Rumen Metabolism of Sheep Fed Silage Containing Poultry Litter

Shahid Rasool*, S.H.Raza and Tanveer Ahmad***

*Dept. Animal Nutrition University of Agriculture Faisalabad, Pakistan.
**Dept. Livestock Management, University of Agriculture, Faisalabad, Pakistan.

1. Introduction

The use of molasses not only improves the energy content of silage but also ensures low pH and prevents proteolysis. The nitrogen (N) concentration of the cereal and grass silages, which is generally low, can however, be improved considerably, without affecting its fermentation characteristics, by the addition of poultry waste at the time of ensiling. Ensiling poultry waste with cereal forages and grasses not only considerably increases their inherent low N concentration but also provide many basic nutrients such as energy, calcium, phosphorus and unidentified nutrients. In this way the poultry waste can be recycled as feed for livestock with no undesirable effects on animal health. The objective of this study was to determine the effect of feeding silage containing broiler litter on the rumen metabolites of sheep.

2. Materials and Methods

Commercial broiler house litter was sun dried, ground and stored for silage making. A representative sample of litter was analysed for total-N, protein-N, ammonia-N, ash, fibre fractions, silica (Van Soest and Robertson 1982) and Non-fibre carbohydrates. Dried broiler litter[1] (30 % DM) and cane molasses (60% of DM) were added to chaffed Sudax fodder[1] (SPL-Silage) for silage making. Control silage without litter was also prepared. To determine chemical changes during ensiling, triplicate samples of each silage were analysed at the start and on 40th day, when opened. Samples were analysed for Dry matter (DM), total-N, protein-N, ammonia-N and lactic acid. Since the poultry litter had a high silica concentration, which dissolves in neutral detergent but not in acid detergent, adding the difference in silica between ADF and NDF to the apparent hemicellulose values made a correction. Lignin was determined as acid detergent (AD) lignin and cellulose as lignin free ADF.

Three adult rumen cannulated mature sheep were randomly allotted to one of the following rations in an experiment run according to 3×3 Latin Square Design experiment.

1) Ration A: Complete farm ration.

2) Ration B: SPL-silage.

3) Ration C: Sudax silage + 30% concentrate mixture

All rations were formulated at 14% crude protein (CP) and 70% total digestible nutrients (TDN). Each ration was fed to a rumen cannulated sheep for a period of 10 days as adjustment period. In the following three days, the rumen liquor samples were collected at 0, 3 and 6 hr post-feeding. The pH of rumen liquor was recorded immediately after collection with Beckman pH meter. The rumen liquor samples were strained through four layers

---

[1] Broiler litter and Sudax fodder contain (%): dry matter at103°C: 90.16, 24.88; organic matter: 79.78, 93.97; NDF: 38.97, 61.23; ADF: 35.97, 34.02; hemicellulose: 3.00, 27.21; cellulose: 18.10, 29.32; non-fiber carbohydrates: 16.01, 22.08; lignin: 2.82, 3.58; silica: 14.56, 1.12; total-N: 3.84, 1.62; protein-N: 1.28, 1.47; ammonia-N: 0.29, 0.09; non-protein-N, 2.56, 0.15. All values are on DM basis.

of cheesecloth and the filtrate was collected in 50 ml plastic bottles, containing 2 drops of N H_2SO_4. After adding a few drops of chloroform. The samples were stored in deep freezer till analysis after thawing, for total-N, protein-N and ammonia-N.

The data on chemical analysis of rumen liquor were analysed statistically using analysis of variance technique in a factorial model (3×3 with interactions) in a Latin Square design (Steel and Torrie 1981).

3. Results

Data on average pH and different N fractions in rumen liquor of sheep fed on different rations is shown in Table 1. Significantly ($P<0.05$) higher pH was observed in rumen liquor of sheep fed the ration containing SPL-silage as compared to that having Sudax silage plus concentrate mixture. The changes in pH of rumen liquor of sheep at different times post feeding were found to be non-significant ($P>0.05$).

Sheep fed on complete farm ration had significantly ($P<0.05$) higher total-N than those on SPL-silage or Sudax silage plus concentrate mixture. The sheep on SPL-silage had the lowest total-N concentration, and was significantly higher ($P<0.05$) when Sudax silage was supplemented with concentrate mixture (Table 1). Significant differences ($P<0.05$) were also observed in total-N concentration of rumen liquor of sheep at different times post-feeding. At zero hours post-feeding the total-N concentration of ruminal fluid of sheep on complete farm ration was significantly higher ($P<0.05$) than that of the other rations. The ruminal total-N concentration of sheep on SPL-silage and Sudax silage plus concentrate mixture rations were similar at 0 hours post- feeding.

At 3 hours post-feeding the total-N concentration of rumen liquor of sheep on Sudax silage plus concentrate mixture ration increased and was higher (P<0.05) than that on SPL-silage ration.

The protein-N concentration of rumen liquor was significantly higher (P<0.01) on complete farm ration followed by regime Sudax silage plus concentrate mixture and SPL-silage. The protein-N concentration of rumen liquor of sheep on all ration at different times post-feeding followed a similar pattern as in case of total-N concentration.

Table 2. Average pH and different N fractions in rumen liquor of sheep fed different rations

Ration*	**Time post feeding (hr)**	**pH**	**Total-N (mg %)**	**Protein-N (mg %)**	**Ammonia-N (mg %)**
A	0	6.39^{c}	127.8^{b}	89.13	23.16
	3	6.24^{c}	120.3^{bc}	83.31	33.64
	6	6.50^{c}	148.0^{a}	105.36	30.53
	Average	6.357^{c}	132.0^{a}	92.60^{a}	29.11^{b}
B	0	6.91^{a}	89.4^{f}	46.53	40.62
	3	6.80^{a}	96.5^{def}	58.76	37.77
	6	6.76^{a}	92.1^{ef}	55.99	36.08
	Average	6.826^{a}	92.66^{c}	53.76^{c}	38.16^{a}
C	0	6.66^{b}	88.4^{f}	56.22	20.52
	3	6.58^{b}	109.2^{dc}	72.38	27.83
	6	6.59^{b}	104.5^{de}	71.33	24.75
	Average	6.608^{b}	100.7^{b}	66.64^{b}	24.37^{c}

*Ration A: complete farm concentrate, B: SPL-silage, C: Sudax silage + concentrate mixture.

[abcdef] Means within column with different superscripts differ significantly (P<0.05)

The ammonia-N of rumen fluid of sheep fed SPL-silage was significantly higher ($P<0.05$) as compared to complete farm ration or Sudax silage plus concentrate mixture (Table 2). An ammonia-N concentration of rumen fluid was the lowest at 0 hours but it increased significantly ($P <0.05$) at 3 hours post-feeding and then decreased again at 6 hours post-feeding. Following this pattern the final ammonia-N concentration of ruminal fluid was not significantly different from that determined at zero hours post-feeding.

4. Discussion

The results as shown in Table 1 indicate that the difference among rations were significant ($P< 0.05$). It has been observed that when 3.1 to 6.0 kg poultry litter was fed to cattle in a daily ration, ammonia concentration in rumen fluid was 3 to 5 times higher than the optimal level of 10 mg/dl for maximum fermentation and optimal microbial protein synthesis (Silanikove and Tiomkin 1992) It was stated that once the microbial requirements for N in the rumen are met, there should be no further increase in the rate of fermentation. Excessive consumption of poultry litter exposes the cow to metabolic burdens, as reflected in ammonia (> 2O mg/dl) concentration and reduces the cell life span (Visck 1984).

Ammonia concentration in rumen fluid had direct relationship with poultry litter intake and the parallel increase with pH would encourage the absorption of ammonia from the gut (Harmeyer and Martens 1980). Excessive ammonia, which is not utilised by the microbes, is absorbed in the blood circulation and converted to urea in the liver with consequent metabolic burden on liver.

Rumen pH, concentration of total-N, protein-N and ammonia-N very much depend upon the physiological status of the animal as happened in our experiment when sheep were fed on SPL-silage. When Sudax silage was fed with supplemental concentrate mixture, the concentration of total-N and protein-N increased and that of ammonia-N decreased compared with SPL-silage, yet it was less (P<0.0l) than the control. The reason being increased DM intake, reduced cell wall or structural carbohydrates with corresponding increase in cell contents and thus increased rate of digestion due to microbial stimulation with corresponding increase in microbial population and protein synthesis.

The pH of rumen fluid on three diets indicated highest value on SPL-silage, probably due to high ammonia concentration. The ammonia-N of the rumen fluid increased to a significantly (P<0.01) higher level, on all the three rations, at 3 hours post- feeding and again decreased to lower level. It was probably either utilised by microbes or crossed the rumen wall, because during this time the pH of the rumen fluid was in the range of favourable ammonia absorption. The results of this trial indicates that SPL-silage alone could not support growth because it was deficient in energy, had higher concentration of soluble N, low concentration of less soluble protein and a high proportion of structural carbohydrates with correspondingly decreased microbial stimulation and low ruminal fermentation.

5. References

Harmayer, J. and H. Martens. 1980. Aspects of urea metabolism in ruminants with reference to the goat. *Journal of Dairy Science* **63,** 1707-1728.

Silanikove, N. and D. Tiomkin. 1992. Toxicity induced by poultry litter consumption: Effects on measurements reflecting liver function in beef cows. *Animal Production* **54,** 203-209.

Steel, R.G.D. and J.H. Torrie. 1981. Principles and Procedures of Statistics. McGraw Hill Book Co. Tokyo.

Van Soest, P.J. and J.B. Robertson. 1982. Analysis of forages and fibrous foods. Cornell University. USA. 198pp.

Visck, W.J. 1984. Ammonia: its effects on biological systems, metabolic hormones and reproduction. *Journal of Dairy Science*. **67,** 481-498.

Voluntary Intake and Digestibility of Treated Oil Palm Fronds

M. Wan Zahari[1], S. Oshio[2], D. Mohd Jaafar[1], M. A. Najib[1], I. Mohd Yunus[1] and M.S. Nor Ismail[1]

[1]Livestock Research Centre, MARDI, P. O. Box 12301, GPO, 50774 Kuala Lumpur, Malaysia
[2]Hokkaido National Agricultural Experiment Station (HNAES), Japan
E-mail: wzm@mardi.my

1. Introduction

Oil palm frond (OPF) is one of the most abundant agricultural by-products in Malaysia. Almost all pruned fronds are discarded in the plantation, mainly for nutrient recycling and soil conservation. It has great potential to be utilised as a roughage source or as a component in compound feed for ruminants. Much research has been carried out by MARDI and JIRCAS to use OPF for animal feeding either fresh, or as silage or pellet (Abu Hassan *et al*. 1995). Detailed studies on the fermentation characteristics and palatability of OPF silage as well as on animal performance have been reported (e.g. Abu Hassan and Ishida 1991; Ishida and Abu Hassan 1997; Oshio *et al*. 1999). The objective of this trial was to study the effect of processing methods of OPF on its digestibility and voluntary intake.

2. Materials and Methods

Four processing methods of OPF (pelleting, dry chopping, silage, and NaOH treatment) were compared for *in vivo* digestibility and intake using 16 Kedah-Kelantan (KK) cross yearling heifers (mean live-weight 160 kg). The fresh OPF collected from the UPM farm in Serdang, Selangor, Peninsular Malaysia, was chopped to 2-3 cm length and blended uniformly. A portion of the chopped OPF was directly packed in plastic drums (approximately 100 l) for making silage. The material was kept for one month before feeding to the animals.

Simultaneously, a portion of the chopped OPF was mixed with 10% NaOH solution at the ratio of 15 kg to 100 kg of fresh OPF. The material was packed similarly in the drums and kept for one month until feeding. For making dry chopped OPF, a portion of the chopped OPF was chopped again using the same machine, dried under the sun for one day, and then completely dried in an oven. OPF pellets were produced with a 12-mm diameter pelletiser after being dried the same way as chopped OPF, and were ground through a 4-mm screen grinder.

