The Effect of Replacing Grass with Urea Treated Fresh Rice Straw in Dairy Cow Diet

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ABSTRACT : Nine tons of fresh rice straw from early-maturing varieties was ensiled with 50 g urea kg $^{-1}$ DM straw in plastic bags immediately after threshing. Five months after storage, preserved straw was used to partially replace elephant grass (*Pennisetum purpureum*, Schumach) for lactating cows. Eight crossbred Holstein lactating cows (75% of Holstein blood) in their second to fourth lactation and in mid-lactation were arranged in a balanced design with two squares consisting of 4 periods×4 treatments (100% grass ad lib. as a control; 75% grass+urea treated fresh rice straw (UTrFRS) *ad lib.*; 50% grass+UTrFRS *ad lib.*; 25% grass+UTrFRS *ad libitum*) in one square. A concentrate supplement was given at a rate of 400 g per day per kg of milk produced. Samples of fresh straw taken in the field and UTrFRS and elephant grass taken at feeding time were evaluated in a degradation trial with 3 fistulated heifers (undefined blood ratio of crossbred of Sindhi and local yellow cattle). Straw preserved for 5-9 months was in nearly all cases of good quality. Crude protein (CP) content was increased 2.1 fold and 48 h dry matter loss (DML) was 20% higher compared to dry straw. Elephant grass cultivated intensively was low in DM content and 10% higher in 48 h DML compared to UTrFRS. Dry matter intake (DMI) was higher for the mixture of UtrFRS and Elephant grass, and highest when one-third of the roughage was UTrFRS. Higher DMI of mixed roughage diets was probably due to the low DM content of elephant grass in the sole grass roughage diet. Increasing substitution of elephant grass with UTrFRS up to 75% of the roughage component increased milk fat content and had no effect on milk yield and other milk composition parameters. Feeding UTrFRS, partially replacing elephant grass in the diets of lactating cows in the dry season can reduce the cost of roughage. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 8 : 1090-1097)***

Key Words : Urea Treated Rice Straw, Elephant Grass, Degradation, Feed Intake, Milk Yield

INTRODUCTION

Dairy production in Vietnam has mainly developed in the outskirts of the big cities with a total number of around 30000 milking cows (Statistical Yearbook, 1999). Dairy cattle feed is based mostly on natural grasses and rice straw in the dry season supplemented with concentrate and agricultural and industrial by-products. One of the limiting factors in dairy production development is the shortage of grass due to small land area available for its cultivation (Man, 1995). Rice straw, the main crop residue, with low nutritive value and digestibility has been used in small amounts in milking cow diets and treating straw with urea has not been adopted by farmers in the region. Traditionally, the feeding of rice straw to livestock has been based on late maturing varieties of rice, which is harvested in the beginning of the dry season (December). The total cultivated area of this rice variety has gradually decreased because of the increase in the cultivation of early maturing varieties (Statistical Yearbook, 1999), which can be planted in double or triple crops with higher yields. Estimated from recent statistics, Vietnam has a total yield of this straw of more than 20 million tons per year (assuming a grain/ straw ratio=1:1.1, Chowdhury et al., 1995). In fact, this straw is underutilized, being left to rot in the field in the monsoon season (July to August) and burned in dry season (March to April) because of difficulties in drying conditions in the rainy season and an undervaluation of this resource for feeding livestock. Tingxian et al. (1993), in their study on the nutritional characteristics of rice straw from early and late maturing varieties found better dry matter digestibility in early maturing varieties compared to others. Chowdhury and Huque (1996a, b, c) in ensiling studies with wet straw used it to feed growing bulls and reported that wet straw was easily preserved by adding 5% urea and was a good feed for livestock. There is a need to find sustainable fodder resources as the base feed in the rations of milking cows in Vietnam. This study therefore aimed to evaluate a technique for preserving fresh early maturing rice straw, and determining the optimum level of substitution of the preserved straw for grass in lactating cow diets.

