Proc. Sixth Ann. Conf. Grassld. Soc. NSW, pp 36-42.

PERENNIALS IN THE TABLELANDS AND SLOPES:

FORAGE CONSERVATION - A KEY TO PRODUCTIVITY IN THE '90's

Don Sapienza

International Operations,
Pioneer Hi-bred International, Inc., Iowa, USA

Abstract: *The area on which maize for silage is grown in coastal NSW has been continually increasing since 1984. It appears that 43% or about 18,500 tonne of the silage produced is being fed to feedlot beef with the remainder used to supplement dairy cows.Animal feeders are incorporating maize silage into their operations because: (1) maize silage is normally available when pasture is in low supply or of low quality; (2) maize silage of consistent high quality can be routinely produced at a low cost (about 3 to 8 cents/kg DM); (3) high energy content and high palatability make maize silage a fine complement to high protein/low energy feeds such as grasses and legumes; and (4) it easily acts as a good base for feed mixes which combine cottonseed, meat and bone meal, urea and/or vitamin and mineral mixes with the forages.*

Cattle and dairy producers are seeking feeding strategies which will improve the production and efficiency of their land and animals. Rather than simply increasing total output of crops and animal products, they are developing systems designed to optimise farm profitability. Animal feeders are developing cropping and farming practices which match the land resource with herd requirements. In many operations, feed self-sufficiency or at least forage self-sufficiency is becoming a reachable goal.

IMPORTANCE OF FEED QUANTITY AND QUALITY

The herd must be provided with sufficient feed so that the marketable products are produced efficiently. The feed source must be of the correct quality or nutrient density to maintain animals in their most productive state. Forages (pasture, forage crops and conserved forms of either) supply the majority of the daily intake of the herd. Forages can be supplemented with purchased grains and concentrates, or alternative own-grown feeds to provide animals with optimum nutritional quality throughout their entire series of productive periods. Dairymen, for example, must supply the correct quantity and quality of feed to heifers, dry cows, and to lactating cows with ration adustments for age, weight, and stage of lactation. Cattlemen must adjust feeding programs for the receiving, growing and finishing periods in feedlot operations.

Pasture plus pasture silage is a feed management system which can conserve good quality grass during times of excess to provide for livestock needs throughout the year. On a NSW property, the incorporation of pasture silage has enabled the farmer to increase his cow herd from 50 to 125 animals. On another property, a combination of sorghum silage and pasture supplies the base ration for 150 cows, 55 beef cattle and 1500 sheep, a stocking density made possible only by including a crop specifically for silage production. Prior planning which matched feed supply with feed requirement, and which included maize silage, helped another dairy farmer to maintain a low cost milk production operation throughout a drought without animals losing condition and without the dairy failing to meet its weekly quota.

MANAGEMENT OPTIONS

If pasture is the only source of forage, the supply may be restricted to a level below that required to meet the demands of livestock and the financial objectives of the farm operation. The periods of shortage indentified for a range of pastures and forage crops grown in different environments in Australia is shown in

Table 1: Supply of green feed expected in a normal rainfall year (Source: Thompson, 1988).

CROP		S	O	N	D	J	F	M	A	M	J	J	A
Improved Pastures:													
Tropical grasses		P	–	–	–	P	P	–	–	–			
Temperate grasses		–	–	–				–	P	P	–	–	–
Tropical legumes		P		–	–	P	–	–	–				
Annual temperate legumes		–	–						P	P	P	–	–
Lucerne		–	–	–	–	–	P	P	P	P	P	P	P
White clover		–	–	–				–	P	P	–	–	–
Forage Crops:													
Forage sorghums		P	P	P	P	P	–	–	–	–	–		
Millet			P	–	–	P	P	–	–	–			
Lablab and cowpeas		–	P	P	P	P	P	–	–	–			
Winter cereals:	Oats	–	–					P	P	P	P	P	–
	Barley	–							P	P	P	P	–
	Triticale	–							P	P	P	–	–
	Canary		–	–						P	P	P	–

– *Period of Feed Availability*
P *Recommended Planting Time*

Table 1. For some farm enterprises such as dairying, the energy limitation of grass may support milk production per cow at a level lower than expectations; or if supplemented, at a cost of production which is above an acceptable amount.