These four types of OPF were mixed with a basal ration comprising 50% palm kernel cake (PKC), 20% palm oil mill effluents (POME), 16% tapioca waste, 10% rice bran, 2% minerals and vitamin mixture, 1% salt, and 1% urea at various ratios. Rations consisting of 40% and 60% OPF pellets, 40% chopped OPF, 40% OPF silage and 40% NaOH-OPF were used to measure the apparent digestibility of each form of treated OPF at maintenance level with 3-4 animals for each ration. Each ration was fed for 14 days and faeces from each animal were collected for measuring the digestibility throughout the last 5 days. OPF pellets and chopped OPF were mixed at the ratio of 25, 40, 60 and 75% of the total feeds on DM basis with the basal ration as mentioned above. Each diet was voluntarily fed to the 3-4 heifers, respectively. OPF silage and NaOH-treated OPF were also mixed with the basal ration and were fed to the animals in the same ratios, except the 75% rations. Each ration was fed to the animals daily at 10-20% above the saturated level for 9 days. The weight and DM content of the remainder were measured in the morning. Collection of faeces was carried out for the last 3 days to measure the digestibility.

3. Results and Discussion

Table 1 outlines the voluntary intake and digestibility of the treated OPF rations. At maintenance level, the digestibility of OPF pellets was the lowest. The intake of OPF pellets mixed with the basal ration was maintained even at the 75% inclusion level. While chopped OPF and OPF silage did not reveal much difference in digestibility, intake was higher for the chopped OPF ration than for OPF silage. Nevertheless, the intake at 75% level of chopped OPS was depressed to 58% of that at the 25% level .

Table 1. Voluntary intake and digestibility of treated OPF rations

Ratio of OPF	OPF pellets		Chopped OPF		OPF silage		NaOH-OPF	
	DM intake g.DM/kg$^{0.7}$	DM dig. %	DM intake g.DM/kg$^{0.75}$	DM dig. %	DM intake g.DM/kg$^{0.7}$	DM dig. %	DM intake g.DM/kg$^{0.75}$	DM dig. %
Voluntary intake level								
25%	104.5	63.7	97.8	61.8	89.7	61.2	104.3	62.1
40%	101.7	56.1	83.0	57.6	74.6	59.4	87.7	60.9
60%	107.9	47.4	65.4	56.2	59.0	57.3	77.1	59.6
75%	87.6	35.8	57.2	51.0				
DM digestibility (%) of each treated OPF at maintenance level								
Basal ration								
69.5		33.3		38.6		41.6		53.4

The digestibility and intake of NaOH-treated OPF were the highest. Although grinding and pelletising lowered the digestibility due to the faster rate of passage through the rumen, these processes were more effective for enhancing the intake. On the other hand, NaOH treatment improved not only the digestibility but also the intake remarkably.

Therefore, this treatment has great potential for improving the OPF quality. However, as NaOH is caustic and dangerous, a safer and more cost-effective procedure for treatment is needed. Ammonia treatment, an alternative to NaOH treatment, was not carried out in this experiment. Although ammonia treatment could be adopted for improving the frond quality, there is a high possibility that reaction between soluble sugars in OPF and ammonia will produce toxic substances such as 4-methylimidazole. Thus, if ammonia treatment is adopted for improving the quality, it is important to identify the occurrence of the toxic materials.

3. Conclusion

The digestibility and intake of NaOH-treated OPF was higher than those of chopped OPF or OPF-silage were. More studies are needed to determine if NaOH treatment is suitable, or can be replaced with ammonia, for improving the OPF quality. Intake was lower for OPF silage than the chopped OPF but the digestibility was comparable. Compared to the fresh-chopped OPF, OPF silage has advantages for animal feeding, in terms of ease of handling, storage, less labour usage, easy to be transported etc. Fresh chopped OPF needs to processed daily. This is not only time consuming but in long-term it is not practical and not cost-effective.

Although pelletising of OPF is effective for improving intake, it depressed the digestibility. Therefore, an alternative processing method such as cubing is required to maintain the same level of digestibility as chopped OPF and simultaneously to improve the intake.

4. References

Abu Hassan O., Ishida, M. and Mohd Sukri, I. 1995. Oil palm fronds (OPF) technology transfer and acceptance, a sustainable in-situ utilization for animal feeding. *Proceedings of the 17th Malaysian Society of Animal Production (MSAP) Annual Conference,28-30 May 1995, Penang* p. 134-135.

Abu Hassan, O. and Ishida, M. 1991 . Effect of water, molasses and urea addition on oil palm frond silage quality. – Fermentation characteristics and palatability to Kedah-Kelantan bulls. *Proceedings of the Third International Symposium on The Nutrition of Herbivores, 25-30 Aug 1991, Penang, Malaysia*, p. 94.

Ishida, M. and Abu Hassan, O. (1997). Utilization of oil palm fronds as cattle feed. *Japanese Agricultural Research Quarterly* **31,** 41-47.

Oshio, S., Wan Zahari, M. and Mohd Jaafar, D. 1999. Feed evaluation for quality control of oil palm fronds as a ruminant feed after pruning. MARDI-JICA Publication no: 07. pp 7.

Sweet Corn Stover Silage Production

A.B. Idris, S.M. Yusoff and A. Sharif

Department of Veterinary Services, Malaysia

Introduction

In Malaysia, livestock production is mainly in the hands of smallholders who are largely dependent on forages for their feed resources. With the assistance of the Department of Veterinary Services (DVS), more farmers are now cultivating forages, especially those who are involved in the milk collecting centre (MCC) dairy projects. Owing to events such as droughts and floods, fodder conservation is likely to play an important role for livestock production among smallholders in certain areas of the country.

Sweet corn is a popular crop in Malaysia. After its cobs have been harvested the stover still contains a good source of nutrients suitable for cattle feeding. With 9.6% crude protein concentration we found in an earlier study, it is comparable to that of stover harvested at 75 days of age (Yacob *et.al.* 1992). The metabolisable energy (M.E.) value of 7.82 MJ/kg of fresh stover is comparable to or in some cases better than most fodder grass species being used in Malaysia. Although this by-product is a valuable forage by itself in the fresh state, at harvesting time the quantity would be too much to be utilised in a short time before they decompose. This material needs to be conserved for feeding in adverse seasons. Ensiling the stover is thought to be the best form of conservation. At present the production of sweet corn silage is carried out in the state of Terengganu with an estimated production of 120 t annually. Since the inception of the sweet corn stover ensilage programme in 1996, an estimated 400 t have been produced for feeding farmers' cattle.

Materials and Methods

The stover of sweet corn harvested after 75 days was collected and chopped into 2 cm lengths, using a portable forage chopper. The chopped stover was tightly packed into 128 l plastic drums, taking care to exclude as much air as possible to maintain anaerobic conditions for successful ensilation.

The ensiled materials were opened after 30 days and samples were sent to the laboratory for analyses using AOAC (1984) methods. Calcium concentration was determined using an atomic absorption spectrophotometer, phosphorus using the molybdate metavanadate complex, metabolisable energy by the gas test procedure as outlined by Menke *etal*. (1975) and the fibre components using the method of Goering and Van Soest (1970).

Result and Discussion

Yacob *et al.* (1992) estimated a production of 10 t of dry matter of stover per ha of sweet corn and this figure is close to the average of 12 t achieved in the current work. It is evident that a substantial quantity of forage can be obtained if stover from every crop of sweet corn is ensiled and utilised by dairy smallholders.

At the normal harvesting age of 75 days, the protein and ME contents of corn stover were 9.6% and 7.82 MJ/Kg respectively. In the silage product the protein concentration had decreased to

8.2% and ME value to 5.86MJ/kg. Very negligible spoilage was observed in the drums during the project.

References

AOAC. 1984 . Official methods of analysis (14th Ed.). *Association of Official Analytical Chemistry*. Arlington. Va, USA

Goering, H.K. and Soest, P.J. 1970. Forage fibre analyses (Apparatus, reagent, procedures and some applications). *Agricultural Handbook 379*, ARS, USDA. Washington, D.C.

Menke, K.H., Raab, L., Salewski, A. Steinggas, H., Fritz, D. and Schneider, W. 1975. The estimation of the digestibility and metabolizable energy content or ruminant feeding stuffs from the gas production when they are incubated with rumen liquor in vitro. *Journal of Agricultural Science Cambridge* **93,** 217-222.

Yacob, M.A., Alimon A.R. and Hilmi, A. 1992. Nutritive evaluation of sweet-corn stover silage for growing lambs. In: Wong H.K. *et al.* (Eds). Towards more efficient, effective and minimal production strategies. *Proceedings 15th Malaysian Society of Animal Production Conference* pp.203-206.

Successful Smallholder Silage Production: A Case Study from Northeast Thailand

Ganda Nakamanee

Pakchong Animal Nutrition Research Centre, Thailand

In Thailand, a major limitation in raising dairy cattle is insufficient feed, especially during the dry season. Farmers are very familiar with the use of crop by-products as animal feed, but less familiar with forage conservation. Despite much research work on silage production at research centres and Universities in Thailand, adoption has been generally low. There are many reasons for this, including

- a lack of herbage,
- silage making is deemed complicated,
- a lack of investment capital for new machinery.

This paper discusses the potential for adoption of forage ensiling techniques in smallholder Thai dairy farms and the factors affecting this potential. The study area is Sung Nuen District, Nakornratchasima in Northeast Thailand. It is located between latitude 14°30' - 15°15' N, longtitude 101°43' - 101°56' E. Average annual rainfall is 805 mm and the principal crops grown are rice, maize ,cassava and sugar cane.

Participatory diagnosis of livestock feeding problems was conducted with dairy farmers in 1997. The major problem was a lack of good quality roughage in the dry season. Two other feed resources the farmers have been commonly using to reduce this problem are crop residues (especially rice straw) and sugar cane tops. Formerly, crop residues were available free of charge, but rising demand has resulted in increased prices and crop residues becoming increasingly scarce. Also, the low protein content of these residues is not adequate for productive cattle during the dry season. As a result, farmers have become interested in testing forage conservation methods including silage making

Silage Making Demonstration

The Animal Nutrition Research Centre at Pakchong collaborated with a district livestock officer to conduct a silage making demonstration in the village, with 53 dairy farmers participating. Three different techniques of silage making demonstrated were:

- Bunker silos
- Black polythene bags of 40-kg capacity
- Plastic bags of about 800-kg capacity

Because they were in a maize growing area, corn silage was made in the demonstration. Farmers provided chopped corn leaves and their labour. The development workers provided labour, materials (plastic bags) and technical advice. Follow-up visits were conducted to check for problems and discuss with farmers their experiences with silage making. All 53 farmers were interested in trying to make silage on their farms. One farmer modified the technique to make silage in plastic buckets and in a below-ground pit silo for sale.

Table1. Preference ranking of various types of silo.

Silage technique	Farmer's preference (%)
• Bunker silo	38
• Plastic bucket	31
• Black polythene bag	23
• Plastic bag (800kg)	8

Farmers' Comments

Black polythene bag:

cheap and easy to feed animals

Plastic bag (800kg):

can make a large amount at one time

Plastic bucket:

even if it is more expensive than plastic bags at the beginning, it can be reused many times and also protect the silage from insects and rodents.

Bunker silo:

Large initial capital investment for construction but lasts for a long time

Factors Affecting the Potential for Adoption of Silage Making On Farm.

- Farmers realised that the lack of good quality roughage in the dry season was their main constraint.
- Learning by doing: farmers found that in fact, silage making is not difficult or as complicated as they had heard and read.
- The development workers know the needs of farmers and provide various alternatives for them to observe, compare and evaluate before choosing the best possible solutions.
- Farmers must have sufficient material available locally to be ensiled.
- As they are smallholder farmers, not all ensiling technologies are appropriate. The cost of the ensiling technology needs to be balanced with the availability of capital on-farm.