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MATERIALS AND METHODS

Rice straw ensiling study

Ensiling method and sampling : This experiment was carried out in 1999 at the University of Agriculture and Forestry Experimental Farm, Ho Chi Minh City, Vietnam. Nine tons of fresh rice straw of an early maturing variety was collected in March, directly after threshing in the field and was ensiled with urea. The urea level was 50 g kg^{-1} DM rice straw. The mean DM of the rice straw that used in the field ensiling process, was taken as the mean of 5 samples collected the day before. The rice straw was placed in 1.2 m-diameter plastic bags in layers up to 1.2 m in height. Urea was mixed with the rice straw at the time of filling and the materials were compacted by one man standing on the bags. After filling, the tops of the bags were bound by plastic string. The weight of the bags varied from 122-130 kg and a total of 78 bags were used. Samples of straw taken at the time of the feeding experiment, 5-9 months after ensiling were evaluated for physical and chemical characteristics and in a comparative study on DM degradation with FRS and Elephant grass. Observations of fungus development, smell, color and pH were made. Twenty samples of UTrFRS in the 4 periods of the feeding experiment were taken. Period samples were pooled after determination of DM. UTrFRS samples with FRS samples taken at ensiling and Elephant grass samples taking at the same time as UTrFRS samples were used in comparative trials.

Chemical analysis : All samples of FRS, UTrFRS and elephant grass were analyzed for dry matter (DM), crude protein (CP), ash, and ether extract (EE) using procedures described by AOAC (1984). ADF, ash-free NDF and permanganate lignin were analyzed according to Van Soest and Robertson (1980). Ensiled straw pH levels were measured by a pH meter (ORION model 420 A).

Determination of degradation characteristics : Three cross-breed heifers (182-206 kg LW, undefined blood ratio of crossbred of Sindhi and local yellow cattle), each fitted with a 40 mm diameter rumen cannula were used in the study using the nylon bag incubation technique, as suggested by Ørskov et al. (1980). They were kept in individual pens and offered a ration with 2 kg UTrFRS and 10 kg elephant grass daily and a mineral supplement. Each sample had a duplicate bag in one heifer and three heifers were used as a replicate in a complete randomized block design. A total of 72 bags were used and with 24 bags per each heifer. The bags, each contained 5 g of air-dry sample and were anchored to a 40 cm plastic ring and withdrawn from the rumen at 48 h of incubation. After being withdrawn the bags containing the undegraded residues of the samples were washed in a washing machine for half an hour. Dry matter losses (DML) after a 48 h incubation represent the total degradability of a roughage feed and is a measure of its nutritive value.

Statistical analysis : The data were subjected to an analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of Minitab (1998). When the F test was significant ($p<0.05$), Tukey's test for paired comparisons was used (Minitab, 1998).

Feed intake and milk production study

The experimental conditions : The UTrFRS prepared in the ensiling study was then used in an experiment to evaluate its replacement grass in the rations of milking cows. Eight lactating cows (75% of Holstein Friesian blood) in the second-fourth lactation and mid–lactating period were arranged by the balanced design method (Cochran and Cox, 1957). The experiment was conducted within two squares, consisting of 4 treatments×4 periods per square. Each period was 20 days with 10 days preliminary period and the last 10 days for data collection. Each of the experimental animals therefore received all 4 treatments: 100% elephant grass *ad lib.* as a control; 75% grass+ UTrFRS *ad lib.*; 50% grass+ UTrFRS *ad lib.*; 25% grass+ UTrFRS *ad lib.*. At the beginning of the experiment a 20-day preliminary testing was done to measure the voluntary dry matter intake of the elephant grass in the diet of each animal in order to determine the ratio of UTrFRS in the experimental diets. The animals were tethered in stalls and individually fed with free access to water. Milking was done twice a day at 05:00 h and 15:00 h by hand.

