflorum (L) DC.	Gliricidia,		
Gliricidia sepium	Makulatha, Vetahira		
H. B. K.	Ipil-ipil		
Leucaena	Nidikumba		
leucocephala (Lam.)	Tropical kudza,		
Mimosa pudica (L)	Puero		
Pueraria Phaseoloides (Roxl)	Pila		
Tephrosia purpuria			

Indications are that, areas grazed by cattle consist of several grasses, legumes and other species exhibiting a considerable biodiversity. Since overgrazing is common, the species listed can be considered to be tolerant to intensive grazing.

Intake of Straw

Intake of straw during different physiological stages is presented in Table 4. *Ad libitum* straw intake was significantly higher (P<0.05) due to supplementation (SS) compared to unsupplemented straw (S) during all three stages. In an earlier study Pathirana *et al*., (1996) reported that *ad libitum* intake of straw nearly doubled due to feeding of the same supplements to more indigenous type of calves up to first oestrus, confirming the present findings. Original investigations by Donefer *et al*., (1969) did classically demonstrate the beneficial effects of urea supplementation of straw, due primarily to an increased digestibility resulting in an increased voluntary intake of roughages. Since then, effects of supplementation have been well documented (e.g. Kumarasuntharam *et al*., 1983; Ibrahim *et al*., 1983; Wanapat *et al*., 1983) and were of much practical significance. Similarly, the beneficial effects of many different supplements on the digestibility of straw have been also reported (Sannansgala and Jayasuriya, 1983; Fahmy *et al*., 1984) which are in agreement with the present findings. Seresinhe and Pathirana (2004) also reported that initial body weights and heart girths of buffalo calves progressively increased with supplementation with low cost supplements such as rice bran.

Table 4. Intake of straw

Group	To 1st oestrus		1st oestrus to calving		In lactation	
	kg/hd/d	% LW	kg/hd/d	% LW	kg/hd/d	% LW[3]
S	0.70[a]	0.51[a]	0.82[a]	0.41[1]	1.08[a]	0.52[4]
SS	1.15[b]	0.73[b]	1.47[b]	0.63[2]	1.80[b]	0.75[5]

[1]Incomplete data (n=6)
[2]– do - (n=8)
[3]Live wt. at calving used in calculations
[a,b]Values within coloumns bearing different superscripts are different (P<0.05)

Performance of cattle

Data on age, live weight and average daily gain (ADG) at first oestrus and first calving are given in Tables 5 and 6.

Performance up to first oestrus

Heifers fed supplemented straw were in first oestrus significantly (P<0.05) earlier, and at a higher (P<0.05) body weight than those fed unsupplemented straw (Table 6). Thus, fairly evenly matched initial ages (11.3 and 10.5 mo) and live weights (76.4 and 76.9 kg) of S and SS groups, respectively differed significantly (P<0.05) in favor of SS at first oestrus. As discussed earlier a higher (P<0.05) intake of apparently more digestible straw by the SS group compared to S group resulting in a grater (P<0.05) ADG (252 vs. 162g/hd/d,

Table 5. Age, live weight and average daily gain up to first oestrus

Group	Age (mo)		Live Weight (kg)		ADG[3] (g/hd/d)
	Initial	First oestrus	Initial	First oestrus	
S[1]	11.3	23.9[a]	76.4	135.1[a]	162[a]
SS[2]	10.5	21.0[b]	75.9	154.6[b]	252[b]

[1]S=Straw
[2]SS=Straw + Supplements
[3]ADG= Average Daily Gain
[ab]Values bearing different superscripts within columns are significantly different ($P<0.05$)

Table 6. Age and live weight at first calving and ADG from first oestrus to first calving

Group	Age (mo)	Live weight (kg)	ADG (g/hd/d)
S	33.3[a]	208.1[1]	233[1]
SS	30.5[b]	253.4[2]	322[2]

[1]From incomplete data (n=7)
[2]- do - (n=8)

respectively) was associated with the SS group reaching the first estrus at a younger age ($P<0.05$) with a higher live weight ($P<0.05$) than the S group.

ADG up to puberty and age at first estrus of even the S group in this study were superior to Zebu cattle traditionally managed in drier locations (Abeygunawardhana and Abeywansa 1995), while the live weight at first estrus was lower in this study (135.1 vs. 147.0 kg). This has been due to the animals in the present study reaching the first estrus much earlier (30 to 32 mo. vs. 23.9 mo.). Even the S group performed better in all respects up to the first oestrus in this study compared with those even fed supplemented straw in an earlier study (Pathirana *et al.*, 1996). It may be due to more Indian and European blood in present animals associated with better care and management by farmers compared to those under restricted grazing in the previous study done with indigenous animals. Liyanage *et al.*, (1989) reported a better ADG of 306g / head/ d with Jersey x indigenous cattle of a similar age, grazing under coconut, but better managed on improved pasture and also with feeding tree legume forage daily plus straw during dry periods. Findings of Liyanage *et al.*, (1989) together will those of Pathirana *et al.*, (1996) and the present study indicate the following. That there is a better cattle production potential through introduction of at least of straw, but more significantly together with critical supplements and better managed improved pasture and tree legume forages into the traditional system of feeding. While tree legume forage remains a valuable feed, straw and supplemented straw in general will be a highly promising potential feed available to resource poor small dairy farmers.