Conclusions

There is some potential for broader application of silage making on smallholder dairy farms in Thailand. However, the particular methods used for silage making will be adapted by farmers to fit their own situations. We are continuing to work with these farmers to monitor adoption and discuss their needs so we have a better understanding of which silage technologies have the best potential under these conditions.

Evaluation of Different Harvest Times of Four Genotypes of Sunflower (Helianthus annuus L.) for Ensiling

Gonçalves[1] L.C., N.M.Rodriguez[1], L.G.R.Pereira[3], J.A.S.Rodrigues[2], I.Borges[1], A.L.C.C. Borges[1], E.OS.Saliba[1]

[1]Professors of Departamento de Zootecnia
Escola de Veterinaria-UFMG, Brazil.

[2]EMBRAPA-Centro Nacional de Milho e Sorgo, Brazil

[3]Graduate student

E-mail: norberto@vet.ufmg.br

1. Introduction

In recent years, the sowing of fodder crops during the rainy season (January to March) has become very popular. Generally, corn and sorghum are used, because they produce a well-preserved silage of good nutritive value. However, their dry matter (DM) yields and quality are uncertain from year to year, because of frequent drought stress.

Sunflower stands out as an alternative for forage production and conservation as silage because of its drought tolerance, its high DM yields, its resistance to cold and heat, its adaptability to different edafoclimatic conditions and its relative independence of latitude, altitude and photoperíod (Cotte 1959, Tomich, 1999).

To obtain silage of good quality and of high nutritive value, the material should be cut at the right point of maturity. Tan and Tumer (1996) ensiled sunflower at several stages of maturity and concluded that the final flowering stage was the best for silage making.

The present study was carried out at the EMBRAPA-National Center of Research in Corn and Sorghum. The objectives were to evaluate the sunflower genotypes V2000, DK180, M734 and Rumbossol-91 grown in a completely randomised block with 3 replications and cut and ensiled 30, 37, 44 and 51 days after flowering.

2. Results

Table 1 shows that many of the plots had inferior stands compared to those recommended by CASTRO *et al.* (1996) of 40 to 50 thousand plants per hectare. Rumbosol-91 was significantly taller than the other cultivars, but had the lowest percentage heads and the highest percentage stem. Dry matter (DM) yield of V2000 was inferior to the others, except for the first harvest time (Table 2). The DM concentration of the material is the most important factor for the quality of the ensiling process (McDonald *et al.* 1991) and it is recommended to be between 30 to 35%.

Laboratory silos of PVC with 40 cm of length and 10 cm diameter were used and the silos were opened after 56 days.

Table 1. Stand (plants/ha), height of the plants (cm), diameter of the heads (cm) and percentages of heads, stems and leaves at 30 , 37, 44 and 51 days after flowering

	Stand	Height	Diameter	Head%	Stem%	Leaf%
			V2000			
30	39.59ABa	195.00Ba	16.84Aa	46.34Aa	35.56Ba	18.12Aab
37	26.74Ba	190.00Ba	20.44Aa	42.17Aa	37.34Aba	20.49Aa
44	33.34Aa	178.33Ba	17.56Aa	47.22Aa	37.16Aba	15.61Bab
51	19.44Aa	176.67Ba	15.55Aa	51.85Aa	37.68Ba	10.47Ab
			DK180			
30	31.60Ba	205.00Ba	17.56Aa	44.38Aa	35.46Ba	20.16Aa
37	39.58Aba	190.00Ba	15.56Aba	52.00Aa	35.03Ba	12.97Ba
44	25.35Aa	200.00Ba	17.67Aa	45.63Aa	38.32Ba	16.05Ba
51	38.19Aa	203.33Ba	12.22Aa	41.16Ba	42.41Ba	16.43Aa
			M734			
30	30.56Ba	193.33Ba	19.67Aa	48.83Aa	32.68Ba	18.49Aa
37	42.71ABa	181.78Ba	14.78ABa	48.99Aa	33.30Ba	17.71ABa
44	46.53Aa	198.33Ba	15.11Aa	50.67Aa	31.25Ba	18.08ABa
51	39.58Aa	191.67Ba	13.22Aa	48.58ABa	35.62Ba	15.79Aa
			RUMBOSOL 91			
30	58.33Aa	235.00Aa	16.67Aa	26.52Ba	50.27Aab	23.21Aa
37	57.64Aa	226.67Aa	13.68Ba	33.38Ba	44.20Ab	22.43Aa
44	25.35Ab	228.33Aa	17.78Aa	29.95Ba	46.05Ab	24.01Aa
51	42.36Aab	228.33Aa	15.00Aa	24.78Ca	57.20Aa	18.01Aa
CV	32.80	6.616	18.42	11.90	11.23	20.01

Capital letters compare harvest times among genotypes
Small letters compare harvest times within of each genotype

The largest densities were observed for V2000, which may be explained because of its lowest DM concentration. Within each genotype, the densities decreased with time, due to the higher DM concentrations as plants matured, with the exception of V2000. These results are superior to those reported by Tomich (1999) who studied 13 genotypes with an average density of 677.4 kg/m^3 and they are also above those found for farm silos, with values of around 600 to 800 kg/m^3 for a good compression (Nussio 1992). The quality of the preservation decreased with age of the plants as shown by increasing pH, particularly for V2000, which also had high ammonia-nitrogen (N - NH_3) levels. In another experiment done at our lab with 13 genotypes (Tomich, 1999) the mean values of ether extract and in vitro DM digestibility of the silages were 13,7 % and 50 %, respectively, and showed normal profiles of lactic acid and AGV production.

Table 2. Production of fresh matter (FM t/ha), DM (t/ha), DM (%) of plants, heads, leaves and stems at 30, 37, 44 and 51 days after flowering.

	FM/ha	**DM yld**	**Plants**	**Heads**	**Leaves**	**Stems**
			V2000			
30	30.94Aa	5.63Aa	17.85Aa	23.45Aa	20.35Ab	22.45Aa
37	16.31Ab	3.05Bb	19.13Ba	6.23Aa	29.27Bb	16.17Ba
44	10.28Ab	3.27Bb	32.80Ba	26.77Aa	48.43Aab	21.37Ba
51	7.57Ab	2.73Bb	35.17Ba	30.30Ba	58.13Aa	22.73Ba
			DK180			
30	24.58Aa	6.03Aa	24.53Ab	24.20Ab	31.77Ab	21.00Aa
37	21.49Aa	6.22Aa	29.30ABb	27.43Ab	46.30Bab	26.47Aba
44	12.85Ab	5.50Aa	42.57ABa	32.10Ab	60.70Aa	24.80ABa
51	11.39Ab	6.40Aa	59.60Aa	51.30ABa	71.97Aa	31.00Ba
			M734			
30	29.93Aa	6.53Aa	22.10Ab	21.70Ab	22.27Ab	19.20Aa
37	20.21Ab	6.24Aa	32.27ABb	25.73Ab	31.30Bb	20.80ABa
44	13.51Abc	7.49Aa	55.43Aa	37.30Aab	68.43Aa	25.70Ba
51	10.35Ac	6.57Aa	67.33Aa	49.73ABa	78.10Aa	32.30Ba
			RUMBOSOL 91			
30	24.38Aa	6.15Aa	25.70Ac	24.77Ab	38.43Ab	31.60Ab
37	12.57Ab	5.32Aa	43.20Ab	39.83Ab	70.10Aa	37.90Aab
44	15.77Ab	6.95Aa	49.23ABb	42.40Ab	76.43Aa	41.80Aab
51	7.43Ab	4.79Aa	68.57Aa	68.97Aa	84.50Aa	55.13Aa
CV	26.50	19.97	26.60	32.62	24.59	31.88

Capital letters compare cutting times among genotypes
Small letter compare cutting times within each genotypes

Table 3. Density (kg/m^3), DM (%), CP (%) of the silages cut and ensiled at 30; 37; 44 and 51 days after flowering.

	Density	DM	CP	pH	N - NH_3
V2000					
30	2092,50^{A}a	18,60Aa	13,09 Aa	4,43	14,76
37	1821,33^{A}a	22,28Aa	13,37Aa	5,26	24,27
44	1559,00Aa	31,10Ba	13,18Aa	5,28	12,52
51	1494,33Aa	32,79Ba	12,66Aa	5,24	21,59
DK180					
30	1673,67Aa	23,06Ab	11,17Aba	4,42	11,00
37	1570,67Abab	28,70Ab	10,31Ba	4,18	9,72
44	1261,00Aab	39,40Abb	11,40Ba	5,14	9,51
51	1050,33Bb	56,56Aa	10,69Ba	*	*
M734					
30	1921,00Aa	21,06Ab	11,25Ba	4,42	8,46
37	1575,00Aba	31,83Ab	10,62Ba	4,17	14,38
44	1240,33Ab	52,05Aa	11,25Ba	5,14	7,75
51	914,67Bb	61,30Aa	12,06Aba	*	*
RUMBOSOL91					
30	1615,67Aa	25,70Ac	9,18Ca	4,07	8,64
37	1189,33Ba	41,24Ab	9,94Ba	4,84	7,48
44	1084,00Aa	44,90Abb	9,44Ca	5,25	9,35
51	666,00Bb	64,57Aa	7,00Cb	*	*
CV	18,87	24,49	8,45		

Capital letters compare harvest times among genotypes
Small letters compare harvest time within each genotype
*Not determined

3. Conclusions

1. The best harvest time for ensiling varied according to genotype, and was 37 days after flowering for DK180 and M734, more than 51 days for V2000 and about 30 days for Rambosol-91.

2. V2000 had the highest CP concentrations, but even though with 35% DM at ensiling provided silages with undesirable pH and $N\text{-}NH_3$. Within each genotype there were no differences between harvest times in the CP concentration, with the exception of Rumbosol-91, which had lower values at 51days.

4. References

Castro, C., Castiglioni, V.B.R., Balla, A. 1996. A cultura do girassol: Tecnologia de Producao. Documentos, EMBRAPA-CNPSo, n.67, 20p.

Cotte, A. 1959. Le tournesol-fourrage. Sunflower for fodder. Herbage Abstract, v.29, n.2, p.92.

Nussio, L.G. 1992. Producao de silagem de alta qualidade in: Congresso Nacional de Milho e Sorgo 19, 1992, Porto Alegre, Conferencias. Porto Alegre: SSA/SCT/ABMS/EMATER-RS, EMBRAPA/CNPMS ,1992, P. 155-175.

McDonald, P., Henderson, A.R., Heron, S. The biochemistry of silage. 2ed. Marlow: Chalcombe Publications, 1991. 340p.

Tan, A.S. and Tumer, S. (1996). Research on the evaluation of silage quality of sunflowers. Anadolu, v.6, n.1, p.45-57,. (Abstracts)

Tomich, T.R 1999. Avaliacao das silagens de treze cultivares de girassol (Helianthus annuus L.) participantes do ensaio nacional. Belo Horizonte: UFMG, Escola de Veterinaria., 117p. Dissertacao. (Mestrado em Zootecnia).

Tropical Maize Silage in Central Brazil

Raúl R. Vera[1] and Esteban A. Pizarro[2]

[1]Pontificia Universidad Católica de Chile, Santiago, Chile
[2]Universidad de la República, Montevideo, Uruguay
E-mail: raulvera@aclaris.cl

Introduction

The long (5-7 months) dry season of the savanna region (*Cerrados*) of Central Brazil makes imperative the conservation of forage for the continuous production of milk.