The fodder and concentrate supplement of the experiment are described in table 1. The cows were supplied a fixed amount of elephant grass in the mixed roughage treatments based on the ratio in DM of grass voluntary intake and the grass DM determined by quick microwave dryer measurements (Undersander et al., 1993) every day. Elephant grass intensively cultivated in small plots was harvested daily with a frequency of cutting of 42 days, and supplied to cows in 3-6 cm chopped pieces. UTrFRS was taken out of the big bag daily in the morning, weighted and placed in a plastic bag to supply feed for the whole day for each experimental cow. An additional 20% of the roughage VDMI was given to each cow in response to the *ad lib.* roughage in each treatment. The concentrate supplement was based on the usual ratio in the region of 400 g concentrate per 1 kg milk produced. Mean of the preliminary 10 days milk production was used in calculating the supplement concentrate for the next period. For all treatments, concentrate was given twice and roughage three times a day. Concentrate was fed at 07:30 h and 16:30 h, followed by roughage in the order of grass and UTrFRS, respectively, and the remaining roughage was fed at 20:00 h. The residue of grass and UTrFRS were weighed every day and the dry matter content measured. Body weight changes of the cows were calculated from the measurements of three consecutive days of initial and final weights in each period.

Concentrates were randomly sampled three times each period, while grass and UTrFRS and the residues were sampled daily for DM measurement, and the pooled samples in each period were used in chemical analyses and the degradation determination trial.

Data collected and chemical analysis : All samples of FRS, UTrFRS, grass and concentrate were analyzed for DM, CP, ash, and EE using procedures described by AOAC (1984). ADF, ash-free NDF and permanganate lignin were analyzed according to Van Soest and Robertson (1980). Milk yield was recorded the last 10 days in each period, and milk samples from each cow was collected and pooled every second day. The five milk samples from each cow in each period were analysed with regard to milk DM, protein and fat contents according to AOAC (1984) and the American Public Health Association (1985).

Statistical analysis : Data of treatment effects, such as body weight change, DM intake of roughage, UTrFRS and total diets, milk yield and milk composition were statistically analysed by analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of Minitab (1998). When the F- test was significant ($p<0.05$), Tukey' test for paired comparison was used (Minitab, 1998).

Table 1. The characteristics of concentrate mixture and roughage used in the experiment

Chemical composition	Roughage				
	UTrFRS*		FRS**	Elephant grass	p***
DM g kg^{-1}	377.6^{a}		371.1^{a}	115.3^{b}	0.00
% in DM	Dry	Wet			
CP	8.30^{b}	14.64^{a}	6.88^{c}	12.72^{d}	0.00
ADF	44.00^{a}		40.41^{b}	37.59^{c}	0.00
NDF	69.43		66.23	68.15	0.27
Ash	19.27^{a}		19.86^{a}	12.11^{b}	0.00
Lignin	7.49^{a}		5.83^{b}	6.34^{b}	0.00
DM loss 48 h incubation (g kg^{-1} DM)	553.8^{a}		460.5^{b}	603.8^{c}	0.00

Concentrate mixture	
Composition	(%)
Maize meal	20.0
Cassava meal	32.5
Rice bran	10.0
Cottonseed cake	16.0
Peanut cake	18.0
Mineral mixture	2.5
Common salt	1.0
Nutritional values	
ME (MJ/kg)	10.25
Crude protein (%)	16.02
Ether extract (%)	4.49
Crude fiber (%)	6.40
Ash (%)	5.59
Ca (%)	0.88
P (%)	0.59
NaCl (%)	0.89

* UTrFRS : Urea treated fresh rice straw; ** FRS: fresh rice straw; *** p value: Probability of a larger F value for the treatment.

[a,b,c] Means within rows with differing superscript letters are significantly different ($p<0.05$).

RESULTS AND DISCUSSION

Ensiling fresh rice straw with urea

The results of ensiling fresh rice straw with urea are presented in table 1. During a period of 5 to 9 months storage after ensiling all the UTrFRS in the bags were in good condition, with a dark brown color, strong ammonia smell and no fungi and almost 100% were well preserved. Nearly one ton of fresh straw occupied 4.5 m^3 volume for preserving (227 kg/m^3). Compared with FRS, UTrFRS in a wet sample had a mean of CP increase of 2.1 fold (6.88 to 14.64%). In the dry samples, UTrFRS had a 1.2 fold increase of CP and a significantly higher ADF and lignin content, although there was a non-significant difference in NDF content. In the degradation trial after 48 h incubation DML was significantly higher in the UTrFRS than the FRS. Urea treatment is a good way to preserve straw. Ammonia, released from the urea hydrolyses, and trapped in the bag caused an increase in straw pH>8 (mean pH: 9.24 in the present study) that inhibits oxidative and microbial fermentation (Wilkins, 1988) and kept the treated straw in a good condition for a long time. Chowdhury et al. (1996a, b) in their studies on the preservation of wet rice straw with 5% urea in a laboratory model with plastic bags, or in a dome, or rectangular heaps covered or not with a polythene sheet showed good results. Excepted that in the open heap only one-third of the preserved wet straw could be classified as well preserved.