Performance from first oestrus to first calving

The results are presented in Table 6. Heifers fed supplemented straw calved significantly (P<0.05) earlier than the heifers fed straw without supplements (30.5 mo. vs 33.3 mo. of age, respectively), while reaching a significantly higher (P<0.05) live weight during the shorter period of growth due to the higher ADG (322 vs. 233 g/head/d, respectively). This was again resulting from a greater intake (P<0.05) of apparently more digestible supplemented straw (SS; 1.47 kg/head/d) compared to unsupplemented straw (S; 0.82 kg/head/d). Again, the age at first calving was less than the ages at first calving (38.7 to 41.6 mo) as reported by Abegunawardhana and Abeywansa (1995) with indigenous cattle reared in drier areas of the country. Same reasons given under the performance up to first estrus may explain these differences.

Performance after calving

Calf weight at birth, yield and composition of milk are presented in Table 7. The calves of better fed cattle (SS) were of a grater (P<0.05) live weight at birth compared to those of unsupplemented (S) treatment. The daily as well as the total milk yields of SS group were higher (P<0.05) while the fat (%) of milk as usual had a opposite trend with SNF (%) being higher with supplementation. The total as well as the average daily yield of milk in both groups was higher than those reported with indigenous cattle grazing natural herbage under coconut, fed straw with similar supplements (Pathirana *et al.*, 1996). Reasons given previously for the better performance of cattle are applicable in this instance as well.

Overall Performance in general

Common to both groups was an increase in straw intake (kg/head/d) with increase in live weight through first oestrus to lactation. However, intake per 100 kg live weight had no such trend and failed to demonstrate an expected greater intake by smaller animals. Significant in this study was an increased (P< 0.05) intake of straw at each stage due to supplementation. Compared to high levels of supplementation in which the effects can be more direct, in the present study, with minimum supplementation, overall performance could be attributed more towards an increasing digestibility and nutrient utilization of the diet. As a result, there would have been a greater increase in the intake of digestible diet of a greater magnitude than the reported intake of straw between the groups.

Considering all animals (S and SS), there was a fairly high correlation between the age and live weight at first oestrus (r = -0.73) signifying earlier oestrus at a higher (P<0.05) live weight with supplements. Further, supplementation while increasing the live weight at first oestrus (Table 6) also resulted in calves of higher live weight at birth (r = 0.89). As expected, liveweight in both groups increased with increasing age, but supplementation resulted in higher weights at lower ages with a utilizing effect on an overall relationship (r). In this investigation, calf weight at

Table 7. Calf weight at birth, Yield and composition of milk

Group	Calf at Birth (kg)	Milk yield (kg/hd)		Milk Composition(%)	
		Total	Per day	Fat	SNF
S	17.9[a]	769[a]	2.75[a]	4.4	8.2
SS	21.9[b]	1176[b]	4.20[b]	4.1	8.6

[ab]Values bearing different superscripts with in a coloumn are significantly different

birth was a good predicator of the potential milk yield of the dam since for all animals (S and SS) there was a very high correlation between the two parameters (r = 0.90).

Following correlations further substantiate the relationships.

Intake of straw vs. ADG to first oestrus : = 0.75
Intake of straw vs. calf weight from first estrus to first calving: r = 0.68
Intake of straw during lactation vs. the average daily milk yield: r = 0.67

Although the grazing behavior of cattle was not recorded in this study, previous observations from a similar study (Pathirana *et al.*, 1996) indicated that animals fed supplemented straw spent less time and therefore less energy in grazing, thereby conserving more energy for production. With these findings, and considering the worsening land availability for grazing together with other associated problems, it can be recommended that the resource poor small dairy farmers should move away from more extensive to less extensive and in to a more intensive stall feeding system of management with a few selected better yielding animals. Feeding should be based on cheaply available renewable resources such as straw and agricultural by products, tree legume forage and critical supplements to balance the ration.

CONCLUSION

A supplement consisting of critical nutrients was introduced to straw fed cattle, tra ditionally managed by small dairy farmers under village conditions in southern Sri Lanka. Supplementation improved the age, live weight and ADG at first oestrus and first calving. The weight of calves at birth and the yield of milk were also higher due to feeding of the supplement.

Magnitude of response was such that they could not be attributed to the low levels of supplements per day, but mainly due to their effects on the diet, but mainly the roughage, resulting in an increased intake of a more digestible diet.

It is recommended that the resource poor small daily farmers should move away from more extensive to a more intensive stall feeding system of management based on cheaply available feed resource such as straw, tree legume forage and critical supplements to balance the ration.

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