Surveys conducted in the late 1970's and early 1980's indicated that in the State of Minas Gerais the conservation of maize, sorghum, elephant grass and mixtures of any two of these species were extremely common among dairy producers. Analysis of on-farm silage samples (Paiva *et al*. 1978) showed that the resulting silages were always of low nutritive value, with a mean in vitro organic matter digestibility (IVOMD) of 60% and 5.6% crude protein (CP). A parallel survey (unpublished) also showed that the process of ensilage was slow and in small dairies it was frequently carried out manually.

It was therefore hypothesised that the low resulting nutritional value was due at least in part to the slow process of cutting, chopping and ensiling. A large number of experiments was carried out to determine maize growth curves, nutritional value throughout the vegetative period, various measurements of the efficiency (Pizarro and Vera 1980) with which field operations can be carried out, material losses during cutting, chopping and conservation, and the resulting nutritional value of maize silages. Lastly, a computer model of the whole process and various alternatives was developed (Pizarro and Vera 1979; Vera and Pizarro 1981).

What follows is a brief summary of results, with emphasis on the inherent nutritional value of maize, and of the resulting silage, when the crop is grown under tropical conditions and on low fertility oxisols.

Results and Discussion

Locally bred and widely available maize varieties were used in all of the trials, including Agroceres 259, Dentado Composto, BR103 and Maia 13. The last two were varieties released by the National Center for Maize and Sorghum Research of EMBRAPA.

The growth curve of the last two varieties was studied for three consecutive years, and regular samples were collected between days 23 and 170 post-planting. Total yields, and components of the biomass were quantified.

The maize crops were fertilised as per then current recommendations, including 100 kg N, 40 P and 40 K. A typical soil analysis (0-20 cm) is as follows: clay 65%, sand 13%, pH 5.2; P 2 ppm, OM 2.6%

Analysis of the growth curves showed that for all practical purposes, between years differences were accounted for by differences in accumulated temperature (ACCTEMP) and rainfall (ACCRAIN), and these two variables together with days since planting (AGE) provided a good prediction of dry matter (DM) yields:

$$YIELD = 8.22\ ACCRAIN + 0.00080\ ACCRAIN^{2} + 4.803\ ACCTEMP - 52.402\ AGE - 0.2212\ AGE^{2} - 2659\ (r=0.96)$$

DM percentage of the whole plant (DMPC) did not vary significantly between years, and was largely accounted for by AGE:

$$DMPC= 7.66 \exp(0.0120\ AGE)\ (r=0.95)$$

The most striking result in terms of nutritional value was the rapid decline in the CP content of the crop, regardless of year and variety. CP tended to stabilise at 4-5% after the 100th day of growth, as follows:

$$CP= 22.56 \exp(-0.0285\ AGE) + 6.09 \exp(-0.003085\ AGE)$$

Dry matter digestibility (DMD) of the standing crop was evaluated in two sets of data. The first one determined the in vitro DMD of samples collected throughout the growth period as explained above. The second set of data was derived from a continuous digestibility trial carried out with penned sheep between days 49 and 177 of the growth period; it should be noted that over the period 140-77 days, the crop was fully matured and field-dried.

Up until 140 days of age, digestibility decreased linearly:

$$DMD = 73.98 - 0.172\ AGE\ (r= 0.84)$$

This implies that over the period of 100-120 days of age, which corresponds to approximately 30% DM (stage generally recommended for ensilage), DMD would be roughly 50-55% and CP 5%.

At approximately this stage of maturity, the contribution of grain to total yield was unexpectedly low despite being reasonably high in absolute terms, as shown in Table 1.

Table 1. Total dry matter and grain yields in two tropical maize varieties

	BR 105	Maia 13
Dry matter yield, kg/ha	11626	18078
Grain yield, kg/ha	3288	4237
Grain yield, % of total yield	28.3	23.4

As shown in Table 2, soluble carbohydrates and starch in particular, were low in the fresh forage. The low starch content in the fresh forage, relative to the ensiled material is almost certainly due to a laboratory artefact since later data determined in a different laboratory found that at a comparable stage of growth, starch in the DM of fresh forage ranged between 18 and 19% (Neto, *et al.* 1984). Nevertheless, soluble carbohydrates in the latter case were even lower than above.

It is worth noting that Neto *et al.* (1984) analysed samples using "definitive" methods (Bailey1967, 1973) and were able to account for 85-90% of the DM, the remaining being ash and possibly minor fractions unaccounted for.

Table 2. Chemical composition of the fresh material and the resulting silage of the variety BR 105

	Green forage	Silage
Dry matter, %	30.43	30.68
Ethanol soluble CHOs, % dm	12.37	1.81
Starch,% dm	5.93	16.28
Cellulose, % dm	22.37	22.12
Hemicellulose, % dm	20.01	22.12
Lignin, % dm	6.67	4.94
Crude protein, % dm	5.35	5.88

For purpose of comparison, it should be noted that the expected composition of temperate maize is generally as follows: water soluble CHOs 15%, starch 25%, hemicellulose 18%, cellulose 23%, lignin 5%, protein 9%, DMD 75% and grain as % of total yield 35-40%. A comparison with the data presented above shows that tropical maize in our conditions tends to be considerably higher in hemicellulose, somewhat higher in lignin and lower in protein and non-structural carbohydrates. It is hypothesised that this may be in part a plant adaptation to soil constraints, but mostly reflects the relatively low ratio of grain relative to the rest of the plant.

Numerous other results, particularly the partitioning of energy and nitrogen digestion in the gastro-intenstinal tract of the animal are available, but the above data should suffice to show the limitations of tropical maize silage, at least when grown on poor soils. In this environment, sorghum showed many of the same characteristics of maize (Pizarro *et al.* 1984), namely, high DM yields, moderate digestibility and marginal CP.

Not unexpectedly, the above tropical silages were unable to support weight gains in steers, unless supplemented with a protein supplement (Table 3)

Table 3. Liveweight gains of steers fed maize silage with different levels of cottonseed cake.

Cottonseed cake, kg/d.head	**LWG, kg/d.head**
Nil	-0.076
0.5	0.320
1.5	0.750

Contrary to our initial hypothesis, it is clear that the low nutritional value of farm silages cannot be attributed to the speed with which field operations are carried out, since the crop is of low quality throughout a relatively long vegetative period, including stages earlier than those most appropriate for ensilage.

References

1. Bailey, R.W. (1967) Q*uantitative studies of ruminant digestion: loss of ingested plant carbohydrates from the reticulo-rumen*. New Zealand Journal of Agricultural Research 10: 15-32.

2. Bailey, R.W. (1973) *Structural carbohydrates*. In: Butler, G.W. & R.W. Bailey, eds., Chemistry and Biochemistry of Herbage. New York: Academic Press, Vol. 1, p. 157-211.

3. Neto, J. M., R. R. Vera and E.A. Pizarro (1984) *Produção e avaliação qualitativa do milho dentado composto, cultivar BR 126. II. Valor nutritivo e digestibilidade in vitro*. 21 Reunião Anual da Sociedade Brasileira de Zootecnia. Belo Horizonte: SBZ, p. 380.

4. Paiva, J. A. J. de, E. A. Pizarro, N. M. Rodríguez and J. de A.C. Viana (1978) *Qualidade da silagem ra regiao metalúrgica de Minas Gerais.* Belo Horizonte, Brazil, Arquivos da Escola de Veterinaria da U.F.M.G., 30: 81-88.

5. Pizarro , E.A. and R.R. Vera (1979). *Efficiency of fodder conservation systems: maize silage*. In Forage Conservation in the 80's, C. THOMAS (Editor). European Grassland Federation, British Grassland Society Occasional Symposium, 11:436-441.

6. Pizarro, E.A. and R.R. Vera (1980). *Efficiency of maize harvesting for silage*. (Portuguese). Belo Horizonte, Brazil, Arquivos da Escola de Veterinaria da U.F.M.G., 32 (1):127-130.

7. Vera, R.R. and E.A. Pizarro (1981). *A mathematical model for the production of maize silage.* (Portuguese). Belo Horizonte, Brasil, Arquivos da Escola de Veterinaria da U.F.M.G., 33 (3):553-567.

8. Pizarro, E.A., R. R. Vera and L. C. Liseu (1984) *Curva de crecimiento y valor nutritivo de sorgos forrajeros en los trópicos.* Producción Animal Tropical 9: 187-196.

Sweet Sorghum - A fine forage crop for the Beijing region, China

Li Dajue and Song Guangwei

Beijing Botanical Garden, Institute of Botany,
Chinese Academy of Sciences, Beijing 100093, China
E-mail: lidj@ibcas.ac.cn

Sweet sorghum (*Sorghum bicolor* (L.) Moench) is a C4 plant, ranging in height between 3-5 m. It is not only known as a "high energy crop" for having a high photosynthetic rate, but it is also called "the camel among crops" with its characteristics such as drought resistance, tolerance to water logging and saline-alkali resistance as well as its wide adaptability. Sweet sorghum is a versatile crop that can be used for silage making, alcohol production and as a grain crop.

Since 1974, a large number of quality varieties of sweet sorghum has been introduced by the Beijing Botanical Garden. Comparative experimentation has shown that the yield of green forage of the varieties 'M-81E' and 'Theis' reached 128 and 125 t/ha, respectively (Table 1). Sweet sorghum is an excellent crop for silage making.

The sown area of sweet sorghum cv 'Rio' in the Nanjiao Livestock Farm of Beijing was increased from 10 ha in 1979 to 400 ha in 1982. The average yield of green forage of sweet sorghum per unit area was 76.8% more than that of maize in 1980 and 1981. According to the statistics of the Beijing Administrative

Bureau of Farming, since 1989 the sown area of 'M-81E' reached over 1333 ha in the outskirts of Beijing every year. Since 1991, the sown area of 'M-81E' has occupied 84% of the total harvested area in summer in the Beijing region. Because of the high yield of 'M-81E', an area of about 1300 ha could be used for sowing winter wheat and other grain crops. Most sweet sorghum is used for silage making.

There are similar situations in many other provinces and cities. In the Tianjin Municipality Worker-Peasant Alliance Agriculture-Livestock Farm, for example, the yield of green forage of sweet sorghum was 149% compared with maize and 191% compared with barley. The Institute of Agricultural Science of Changde District, Hunan Province showed that the biomass yield of 'M-81E' reached 125 t/ha, which is 181 % of that of maize.

Sweet sorghum can be grown not only in North China but also in South China. The total accumulative harvested area in recent years has been about 1000 ha in Bright Farm, Shenzhen City.

Table 1 shows the yields of different fractions of the crop of a number of cultivars tested in China.

It will be of great significance through popularisation of sweet sorghum as a silage crop to change the livestock farming structure by devoting greater effort to the development of grazing-livestock farming (cattle, sheep, rabbits, geese, etc.), in order to increase the total output of meat and reduce the pressure on grain used for poultry.