Ensiling fresh rice straw with urea improved the value of the straw by increasing the non-protein nitrogen (NPN) content by trapping NH_3 and supplying it to the rumen. The increases were from 3.6 to 6.4 fold over that of dry straw in a study reported by Chowdhury et al. (1996a) and in the present study it was a little lower (2.1 fold). However, the CP content of untreated straw in this study was higher compared to their study (6.88 vs. 4.8% DM) that might influence the magnitude of the increase. The quality of straw is one of the factors, which affect the result as reported by Kernan et al. (1979). Other important factors that affect the magnitude of the CP increase are the urea level in treating, the water content of material, the temperature, etc. CP content increased with the urea concentration in the treatment and a level of 40 to 50 g urea kg DM^{-1} straw is considered to be an appropriate level (Verma et al., 1996). Low water to straw ratios resulted in low N content, and with ratios of 3:10 and higher no effect of water content was noted (Ibrahim et al., 1986). In our study the ratios varied from 13:10 to 21:10. Preserving fresh rice straw with urea treated right after threshing may save more nutrients, such as nitrogen and minerals. Tuen and Dahan (1991) in their study reported that exposing rice straw to rain or sunshine increased the loss of nitrogen (33%) and phosphorus (49%).

The response to urea treatment in this study was a significant increase in ADF and a slight increase in NDF, which was different from the expected unchanged ADF and decrease in NDF, due to the reduction of the hemicellulose content (Rajeev et al., 1996). However, our results are similar to those in studies reported by Mgheni et al. (1993), Chowdhury and Huque (1996a), and the explanation for the different effects may be the high silica and relatively low lignin content of rice straw. Water lost from high moisture material (as in the present study) during ensiling and storage may be another reason for increasing DM and changes in chemical composition.

Compared with elephant grass cut in the feeding trial, UTrFRS had higher DM (3.3 fold), ADF, ash, lignin, lower CP and not significantly different NDF content. The same NDF but higher ADF content in UTrFRS compared to elephant grass may be result of the high content of ash, especially the high silicate content in rice straw (Soebarinoto et al., 1997).

The 48 h incubation DML of a straw is used to illustrate the ranking of straw qualities (Ørskov et al., 1990). In this study the 48 h incubation DML of fresh rice straw preserved with 5% urea were always higher than the untreated straw (table 1). The result is similar to many other reports (Mgheni et al., 1993; Chowdhury and Huque, 1996a). Higher degradation of urea preserved straw is probably due to the greater accessibility of hydrolytic enzymes to fibrous material as a result of the solubilization of hemicellulose and lignin by the NH_3 (Chesson and Ørskov, 1990). In their results in a study of urea treatment of wet rice straw Chowdhury and Huque (1996a) also suggested that none of the degradation characteristics were affected by the length of preservation.

Feeding urea treated fresh rice straw to lactating cows

Dry matter intake : The results of dry matter intake are summarized in table 2. The total daily DMI per cow and per 100 kg live weight (LW) increased when replacing parts of the elephant grass in the diet with UTrFRS. The DMI was significantly higher on the 75% grass treatment compared to 100% grass. The extra UTrFRS intake above the replaced 25% grass resulted in a ratio of 35.4% UTrFRS of the total roughage intake. In the higher ratios treatments (50% and 75% of UTrFRS), the actual ratios were a little higher but not significantly different compared to the 100% grass treatment.

Roughage ME intake was highest in the treatment 75% grass following by treatment 50% and 25% grass, and lowest in the treatment 100% grass. However the only significant difference found was between treatment 75% and 100% grass. The DM intakes of grass on the treatments 75%, 50% and 25% grass, which were 75.8, 51.7 and 25.8% of *ad lib.* grass treatment, respectively were close to the predicted level based on *ad lib.* grass intake of individual cows during the pre-experimental period.

When calculating CP intake on the N content of dry samples of UTrFRS the highest CP intake was in the 75%

Table 2. Daily intake at *ad lib.* grass (Gr.) feeding (100% grass) vs. 75%, 50% or 25% of *ad lib.* grass and *ad lib.* UTrFRS

Daily intake	100% Gr	75% Gr	50% Gr	25% Gr	p**	SEM*
DMI (kg DM/day)						
Total/cow	10.98^{a}	12.33^{b}	11.86^{ab}	11.60^{ab}	0.02	0.37
Roughage	7.28	8.63	8.05	7.96	0.00	0.26
Elephant grass	7.28^{a}	5.52^{b}	3.77^{c}	1.88^{d}	0.00	0.40
UTrFRS	0.00^{a}	3.11^{b}	4.28^{c}	6.09^{d}	0.00	0.42
Concentrate	3.70	3.70	3.81	3.64	0.98	0.16
UTrFRS/roughage (%)	0.0^{a}	35.4^{b}	53.1^{c}	76.1^{d}	0.00	5.97
Total DMI/100kg LW***	2.59^{a}	2.94^{b}	2.83^{ab}	2.78^{ab}	0.02	0.07
Roughage ME intake (MJ/d) #	66.84^{a}	77.71^{b}	71.79^{ab}	70.20^{ab}	0.02	2.34
Roughage CP intake (g/d) ##	926.1^{a}	960.1^{ba}	834.8^{cb}	744.1^{c}	0.00	31.20
Roughage NDF intake (kg/d)	4.96^{a}	5.92^{b}	5.54^{ab}	5.51^{ab}	0.01	0.18
Dietary ME intake (MJ/d) #	105.8^{a}	116.6^{b}	111.9^{ab}	108.5^{ab}	0.04	3.51
Dietary CP intake (g/d)	1519.0^{ab}	1552.8^{b}	1445.3^{ca}	1327.0^{c}	0.00	49.70

* SEM: Standard error of mean; ** p: p value: Probability of a larger F value for the treatment; *** LW: live weight.

a,b,c Means within rows with differing superscript letters are significantly different ($p<0.05$).

Estimated from the degradability of straw as ME (MJ/kg DM)=2.756+48h DM loss*0.173 (cited from Chowdhury and Huque, 1996a). Elephant grass ME from NIAH (1996).

Calculation based on CP content in dry samples of UTrFRS.

grass treatment, followed by the treatments 100% grass and 50% grass, while the lowest was in the 25% grass treatment. Significant differences were found between the treatments 100% grass and 50 and 25% grass and between 75% grass and 25% grass.

In the present study, results for total DMI/100 kg LW were a little lower compared to the results reported on feeding urea treated rice straw based diets to milking cows in this region (Wanapat et al., 2000; Prasad et al., 1998). Differences in breed, body size, level of concentrate offered and diet composition were probable explanations for the result of the present study. In the DMI results, adding UTrFRS to the grass diets increased roughage intake. Of course, more treated straw in the diet reduced the additive roughage DMI. Feeding mixed roughage may improve DMI, as was reported in a study of Wanapat et al. (2000) on the utilization of urea treated rice straw and whole sugarcane as roughage sources for dairy cattle. Higher ratios of treated straw in the mix roughage treatments resulted in higher indigestible parts in the diets because of low digestibility of treated straw compared to grass, and this will result in low DMI (table 2: treatments: 75, 50 and 25% grass, respectively). Low DMI on the 100% elephant grass diet may be related to the dry matter content of grass. In this study, elephant grass was intensively cultivated on irrigated and fertilized land, which resulted in the lower DM content of the elephant grass compared with the common practice in the region (12.7 vs. 15.3-18% in NIAH, 1995). The problem is that when feeds are very succulent, the intake may be reduced because of the large amount of water that is ingested. Several authors e.g. Dodsworth and Campbell (1953), Stoll and Jans (2000) have reported a reduction of DMI with lower DM content of the silage. Highly succulent elephant grass in this study may be the reason for low DMI, and this should be considered in feeding practice. Wilting the grass or adding straw in order to increase DMI may be a solution, although this is controversial.