Harvesting sweet sorghum for silage making

Table 1. Mean yield of stalk, fermentable sugar, alcohol, fresh biomass and seed of sweet sorghum in experiments at the Beijing Botanical Garden

	CULTIVAR					
	Theis	**M-81E**	**Wray**	**Keller**	**Brandes**	**Rio**
Stalk (kg/ha)	95	89	76	76	62	52
Fermentable sugar (t/ha)	10.6	9.6	10.3	10.5	6.4	6.2
Alcohol (l/ha)	6159	5607	5981	6131	3696	3617
Fresh material (t/ha)	125	128	106	107	89	82
Seed (kg/ha)	6674	6213	1426	1960	3500	2866

Development of Ensiling Technology for the Small Holder Cattle Owners in Zimbabwe

Titterton[1], M., O.Mhere[2], T.Kipnis[3], G. Ashbell[4], Z.G. Weinberg[4] and B.V. Maasdorp[5]

[1]Department of Animal Science, University of Zimbabwe,
P.O. Box MP 167, Mt. Pleasant, Harare. Zimbabwe.
[2]Matopos Research Station, P.B. K 5137, Bulawayo. Zimbabwe
[3]Institute of Field and Garden Crops, The Volcani Centre,
Bet Dagan, Israel.
[4]Forage Preservation and By-Products Research Unit,
The Volcani Centre, Bet Dagan. Israel.
[5]Department of Crop Science, University of Zimbabwe,
Harare. Zimbabwe.
E-mail: marion@ansci.uz.zw

1. Introduction

Commercial dairy farming is keenly desired by many smallholder livestock owners in semi-arid areas of Zimbabwe. However, it is not feasible unless one of the major constraints to productivity in their cows is overcome and that is, the very poor availability of forage to feed in the dry season. Rain-fed forages are being grown to feed in the wet season but conservation as high quality hay is difficult due to leaching and rotting of the harvested material. Ensilage of forage, can, if done correctly, maintain productivity throughout the dry season. However, storage in a pit or bunker requires expensive machinery for chopping and compaction. Experience has shown, furthermore, that pit silage, through frequent exposure, suffers large spoilage losses. We examined the use of low-cost technology to produce silage from semi-arid adapted crops in a small-scale silo, in this case, an easily portable plastic bag. In order to produce a high quality silage, we used a mix of either sweet forage sorghum or Napier (*Pennisetum purpureum*) with a legume, dolichos bean (*Lablab purpureus)*

2. Methods

2.1 The crops

Two forage crops: Sweet forage sorghum (FS) (var. Sugargraze[a]) and Pennisetum (PS) (var. SDBN3[b]). One legume: Dolichos bean (DB).

Ensilage was carried out in each plastic bag with either one of the forage crops mixed on a 50:50 by fresh weight basis with legume to produce 8 kg total fresh weight, or with one of the forage crops alone, also at 8 kg fresh weight. The crop material ensiled was thus: FS/DB; FS; PS/DB; PS

2.2 Treatments

1) Chopping: Chopping was done by one of two ways:

- with the use of a petrol motor driven chaffer, producing a chop with an average length of about 2.5 cm.;
- manually, with the use of pangas, producing a chop with an average length of about 7.5 cm.

2) Compression: Compression was done by one of two ways:

- with the use of a manual tobacco press which comprises a manual driven screw press on to a metal plate sitting on the bag of crop material;
- by leaning as hard as possible on the bag, using hands to remove as much air as possible.

2.3 The silos

The silos were black bags which were recycled plastic bags used for garbage and of the size which could carry up to 50 kg material.

Upon filling and evacuating the bags of air, they were tightly tied with twine and stored in a closed storeroom.

3. Results

The fermentation quality of all silages were good, showing pH less than 5.0, ammonia to total nitrogen ratio of less than 10%, dry matter loss of less than 20%, lactic acid ranging from 2 to 7%, acetic acid ranging from 1-2.5% and butyric acid ranging from 0 to 1.8%, Table 1. Visual and sensory evaluation of the silages also produced good results. However, while treatments of chopping method and compression method had no effect on fermentation, crop variety showed significant differences in pH, NH3-N ratio, lactic and volatile fatty acids. Sorghum silages had better fermentation quality than pennisetum silages, with or without legume. This is probably due to the high levels of water soluble carbohydrates in sweet forage sorghum (av. 220 g/kg) compared with pennisetum (av. 75 g/kg) at ensiling.

Nutrition quality of silages showed that addition of legumes produced silage with significantly higher crude protein content (range 13-14%) over sorghum and pennisetum and improved digestibility (range 52-56%) over pennisetum alone, Table2.

Table 1. Fermentation quality of different forage crops ensiled after differing treatments.

Crop material	DM loss %	pH	NH_3:N %	Lactic acid %	Butyric acid%	Acetic Acid%	Ethanol %
All sorghum (FS)	9.36	3.70	4.07	5.63	0.05	2.04	2.12
All pennisetum (PS)	18.0	4.3	4.99	4.25	1.17	1.89	0.97
FS/DB	12.3	3.78	4.37	6.55	0.3	2.34	0.72
FS only	7.15	3.63	3.85	4.76	0.07	1.74	2.81
PS/DB	16.46	4.25	5.26	2.32	1.7	2.42	0.68
PS only	19.79	4.4	4.71	1.92	0.57	1.34	0.72
All materials fine-chopped	12.43	3.84	4.4	4.65	0.50	2.12	1.22
All materials coarse-chop	15.31	4.20	4.7	4.62	0.72	1.8	1.6
All materials tobacco-press	15.04	4.05	4.5	4.18	0.5	1.74	1.38
All materials hand -press	12.88	4.01	5.2	3.59	0.67	2.13	1.45

Table 2. Nutritional quality of silages made from different crops.

Crop	DM%	Digestibility g/kg	Crude Protein g/kg
PS	30.55	471.05	66.5
SE	0.41	10.76	1.66
PS/DB	27.5	523.17	133.23
SE	0.76	8.92	9.22
FS	32.8	544.15	64.98
SE	1.34	16.2	7.90
FS/DB	30.1	536.29	144.88
SE	0.94	11.55	12.13

4. Conclusion

Mixed forages and legumes adapted to semi-arid conditions can be ensiled successfully in plastic bags with only manual chopping and compression. On-farm trials with four farms have subsequently shown the same success.

Forty farmers are presently participating in farmer-controlled, researcher- monitoring trials in Gulathi communal area in the semi-arid region of Matabeleland in Zimbabwe.

Grain Corn Silage and Forage Corn Silage Evaluation on the Nelore and Canchim Cattle Performance in Feedlot

Anselmo Jose Spadotto[1], Antonio Carlos Silveira[2], Luiz Roberto Furlan[3], Mario de Beni Arrigoni[4], Ciniro Costa[5], Henrique Nunes de Oliveira[6], Claudinei Parre[7]

[1]UNESP-IB/IBD;
[2, 3, 4, 5, 6, 7]UNESP-FMVZ
Botucatu – Sao Paulo – BRAZIL

E-mail: spadotto@surfnet.com.br

An experiment was carried out to evaluate corn grain and corn forage variety productivity and nutritive value of silage based on the performance of cattle in a feedlot. A completely randomised design was used with a 2 x 2 factorial arrangement based on two breeds (Nelore and Canchim) and two corn varieties (grain and forage). The maize was harvested 120 days after sowing, when plants showed more than 2/3 of dry leaves and grains were in the dough stage. The silage was stored in 400 t silos. The experimental diet consisted of grain or forage corn silage, 7.2 liters of liquid yeast (1.5 kg of dry yeast/head/day) and 1.1 kg of ground corn (1.0 kg of dry matter/head/day). The experiment duration was 110 days, with a 20 days adaptation period and 90 days for data collection. Animals were weighed every 28 days. It was concluded that corn grain was more appropriate for silage than corn forage, because at the same stage

of growth it produced a better quality silage with a higher dry matter content and a 41.3% higher grain yield, promoting higher weight gain and better feed/gain ratio in the feedlot beef cattle.

Table 1: Forage corn variety: Yield characteristics and composition.

Parameters	**Forage Corn Variety**	
	Forage Corn	**Grain Corn**
As fed yield [1] (ton/ha)	45.00	27.20
Dry matter (%)	32.00	44.00
Yield DM [2] (ton/ha)	14.40	12.00
Grain yield (ton/ha)	5.40	6.40
Remainder [3] (ton/ha)	9.00	5.60
Grains in DM (%)	37.50	53.00

1. As fed matter
2. Dry matter
3. Remainder of the plant

Table 2: Corn silage: Chemical characteristics and pH.

Parameters	**Corn variety**	
	Forage Corn	**Grain Corn**
Dry matter (%)	34.80*	45.60*
Crude protein (%)	7.37	8.32
Acid detergent fiber (%)	26.10*	23.80*
Lignin (%)	4.10*	2.80*
Ammoniacal nitrogen [1] (mg)	8.73*	6.52*
Acid detergent insoluble nitrogen (mg)	8.02*	6.12*
PH	3.96	3.20
Cellulose (%)	19.53	18.62

1. Ammoniacal nitrogen as a percent of total nitrogen.
* Significant at the level of 5% of probability.

Table 3: Animal performance during 90 days in feedlot.

Breed	Corn variety						Mean		
	Forage Corn			Grain Corn					
	DG[1]	DFI[2]	FG[3]	DG	DFI	FG	DG	DFI	FG
Nelore	0.79	10.09	12.77	1.17	10.23	8.74	0.98	10.16	10.76
Canchim	1.29	9.39	7.28	1.38	9.63	6.98	1.33	9.51	7.13
Mean	1.04	9.74	10.03	1.28	9.93	7.86			

DG: Daily weight gain (kg/day)
DFI: Dry matter intake (kg/day)
FG: Feed/gain ratio (kg DM/kg DG)
1. CV = 16.0%
2. CV = 6.9%
3. CV = 7.3

Table 4: Dry matter intake.

Intake (kg/day)	Corn variety	
	Grain Corn	Forage Corn
Dry matter	9.93	9.74
Concentrate	2.50	2.50
Ground corn	1.00	1.00
Yeast	1.50	1.50
Silage	7.43	7.24
Grains corn from the silage	3.94	2.71
Remainder of the plant	3.49	4.53
Total intake of corn		
(Concentrate + silage)	4.94	3.71
Total of concentrate		
(Concentrate + grains from the silage)	6.64	5.21
Total forage	3.49	4.53
Forage: concentrate ratio	35:65	46:54
Daily gain	1.28	1.04

Evaluation of Quality and Nutritive Value of Napier Grass Silage with Different Growth Stages Either Chopped or Unchopped in Northeast Thailand

Mitsuru Shinoda[1], Tomoyuki Kawashima[2], Pimpaporn Pholsen[3] and Taweesak Chuenpreecha[3]

[1] Tohoku National Agricultural Experimental Station, Morioka, Iwate 020-0198, Japan

[2] National Institute of Animal Industry, Kukisaki, Inashiki, Ibaraki 305-0901, Japan

[3]Khon Kaen Animal Nutrition Research Center, Tha Pra, Khon Kaen 40260, Thailand

E-mail: tkawa@niai.affrc.go.jp

1. Introduction

Stable supply of forage throughout the year is the key constraint for further development in cattle production in Northeast Thailand. Although Napier grass (*Pennisetum purpureum)* is not popular in the region, it may have high possibility under an intensive management with high manure input. The present study aimed at identifying nutritive value and fermentative quality of silages made of Napier grass with different growth stages either chopped or unchopped, and physiological changes in cattle given the silages.

2. Materials and Methods

The following three kinds of Napier grass were ensiled in cylindrical concrete tanks (0.75m diameter and 0.5m height), pressed by foot and covered by plastic sheet with sand weight on top.

1) Chopped silage of 1m grass height (about 30 days after cut)

2) Unchopped silage of 1 m grass height (about 30 days after cut)

3) Chopped silage of 1.5 m grass height (about 80 days after transplanting)

Aliquot of silage sample from each silo was placed into a bottle with water and kept in a refrigerator for overnight. The extracted fluid was subjected to the analyses of VFAs with gas chromatography, lactic acid with diagnostic kit, volatile basic nitrogen (VBN) and total nitrogen content.

Two castrated male native cattle (average body weight 166kg) were used for digestion trials with the above-mentioned three feeding treatments, which were conducted in this order. Silage was given to the animals *ad libitum* to measure maximum intake. Nutrient digestibility was examined by total collection method. Blood samples were collected from the jugular vein into heparinised tube at the end of each collection period before feeding and 3hr post feeding, and subjected to the analysis.

3. Results and discussion

Although the original grass used in the treatments of 1 and 2 were the same, CP and NFE contents were lower in unchopped silage, which would be owing to the difference in the fermentation process during being ensiled (Table 1). CP content in the treatment 3 was lower than the others, which would be due to the difference in the maturity. Fermentative quality of unchopped silage was also worse than that of chopped silage of treatment 1 (Table 2). The unchopped silage showed higher pH and the ratio of volatile basic nitrogen to total nitrogen (VBN/TN), and lower lactic acid concentration. If grass was ensiled without chopping, there was considerable space between the pieces of grass, which made anaerobic fermentation difficult. V-score was calculated from VBN/TN, total content of acetate and propionate, and butyrate content (Masaki, 1996), which is one of methods to evaluate silage quality and used in Japan to evaluate low moisture silage and high moisture silage at the same criterion. It clearly showed the difference in the fermentative quality in spite of not using the value of lactic acid contents for the calculation. It would be a useful method for the evaluation of silage quality especially in developing countries where the analysis of lactic acid is not practical in terms of cost and facilities. The value of pH itself may also be a useful and very simple indicator for the evaluation of silage quality.

The TDN content of the silage in treatment 1 was significantly higher than that in treatment 2 (Table 3). It was considered, therefore, that large amounts of nutrients, especially NFE, were lost during the fermentation process in treatment 2. The voluntary intake of silage also decreased in treatment 2. Consequently, TDN intake in treatment 2 was about 68% of treatment 1.

There was no difference in D-3-hydroxybutyric acid (BHBA) level between at 0hr and at 3hr after feeding in cattle fed chopped silage (treatment 1). On the other hand, BHBA level in cattle fed unchopped silage became higher after feeding (Table 4). It was considered that the difference of butyrate concentration in the silage influenced BHBA level in blood. However, the physiological effects of butyrate on animals would be minimum even if cattle received such low quality silage for longer period, as the values of BHBA and NEFA in blood were within normal range and there was no change in glucose content.

Chopping of original grass before ensiling is highly recommended not only for making better quality silage but also for making better use of silo capacity. Proper preparation of silage minimises the loss of nutrients during the fermentation process and increases voluntary intake, which results in higher TDN intake.

References

Masaki, S. (1994) Judgment of silage quality. In "Guidebook for quality evaluation of roughage (edited by Japanese Research Association on Quality Evaluation of Self-supplied feed). Japanese Association of grassland. 79-87 (in Japanese).

Table 1. Chemical composition of silage

Treat.	Height of grass	Chopping	DM[1]	OM	CP	EE	NFE	CF	ADF	NDF
			%	----------	----------	----------	% of DM	----------	----------	----------
1	1m	Chopped	16.9	89.3	11.9	3.9	42.7	30.7	37.7	64.2
2	1m	Unchopped	16.1	86.9	10.2	3.6	39.1	34.0	40.9	64.3
3	1.5m	Chopped	16.6	90.0	7.3	3.1	42.6	37.0	43.9	70.2

[1]DM, dry matter; OM, organic matter; CP, crude protein; EE, ether extracts; NFE, nitrogen free extracts; CF, crude fibre; ADF, acid detergent fibre; NDF, neutral detergent fibre.

Table 2. Fermentative quality of Napier grass silage

Treatment		1			2			3		
		LSM	SE	No	LSM	SE	No	LSM	SE	No
pH		4.02[b]	0.18	3	5.58[a]	0.15	4	3.87[b]	0.14	5
VBN/TN[1]	%	8.03[b]	2.87	3	17.40[a]	2.49	4	6.88[b]	2.22	5
Acetate	%	0.127	0.178	3	0.460	0.154	4	0.232	0.138	5
Propionate	%	0.007[b]	0.018	3	0.140[a]	0.016	4	0.002[b]	0.014	5
Butyrate	%	0.007	0.096	3	0.243	0.083	4	0.161	0.074	5
V-score		93.2[a]	12.9	3	47.1[b]	11.2	4	82.2[ab]	10.0	5
Lactate	%	1.21[a]	0.09	1	0.06[b]	0.09	1	0.99[a]	0.04	5

[1]VBN/TN: ratio of volatile basic nitrogen to total nitrogen; LSM, least square means; SE, standard error; No, the number of samples.

[a,b]Means with different superscripts among treatments significantly differ ($p<0.05$).

Table 3. Body weight, feed intake and nutrient digestibilities of native cattle given Napier grass silage

Treatment		1	2	3	SE
BW	kg	166	166	166	0.4
DM intake	gDM	4015[a]	3163[b]	3223[b]	48
Digestibilities of					
DM	%	70.5	62.7	66.8	1.4
CP	%	71.7	60.8	62.3	1.8
NFE	%	70.1[a]	55.9[b]	61.8[b]	1.3
CF	%	77.5	74.5	77.1	1.3
TDN	%	71.8[a]	61.6[b]	66.9[ab]	1.3

[a,b]Means with different superscripts among treatments significantly differ ($p<0.05$).

Table 4. The Change of NEFA, glucose, total protein and BHBA contents in plasma of cattle given Napier grass silage before and after feeding

	Treatment	**NEFA1**	**Glucose**	**TP**	**BHBA**
		mEq/l	**mg/dl**	**g/dl**	**mM**
Before feeding	1	0.049	94.5	5.78	0.276
	2	0.129	85	6.05	0.219
	3	0.076	82	5.91	NA
	SE	0.024	3	0.21	0.012
3 hours after feeding	1	0.046	88	6.73	0.291
	2	0.051	96.5	5.84	0.411
	3	0.074	127.5	5.96	NA
	SE	0.01	24	0.12	0.017
	Tr	-	-	-	-
	Ti	-	-	-	-
	T*T	-	-	-	**

[1]NEFA, non esterified free acid; TP, total protein;
BHBA, D-3-hydroxybutyric acid; Tr, Effect of treatment;
Ti, Effect of time after feeding;
T*T, Interaction between treatment and time after feeding.

Effect of Time of Day on the Water Soluble Carbohydrate Content of Kikuyu Grass

Alan G. Kaiser, John W. Piltz, John F. Hamilton* and Euie J. Havilah*

NSW Agriculture, Wagga Wagga Agricultural Institute,
PMB, Wagga Wagga, NSW, 2650, Australia

* NSW Agriculture, Pasture Research Unit,
PO Box 63, Berry, NSW, 2535, Australia

E-mail: alan.kaiser@agric.nsw.gov.au

1. Introduction

In studies with temperate forage species water soluble carbohydrate (WSC) content has been observed to increase during the day due to photosynthetic activity within the plant. With warm and sunny conditions the content of WSC in the plant is higher in the afternoon than early morning. It has been suggested that cutting of forages for silage should be delayed until the afternoon to maximise the amount of WSC available for fermentation. There are few data available on variation in WSC content of tropical grasses, so the current study was conducted to monitor changes during the day in the composition of kikuyu grass (*Pennisetum clandestinum*).

Table 1. Effect of time of day on the composition of kikuyu grass in study 1

Sampling time (Australian Eastern Standard Time)	DM content (g/kg)	N content (g/kg DM)	Water-soluble carbohydrate (g/kg DM)	Starch (g/kg DM)	OMD
March - 30 day regrowth					
7.35 h	167	34.6	50.2	42.3	0.698
11.45 h	167	34.9	68.4	51.4	0.710
15.55 h	171	33.6	66.1	57.8	0.726
Time of day	ns	P<0.10	P<0.01	P<0.01	P<0.01
s.e.d.	5.5	1.07	2.66	4.17	0.0073
April - 30 day regrowth					
8.20 h	191	24.4	48.1	40.4	0.668
14.00 h	203	23.6	60.2	50.6	0.674
17.00 h	202	23.2	63.2	53.3	0.673
April - 45 day regrowth					
8.20 h	193	24.4	48.0	39.0	0.672
14.00 h	196	23.6	61.0	52.0	0.681
17.00 h	202	22.9	63.8	51.7	0.674
Regrowth	ns	ns	ns	ns	ns
Time of day	P<0.01	P<0.01	P<0.01	P<0.01	ns
Regrowth × time	P<0.10	ns	ns	ns	ns

2. Materials and Methods

Two studies were conducted in which nitrogen (N) fertilised kikuyu grass was sampled to monitor changes in WSC during the day. The first study was conducted over 3 days in March with 30 day kikuyu regrowth and in adjoining plots over 3 days in April with 30 and 45 day kikuyu regrowths. A second study in April investigated the change in WSC content of 30 and 45 day regrowth kikuyu mown for silage production at three times during one day. The two studies were conducted at different sites within the same paddock. The forage samples were analysed for DM, N, WSC, and starch content, and for *in vitro* organic matter digestibility.

3. Results and Discussion

In the first study weather conditions over the three days during the March sampling ranged from warm and sunny through to overcast. Warm and sunny weather was experienced on all days during the April sampling. No significant differences were observed between days in forage composition at either sampling. Composition of the kikuyu grass from this study is presented in Table 1.

During the second study warm and sunny weather conditions prevailed until just prior to the last mowing. Rainfall from local storms commenced during mowing and continued to fall during the collection of samples. This resulted in a decline in DM content but no differences in the composition of the DM. Composition of the kikuyu grass from this study is presented in Table 2.

The results from this study confirms that sugar levels are higher in kikuyu grass in the middle of the day and in the afternoon (60.6 g/kg DM), than in the morning (47.2 g/kg DM). Despite this increase in sugar content (to 12.0 g/kg fresh forage) the level was still well below the critical value (25-30 g/kg fresh forage) for low risk preservation of unwilted forage (Wilkinson, 1990). Other effects of changing the time of cut to the afternoon were a small increase in forage DM content, a small reduction in N concentration, an increase in starch content but no effect on digestibility.

Table 2. Effects of regrowth intervals and time of day on composition of kikuyu grass in study 2

Sampling time (Australian Eastern Standard Time)	DM content (g/kg)	Total N (g/kg DM)	Water-soluble carbohydrates (g/kg DM)	Starch (g/kg DM)	OMD*
30 day regrowth					
10.30 h	221	19.8	43.8	39.6	0.720
14.15 h	231	20.4	59.2	53.7	0.675
16.15 h	204	19.9	53.6	45.4	0.714
45 day regrowth					
10.30 h	208	19.8	46.0	37.6	0.640
14.15 h	214	18.6	55.3	54.9	0.647
16.15 h	191	17.4	54.7	49.4	0.621
Regrowth	P<0.05	P<0.10	ns	ns	P<0.10
Time of day	P<0.01	ns	P<0.01	P<0.05	P<0.05
Interaction	ns	ns	ns	ns	P<0.01
s.e.d.	7.3	0.86	1.92	5.20	0.0197

4. Conclusions

The benefits of higher WSC content obtained by delaying cutting to the afternoon are small, as WSC levels were still well below the critical value required to ensure a good silage fermentation. In addition, cutting in the afternoon could have a negative effect on the ensiling process by slowing wilting. A slow wilt has been shown to adversely affect the fermentation quality of kikuyu grass.

5. Acknowledgements

We are greatly indebted to the Australian Dairy Research and Development Corporation and NSW Agriculture for funding this research, and for assistance from local dairy producers who provided access to land and equipment.

6. Reference

Wilkinson, M. 1990. "Silage UK", 6th edition. Chalcombe Publications, Marlow, UK.

Little Bag Silage

Ian R. Lane

Ian Lane Associates, Lower Kenfield Cottage,
Petham, Canterbury, CT4 5RN, UK.
Tel & Fax: +44 1227 700 772
Email: ianlaneuk@aol.com

1. Introduction

This paper summarises the development of "Little Bag Silage" (LBS) during 1988 – 92, while the author was fodder and livestock consultant on development projects in northern Pakistan and in Nepal. It relates to the mechanics of ensiling on a small scale, and how this fits within the overall livestock and farming system. While working in northern Pakistan, the problem was how to improve the nutrition of farmers' milking animals when each family keeps only one dairy cow or buffalo? During the cold continental winter the major fodders available were maize stover and wheat or rice straw, together with very poor quality hay made from mature summer hillside pastures after the rains have ended. Although loans were made to farmers for the purchase of high yielding improved buffaloes from the lowlands, farmers were disappointed that yields soon fell to those of local stock as a result of feeding the same rations as before. As a minimum it was essential to provide a green fodder supplement to enhance rumen function for these animals. One course was to develop winter fodder crops, but this still left 3 months without green feed. Strong plastic shopping bags were available in the lowlands, and it was found that these had a minimum capacity of 5 kg of fresh chopped green fodder sorghum. If these were used for silage, it would mean that one buffalo could be fed one bag of silage a day, providing the minimum of 5 kg green fodder needed as a supplement. This was the birth of the concept of "Shopping Bag Silage", or "Little Bag Silage" as it became known.