In the design of the study, the amounts of concentrate offered were almost the same on all experimental treatments, and with the fixed ratio of elephant grass on all treatments, the roughage intake and its component ratios may indicate differences in palatability of the roughage. The large DMI increase in treatment 75% grass increased the ratio of UTrFRS/roughage by 35.4%, which was more than expected, but the increase was not as great on the higher UTrFRS ratio treatments. It can be said that mixed roughage of UTrFRS and elephant grass in the ratio of 2:1 has the highest DMI.

Higher DMI in mixed roughage diets results in higher dietary ME intake because the amounts of concentrate offered were nearly the same among treatments. Based on the calculation of daily nutrient requirements (NRC, 1988) of lactating cows in this experiment, the daily ME intakes (table 2) were a little higher, and sufficient for additional milk or weight gain. Of course, with the short period for measurement, milk yield and LW change (table 3) did not show any clear response to the different ME intakes. In the same comparision, the daily CP intake can satisfy the increase of milk yield and weight gain even on the lowest CP intake treatment (25% grass). This calculation is based on the CP content of dry samples. In fresh samples there will be a high level of CP intake in the mixed roughage diets. However in practical feeding, exposure of treated straw to the atmosphere increased the loss of NH_3 (25% in 2 h: Jayasuriya and Perera, 1982) and reduced CP intake.

Milk yield and milk compositions : The effects of partial replacement of elephant grass with UTrFRS on milk yield and milk composition are presented in table. 3. Plain milk yield and 4% fat corrected milk (FCM) yield were very close to 10 kg milk per day and non significant differences were found among treatments, although there was a gradual increase of 4% FCM yield in connection with the increase of UTrFRS in the experimental diets. The same trend was found in the milk fat yield, with the highest yield on the treatment with the highest proportion of treated straw diet. However these differences were non-significant.

The milk fat content was lowest for the 100% grass diet, and gradually increased ($p<0.05$) with increased ratios of UTrFRS offered in the experimental diets. Milk protein and milk dry matter contents were 3.15 and 11.4%, respectively, and there was no difference among treatments.

Increased use of UtrFRS in lactating cow diets up to a ratio of 75% roughage did not result in differences in milk yield and milk composition, except for milk fat content, which as positively related to the proportion of acetate and butyrate in the rumen volatile fatty acids (VFA). It is known that acetate predominates with the increasing proportion of dietary fibre (Jorgensen et al., 1965; Gordon and Forbes, 1971). Beauchemin (1991) found similar result in increasing of VFA and acetate/propionate (A/P) ratio with dietary NDF. In the present study there was a good response of milk fat content to increasing dietary NDF (tables 2 and 3).

Urea treated fresh rice straw and animal health : 'Hyperexcitability' cases in feeding ammoniated straw, which were previously described by Perdok and Leng (1987), were also reported by Chowdhury et al. (1996c). No unusual symptoms or harmful effects on animal health were observed in the present study. Of course, the feeding time was shorter and the animals were fed a mix roughage included grass in our study. In a more detailed evaluation of the effect of prolonged feeding of urea-treated rice straw, compared with feeding of hay on the regulation of body fluids, milk yield and mammary circulation, Chaiyabutr et al., (2000) reported no significant differences in health and

Table 3. Effects of partial replacement of elephant grass (Gr) with urea treated fresh rice straw (UTrFRS) on milk yield, milk composition and live weight (LW)

Roughage based ration	100% Gr	75% Gr	50% Gr	25% Gr	p*	SEM**
Milk production						
Milk yield, kg/day	10.23	9.99	10.14	9.76	0.70	0.42
4.0% FCM ***, kg/day	9.79	9.86	10.08	10.13	0.84	0.40
Milk fat yield, g/day	380.0	390.9	401.4	415.5	0.30	16.90
Milk CP yield, g/day	319.5	313.5	314.0	307.8	0.91	12.50
Milk composition						
Milk fat (%)	3.71[a]	3.91[ab]	4.02[b]	4.35[c]	0.00	0.12
Milk protein (%)	3.13	3.15	3.12	3.18	0.86	0.05
Milk dry matter (%)	11.44	11.47	11.26	11.31	0.90	0.17
Mean LW (kg/cow)	422.5	420.8	420.7	419.7	0.90	11.2
Mean LW change (kg/cow)	+ 2.12	+2.56	-1.31	+0.68	0.09	0.67

* p: p value: Probability of a larger F value for the treatment; ** SEM: Standard error of mean: *** FCM: Fat corrected milk.
[a,b,c] Means within rows with differing superscript letters are significantly different ($p<0.05$).