2. Methods

The same basic method for making LBS was used in both N. Pakistan and Nepal:

- Strong high density plastic shopping bags with a capacity of 5 kg chopped green fodder and with no obvious holes in the seams were purchased in packs of a hundred;
- At least 100 kg of summer fodder crop such as multi-cut fodder sorghum was cut and carried to the chopping floor. The fodder was either hand chopped with a large knife against a wooden chopping block, or chopped through a chaff cutter with a rotating blade;
- 5 kg of chopped green fodder was carefully packed into one of the shopping bags so as to avoid making any holes in the bag;
- The bag was gently but firmly squeezed by hand to expel air, and while compressed the neck of the bag was twisted then turned over and tied with twine [it is possible to close bags by tying the two handles in a knot, but this does NOT result in an air-tight closure];
- The bag of silage was then inverted into a second empty shopping bag, which was also closed and tied;

- The bag of silage was then inverted into a third empty shopping bag and sealed. Each bag of silage was therefore triple wrapped, and seams which might be expected to leak air were doubly protected;

- The bags were carefully stacked in a room protected against rats, mice and other pests;

- After a minimum period of one months LBS was fed to buffaloes at a rate of one bag per head per day.

- The outer two plastic bags of each LBS were kept for re-use.

3. Results

In N Pakistan the method was initially developed with a farmer/store-keeper who had a couple of Nili-Ravi dairy buffalo and who had planted 0.1 ha to Sadabahar, a local multi-cut Sorghum x Sudan grass hybrid. 120 kg of fodder chopped with a chaff cutter made as LBS and stored under the farmer's bed was compared with 120 kg of fodder conserved in a single bag made from heavy gauge plastic. Both lots of fodder ensiled well, and the farmer was pleased with milk yields from the buffalo fed silage, although no records were kept. He was especially pleased with the LBS, since it was much easier to feed individual bags, instead of having to untie and re-tie the large bag of thick plastic. His practice was to feed half of each Little Bag in the morning and the remainder in the evening. Neighbouring farmers were impressed that at a time when they had only dry fodders this farmer had green fodder. In response, our entrepreneur was planning to plant up much of his land with Sadabahar, so that he could make sufficient LBS to sell it to his neighbours in the following winter!

The first trial of LBS in Nepal was on-station. Leafy Paspalum grass was harvested at Kathmandu, chopped and ensiled. Bags were well conserved, although the fermentation was not strongly lactic acid. Results were good enough to proceed.

In the second station trial in Nepal LBS was made from Napier grass in the Terai (100 m.a.s.l.), and from maize grown for fodder harvested at the soft dough stage with chopped cobs included at Kathmandu (1,250 m.a.s.l.) and at Jiri (1,800 m.a.s.l.).

After two months excellent lactic acid fermentation resulted from all lots of LBS, and undamaged bags kept well for six months with little fungal spoilage. However LBS from fodder maize appeared to attract every mouse from a km radius, and when the door to the store was opened to remove a bag mice were seen to leap in. Once in, mice could easily hide between the bags. Mice then chewed through the plastic bags, and most of the bags were lost as aerobic spoilage ruined the silage.

The third trial in Nepal was an extension trial with Livestock Development Groups at three locations. In Kathmandu there was a small factory making bags, using machinery from Thailand and plastic prills from the Gulf; special bags of thicker gauge and without loops cut out to make handles were ordered. At each site kits were issued to 20 farmers. Each kit included a pack of 100 high strength plastic bags, an illustrated guide to making LBS, and a record sheet. The making of LBS was demonstrated to each Group by project staff, and the local livestock technician assisted farmers during the trial. Details on the crop to be conserved, the look and smell of the silage, and the milk yield of the selected cow or buffalo before and during a thirty day feeding period were recorded by each farmer.

At Pokhara (800 m.a.s.l.) the farmers were delighted with the bags for a hundred and one uses, but since they were already growing irrigated winter fodder oats making LBS was not one of them! At Jiri (1,800 m.a.s.l.) farmers used wet mature summer grasses, which unfortunately turned to compost! Within Kathmandu Valley, however, there were peri-urban milk producers who stall-fed buffaloes and who had to purchase all their feeds, including padi straw. In the Valley there was also a tradition of threshing padi while it was still green, with the production of a cooked beaten rice which was sold as a snack food. These milk producers made LBS from the green padi straw, and found their traditional buffalo could eat one bag of silage a day in addition to their normal ration of dry straw and bran. As a result milk yield increased by fifty percent, from 2 l per day to 3 l. The extra litre of milk, sold in Kathmandu diluted with water, was worth Rs 20. It had cost Rs 3 to produce, being the cost of 3 plastic bags @ Rs1 per bag, plus the minimal cost of 5 kg of green padi straw. With care, two of the three bags could be re-used, reducing the total cost for the extra litre of milk to little more than Rs 1.

4. Discussion

Making LBS is labour intensive, and does need care and attention for success. It has to fit the local livestock and farming systems, and having expenses has to be linked to semi-commercialisation of production. The place of LBS within the overall strategy for fodder development in N Pakistan and Nepal has been described elsewhere (Lane, 1999).

The quality of bags for LBS is important. High rather than low density plastic reduces potential for tearing. The seal must be without holes, and this may relate to factory practice. If holes are present along the seal, sticky tape or tar/mastic may be used to repair seals as the bags are tied. Inner bags do tend to get damaged, but the thicker gauge bags used for the extension trial in Nepal were less damaged to an extent where two rather than three layers of bags may have been sufficient. Initially commercially available shopping bags were used. These happened to be strong enough for the purpose. Some bags are thin and flimsy, as found in China, and these would not be suitable. As in Nepal, discussions with local plastic bag makers will be useful. It happened in Pakistan and Nepal that shopping bags could readily hold 5 kg of chopped green fodder; if larger bags are available, or if handles are omitted, larger quantities could be made per bag. This will reduce the costs of bags per kg silage stored, and reduce losses from damage and surface moulds. However the amount stored per bag should relate to feeding practices, although it is easy to reseal little bags so that feeding of silage from individual bags could readily be spread over 1-2 days even in hot climates.

Fermentation characteristics of LBS depend on the fodder being conserved, and the old saying "Rubbish in, Rubbish out" applies equally to silage made in little bags. Fodder with high sugar content, whether from specialised temperate or tropical fodder crops or from temperate leafy pasture, will conserve well. Fodder with low sugar content is more likely to rot than ferment, and this has led to a bad reputation for silage in general in the tropics, LBS included. Problem fodders include mature C4 pasture grasses harvested in the rains, legumes in general, and possibly tree fodder. Wet grasses must be partially dried before ensiling, under shelter if it is still raining, and legumes should also be wilted.

The example of peri-urban dairy farmers making good LBS from green padi straw is important, since many crop residues loose much of their soluble carbohydrates during the final stages of grain ripening, and while the residue is left to dry in the field. Under smallholder systems padi is frequently harvested comparatively green, and the crop sun-dried in the field with loss of nutrients from the straw; heating in the stack before threshing completes the loss of sugars. In the Sudan, M. Wade encouraged the ensiling of maize stover in trench silos on commercial dairy farms to improve fodder value of the stover when fed to cows; while maize with stay-green fodder characteristics has been widely adopted by farmers in N Pakistan. Improved utilisation of crop residues through ensiling needs further attention.

A key feature of LBS is that it allows conservation of available fodder in small quantities over a long period of time. This strongly contrasts with traditional silage making techniques where large amounts of fodder must be harvested and chopped at one time. Thus a small-holder family might be able to conserve a couple of bags of LBS a day over a 100 day growing season, which would allow their milking animal to be fed one bag of LBS a day over a 200 day dry season. This fodder might include leafy grass weeds harvested from the crop fields, terraces and bunds, which could readily be partly air-dried under shelter a little at a time before chopping and ensiling. In Nepal, leaves were progressively removed from maize plants as they commenced to senesce, and these would make excellent LBS.

Although summer fodder crops were frequently used in the trials above, they take land away from food production and would only be financially attractive to families in commercial animal production. Lane (1999) allocated them to high cost systems likely to be adopted by only 25 per cent of farmers. A range of fodder sorghums and millets were, however, grown in trials in both N. Pakistan and Nepal at three sites in each country, and fodder yields were doubled by application of 200 kg N per ha. In the Mediterranean countries conservation of temperate fodder crops for feeding in the dry summer is relevant, and this also applies to countries in monsoonal zones. In 1976 the author working in Tanzania carried out small scale ensiling trials with cassava, and produced silages from chopped cassava root, leaves, and root + leaf mixtures. Although the fermentation characteristics differed between the silages, they were all edible by sheep. These feeds could easily be ensiled as LBS, and allow cassava to be fed throughout the dry season when harvesting is difficult due to hard ground and when leaves have been lost.

In common with silage making in general, there is interest in the use of additives to assist conservation of the problem crops outlined above. A small station trial was made with sodium bisulphate, but as maize fodder was used no benefit resulted. Any compound for smallholder use must be cheap, non-toxic, non-corrosive and easy to apply. While various additives used in industrialised countries might be reduced in scale and packed in individual sachets for use on individual 5 – 100 kg lots of fodder, they do not meet the above criteria. Even molasses, which does, is not widely available. It was concluded that sugar, in the cheaper less refined brown lump form, would be most applicable. However, it would still be relevant to partly dry the fodder to reduce the amount of sugar required for effective conservation, and to reduce the quantity required relative to the actual quantity of fodder being preserved. Where very difficult crops are to be ensiled, the use of common salt (NaCl) as a straight preservative also needs evaluation, as many livestock are also deficient in salt as a nutrient.

Essential for success with LBS is protection of the bags, for up to 4-6 months. This has been a major weakness, but may be related to the crop being ensiled. As noted, maize fodder with chopped cobs was a major problem, but green crop residues may be less attractive. Fodder sorghums do still produce HCN in LBS, which may be a deterrent to pests, and no problems of damage by mice was reported in N. Pakistan. Otherwise some form of construction may be required. This might be within an existing store such as large cement or clay storage jars with strong lids. Alternatively, specialised buildings might be constructed, with legs to keep the store off the ground and shaped to prevent rats and mice climbing in, such as the mushroom shaped stones traditionally used in England for grain stores, or protected with metal horizontal discs or downward facing cones. In Nepal a relish for human consumption known as "Gundruk" is made by fermenting wilted cabbage leaves in air-proof clay pots. Thus the actual nature of the vessel used for making small quantities of silage is open to local variation and adaptation of available items and materials.

For harvesting pastures, rather than fodder crops, the Swiss scythe has been successfully introduced into the hills of Nepal, and is used by contractors for making hay along with the hay fence technique. Unfortunately the grass is cut when over-mature but while the rainy season continues, so that the hay is moist when stored and is of little fodder value. Swiss farmers now use a system of a two-wheeled mechanical mower with a tedder and hay rake, and this range has now been extended to a mini-round baler and a bale wrapper for making silage. In hay the bales weigh about 20 kg, in silage following wilting about 50 – 60 kg. Many of the benefits of LBS would result from use of this equipment with young leafy wilted pasture crops, and it would be relevant for commercial dairy farmers with 5 – 20 cows, such as in the highlands of Kenya.

5. Reference

Lane, I.R. 1999. Fodder development for smallholder dairying in Azad Jammu and Kashmir and Nepal. Tropical Agricultural Association Newsletter, 19 (1): 23-27.

6. Acknowledgements

In N Pakistan to all colleagues on the World Bank Integrated Hill Farming Development Project, 1988-89; in Nepal to all colleagues on the ADB 2nd Livestock Development Project; plus all family, friends and colleagues who continue to provide support and inspiration.

Further details and a copy of the reference are available on request from the author.

Sila-wrapped Grass Silage Production Using the Small Bale System (SBS) for Feeding of Goats and Sheep

S.S. Shariffah Noorhani, A. Aini & A.B. Idris

Department of Veterinary Services, Kuala Lumpur, Malaysia

Silage making involving mechanised sila-wrapping of small round bales has been introduced in Malaysia in 1991. This method of silage production, which involves mainly grasses, has been undertaken on three ruminant farms as well as on grazing reserves. However, regular production using this method is now primarily carried out on two farms, the Sheep Multiplication Centres in the states of Kedah and Trengganu, which normally suffer from drought during part of the year.

Fresh grass is cut using a mower conditioner and then baled to produce small round bales averaging about 30 kg per bale. These bales are then collected from the field and delivered to the storage shed where the sila-wrapping machine is located, wrapped mechanically and stored. In some cases, sila-wrapping and storage are done in the field.

Annually, about 500 bales of sila-wrapped silage, equivalent to 15 tonnes, are being produced to feed cattle and sheep during the dry season. In the first 8 months of this year, a record of 2000 sila-wrapped bales have been produced. Up-to-date, a production of about 290 tonnes of sila-wrapped silage has been achieved.

Grasses used are *Brachiaria humidicola*, *B. ruziziensis*, *B. decumbens*, *Panicum maximum* and *Setaria sphacelata* cv Kazungula. Crude protein determined in the silages produced ranges between 5% to 13.4% in the grasses cut between 21 days to 2 months of maturity.

The sila-wrapping system is considered a very convenient means of silage production. However, the main problem is in the high cost of sila-wrap film which has to be imported. Another problem is rats chewing through the sila-wrap film to get at the silage causing spoilage.

The Use of Molasses to Improve the Fermentation of Low-Dry Matter Kikuyu Grass Silages

John W. Piltz, Alan G. Kaiser, John F. Hamilton* and Euie J. Havilah*

NSW Agriculture, Wagga Wagga Agricultural Institute, PMB, Wagga Wagga, NSW, 2650, Australia
* NSW Agriculture, Pasture Research Unit, PO Box 63, Berry, NSW, 2535, Australia
E-mail: john.piltz@agric.nsw.gov.au

1. Introduction

Kikuyu grass (*Pennisetum clandestinum*) is a valuable forage resource for dairy and beef cattle in the coastal areas of eastern Australia. Production of wilted silages is often difficult due to wet weather during summer and autumn, the periods of maximum growth of kikuyu pastures and when surplus material is available for conservation. Kikuyu grass is also low in the water soluble carbohydrates (WSC) required to support a lactic acid fermentation. As a result kikuyu silages produced on farms are often characterised by low dry matter (DM) content, high pH and high ammonia nitrogen (N) levels, which indicate poor fermentation quality. Previous studies have shown that inclusion of molasses as a source of readily fermentable WSC has improved the fermentation of tropical pasture silages (Catchpoole and Henzell 1971).

2. Materials and Methods

Two experiments were conducted to determine if molasses could improve the silage fermentation of low-DM content kikuyu. In each experiment 30-day regrowth kikuyu pasture was mown using a conventional disc mower. Two field wilting treatments were compared. In the first the mown forage was left without windrowing (at near mower width) and subsequently manually tedded (morning and afternoon) to maximise drying rate (fast wilt). In the second the forage was raked into windrows immediately after mowing (slow wilt) to simulate common farming practice in Australia.

An unwilted control silage was made immediately post-mowing in both experiments. After two wilting intervals mown kikuyu was collected and manually fed through a precision chop forage harvester, and approximately 3-10 kg batches of fresh forage were ensiled in small plastic bag mini-silos (three per silage treatment). Molasses was applied at varying rates (Table 1) to the forage harvested material using a watering can just prior to ensiling after dilution (1:1) with water.

3. Results and Discussion

In both experiments silages differed significantly ($P<0.01$) in DM content, pH, and ammonia N content (Table 1). Ideal drying conditions in Experiment 1 enabled the fast wilt silages to be made after 6 hours and the slow wilt material after 28.5 hours. Continual rainfall in Experiment 2 resulted in no drying and silages were made after 48 hours. The differences between silages in DM content in experiments 1 and 2 reflected effects of molasses treatment, initial forage DM (Experiment 1) and wilting treatment (Experiment 2).

In Experiment 2 the slow wilt windrowed treatment seemed to retain more of the rainwater and there appeared to be more discoloration and yellowing of the forage compared to the fast wilt material, which may be indicative of greater deterioration. Many of the silage ammonia N levels were very high (>150 g/kg total N) indicating severe degradation of the protein fraction. In general, silage fermentation characteristics were either poorer or unaffected as a result of the slow wilt treatment compared to the fast wilt. The greater difference in Experiment 1 was attributed to more favourable weather conditions that allowed wilting rate differences to be expressed.

Table 1. Effect of molasses on the fermentation of kikuyu silages

Treatment	**Experiment 1**			**Experiment 2**		
(kg molasses/t fresh forage)	DM content (g/kg)	pH	Ammonia N (g/kg total N)	DM content (g/kg)	pH	Ammonia N (g/kg total N)
Unwilted control	133	4.34	148.7	109	4.75	220.9
Fast wilt						
0	224	4.45	136.2	92	4.87	453.7
20	-	-	-	116	3.93	171.7
40	-	-	-	116	3.76	189.3
60	246	3.85	93.6	-	-	-
Slow wilt						
0	239	5.51	260.4	91	4.87	436.6
40	-	-	-	120	3.74	158.7
60	257	4.03	137.4	-	-	-
l.s.d (P<0.05)	11	0.10	15.6	9	0.13	58.4

4. Conclusions

Well-preserved silages should have an ammonia N concentration ≤100 g/kg total N (Wilkinson 1990). Without additives it is difficult to produce adequately preserved silage from low-DM kikuyu grass, particularly when prolonged and ineffective wilting occurs due to poor weather conditions. Our other research has shown that where weather conditions favour wilting, rapid wilting will produce satisfactory silage. Where low-DM silages are produced from rapidly wilted kikuyu, silage ammonia N can be further reduced by the application of molasses. When unfavourable weather conditions prevail molasses can produce large improvements in silage fermentation, but the level of application will need to be higher than that used in Experiment 2. Apart from improving silage preservation, molasses addition will also increase the metabolisable energy content of the silage.

5. Acknowledgements

We are greatly indebted to the Australian Dairy Research and Development Corporation and NSW Agriculture for funding this research, and for assistance from local dairy producers who provided access to land and equipment.

6. References

Catchpoole, V.R. and Henzell, E.F. 1971. Silage and silage-making from tropical herbage species. *Herbage Abstracts* **41**, 213-221.

Wilkinson, M. 1990. “Silage UK”, 6th edition. Chalcombe Publications, Marlow, UK.

Use of Dehydrated Sugar Cane (Saccharum officinarum)as an Additive to Napier Grass (Pennisetum purpureum) Ensilage

José Neuman Miranda Neiva,
Ana Cristina Holanda Ferreira, Maurício Teixeira

Federal University of Ceará, Caixa Postal 12168,
Fortaleza-CE, Brazil CEP: 60355-970
E-mail: zeneuman@ufc.br

1. Introduction

Tropical grass biomass increases with maturity, but decreases in nutritive value. To overcome this problem these grasses are frequently ensiled at an early growing stage. However, young plants have a high moisture content, high buffering capacity and a low level of soluble carbohydrates. According to Woolford (1984), these factors have a negative influence on the fermentatioin process, preventing a rapid lowering of the pH and thus allowing unwanted secondary fermentation, consequently damaging the quality of the final product.

Assuming that the above problems are the main limitations to the ensilage of Napier grass, research was undertaken with the objective to find practical solutions to enable the production of good quality silage from the Napier grass.

Amongst the existing alternatives, the addition of dehydrated sugar cane to the Napier grass to be ensiled appears to be interesting, because it has high contents of dry matter (DM) and water soluble carbohydrates (WSC).

The aim of this study was to evaluate the chemical and fermentation characteristics of the Napier grass silage with different levels of added dehydrated sugar cane.

2. Materials and Methods

This experiment took place at the Forage Section of the Federal University of Ceará. The chemical and fermentation characteristics of Napier grass silage with the addition of 0, 5, 10 and 15% of dehydrated sugar cane on a fresh matterial basis. The Napier grass biomass, aproximately 80 days old, was chopped and mixed with the dehydrated sugar cane. The sugar cane was ground in a mill fitted with 3mm sieves. A replicated, completely randomised design was used.

We used polyethylene laboratory silos with a 100 mm diameter and 340 mm depth.. Sixty days after filling, the silos were opened and homogeneous samples of aproximately 300 g were taken to determine DM, crude protein (CP), pH and N-NH_3. Analyses of variance and regression were used to test the data.

3. Results and Discussion

The DM content of the silage increased linearly with the addition of dehydrated sugar cane (Table 1). Almeida *et al.* (1986) and Tosi *et al.* (1989), studying the addition of sugar cane and sugar cane bagasse, respectively, in the ensilage of Napier grass, also observed a rise in the DM levels.

Table 1: Average value of the levels of DM, CP, ammoniacal nitrogen ($N\text{-}NH_3$), pH and regression equations

Parameter	Sugar cane				Mean	Regression Equations
	0%	5%	10%	15%		
% DM	21.2	25,2	27,5	29,9	25,9	Y=25,9465+2,8442x R^2 =98,05%
% CP	7,3	5,7	5,6	4,9	5,9	Y=5,8895–0,6954x R^2 = 99,25%
$N\text{-}NH_3$	4,6	3,9	4,9	4,4	4,5	NS
pH	3,6	3,6	3,6	3,7	3,6	NS

CP levels decreased linearly with the addition of dehydrated sugarcane. Similar results were obtain by Almeida *et al.* (1986). Tosi *et al.* (1989), using sugar cane bagasse as an additive in Napier grass ensilage observed that the CP level of the silages fell below 4%. This reduction is explained by the very low CP concentration of sugar cane bagasse (ca 2%)

We have not observed significant differences in $N\text{-}NH_3$ and pH value between the silages. The quality of the silage without sugar cane was as good as that with. Almeida *et al.* (1986) and Tosi *et al.* (1989) also found that wilted Napier grass made well-preserved silage without sugar cane or bagasse.

Conclusions

From the data obtained on this study we can conclude that the addition of dehydrated sugar cane did not change the characteristics of the fermention of the silages, but reduced its CP levels.

As the CP reached very low levels with the addition of the sugar cane, further studies need to take place to test the inclusion of a nitrogen source together with sugar cane.

References

ALMEIDA, E.X.; PINTO. J.C.; PÉREZ, J.R.O. Cama de frango e cana-de-açúcar na qualidade da silagem de Pennisetum purpureum Schum. Cv. Cameroon. ***Revista da Sociedade Brasileira de Zootecnia***, v.15 n.3, p.193-199, 1986.

TOSI, H,; BONASSI, I.A. ITURRINO, R.P.S. et al. Avaliação química e microbiológica da silagem de capim elefante, cultivar Taiwan A-148, preparada com bagaço de cana. ***Pesquisa Agropecuária Brasileira***, v.24, n.11, p.1313-1317, 1989.

WOOLFORD, M.K. ***The silage fermentation***. New York, Marcel Dekker, 1984. 350p.