Table 4. Urea treated preservation cost of fresh straw at a dairy farm (CuChi, HCM city, Vietnam, 3/1999 in US $; 1US $ # 14000 VN $)

Items	Quantity	Expense (US $)	Note	Elephant grass
Cost of fresh straw/0.5 ha	# 4000 kg	14.286	Opportunity cost*	Farm gate price
Cost of plastic: 32 bags	64 kg	22.857	discount 1/3	
Cost of urea	100 kg	14.286		
Cost of labor	8 days	17.143	Opportunity cost	
Cost of transportation	4 tons* 1 km	4.286	Opportunity cost	
Total cost		72.857		Dry season
Cost per 1 kg urea treated fresh rice straw		0.018	1 kg in fresh	0.014
In dry matter		0.047	1 kg in dry matter	0.124

* Opportunity cost: might be from farm resources.

milk physiological data between the two treatments.

Urea treated fresh rice straw of early maturing rice varieties, which usually is in pale green of ensiling material, in general looked similar to treated mature grass or other green crop residues. In the Tropics, late maturing grasses are low in nutritive value, and not so much different from straw and many studies have focused on treating these materials. Urea has been used in ensiling tropical grasses such as Guinea grass (*Panicum maximum*) (Matsuzaki and Ogawa, 1994), hill grasses (mostly *Cymbopogon martini*) (Singh and Taparia, 1992) and Themeda grass (*Themeda spp.*) (Ambre and Toro, 1993). These authors reported good results in improved quality and feeding value of urea treated grasses. With a good quality of the product and long time in preservation in the present study and in the study of Chowdhury and Huque (1996) it can be concluded that this method is a promising technique for preserving high fibre green materials that are very low in the water soluble carbohydrates needed in common ensiling methods.

Costs in urea preservation of fresh straw : The main costs in preservation of 1/2 ha (a typical rice farm area) of fresh rice straw with urea in plastic bags in a typical small scale dairy farm in Ho Chi Minh City, Vietnam, are shown in table 4. In the total cost of preservation, cost of urea and plastic are counted as expenditure costs and may be up around 50% of the total. The other 50% are counted as opportunity costs because they can be supplied from farm resources.

The mean cost of 1 kg of UTrFRS is higher than the cost of 1kg of elephant grass bought in the dry season. Of course, the dry matter based cost of 1 kg UtrRS is much lower, around one third of the grass cost (0.047 vs. 0.124 USD). The cost of preservation on-farm can be reduced by using the farmer's resources, such as rice straw, that usually be wasted. Adding to this reduction, the cost of plastic bags will decrease when using polythene sheets to cover the urea treated straw heap, as proposed by Chowdhury and Huque (1996b) and this results were not so different to the present study.

In view of the present situation and the immediate future, tropical farm size of the small scale farmer will not change and intensive rice based cultivation systems will still probably be the most popular systems in Vietnam. Crop residue based livestock production is being continually developed, and better use of fresh high yielding varieties rice straw is a promising strategy.

CONCLUSIONS

The present data indicate that fresh rice straw can be preserved safely and with improved nutritional value by ensiling with urea (50g kg^{-1}DM rice straw). Substitution of elephant grass with UTrFRS at up to 75% of the roughage in lactating cow diets improved the milk fat content and had no effect on milk production and milk composition. Urea preservation of fresh rice straw for dairy cattle can reduce the cost of buying grass in the dry season, which is a common practice in dairy production in Vietnam. Further studies on preservation methods, in reducing the amounts and cost of the chemicals used are needed .

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