High yielding forages like maize and sorghum for silage can increase the quantity of feed, and when made correctly, reduce feeding losses and raise the energy density of the ration above that provided by pasture only. By adding lucerne into pasture improvement programs, the resultant multi-ingredient feeding system can improve the production efficiency of the enterprise. Higher stocking densities and higher production per animal can be converted easily into higher total farm productivity and profitability.

Table 2 shows results of a computer simulation which compares two typical spring calving dairy farm operations in production and financial terms. System A uses pasture and pasture silage to provide for the needs of the dairy operations, while System B incorporates maize silage into the pasture plus pasture silage system. The starting point used production optimised rations based on locally available feeds for 600 kg LW cows producing 288 kg butterfat per lactation. These rations were then used to calculate the area allocations for pasture, pasture silage and maize silage (System B only).

The model was run through five years covering normal, good and poor growing conditions. The model assumed that at the start both farms were similar with 1.28 t DM/ha of forage available on pasture areas and 115 tonne of conserved feed in storage, and that over the five year period pasture cover was 1 t/ha. Losses were standardised at 10% for maize silage, 15% for hay, and no losses were assessed against grazed pasture.

The result averaged over the five years shown in Table 2 highlights the potential to increase farm profits by utilising maize silage with farm profit increasing by $29,000/yr due to increase in production per cow and production per hectare. However, the advatages of income stabilization and productivity will not come easily. Good farm management, crop husbandry and feeding principles must be applied.

Table 2: Comparison of production and profit for System A (pasture + pasture silage) and System B (pasture + pasture silage + maize silage) simulated for a spring calving dairy enterprise.

PARAMETER	CONSERVATION SYSTEM SYSTEM A	SYSTEM B	PERCENTAGE ADVANTAGE OF MAIZE SYSTEM
	(Average for 5 years)		
Cows milked (#)	323	347	7.5
Cows culled (#)	48	67	39.6
Silage produced:			
Pasture (ha;t)	24;110	29;66	
Maize (ha;t)	0;0	6;116	56.9
Other feed conserved (t)	6	0	
Annual Pasture (t/ha)	16	16	
Cows months in milk	2978	3212	7.9
Butter fat production (t)	62	66	6.5
Gross income ($)	377784	425994	
Nett income ($)	255013	284668	11.7

HARVEST TIME SELECTION

BEST TIME TO HARVEST

The selection of harvest time has possibly the greatest influence on yield of total feedable material (TFM). TFM is calculated by combining total crop (and/or pasture) yield in the field and then adjusting this figure for losses incurred in dry matter up until it is eaten by livestock. For silage these losses include: harvest (leaf shatter or grain loss); primary fermentation (gas production, dry matter conversion, spoilage), secondary fermentation (aerobic or anaerobic stability) and feeding (palatability, digestion, feed conversion). Together these factors can cause dry matter loss of 12 to 53%, although harvest losses and primary fermentation account for two-thirds of the loss incurred.

Table 3: Relative feed quality of grasses, lucerne, maize silage, and grass silage as influenced by maturity.

FEED SOURCE/ GRADE DESCRIPTION	CP (%DM)	ADF (%DM)	NDF (%DM)	RFV	NEL MJ/kg	%DM
1. GRASSES[1]						
1 Vegetative	17–19	31–35	40–46	127–142	–	–
2 10% flowering	14–16	36–40	47–53	109–126	–	–
3 50% flowering	11–13	40–42	53–60	95–108	–	–
4 75% flowering	8–10	43–45	61–65	81–94	–	–
5 100% flowering	>8	>45	>65	<80	–	–
2. LUCERNE[1]						
Prime preflowering	>19	<30	<39	>143	–	–
1 10% flowering	17–19	31–35	40–46	127–142	–	–
2 50% flowering	14–16	36–40	47–53	109–126	–	–
3 75% flowering	11–13	40–42	53–60	95–108	–	–
4 100% flowering	8–10	43–45	61–65	81–94	–	–
3. MAIZE SILAGE[2]						
High quality	8.8	30	51	–	12.1	30–35
Medium quality	8.5	31	58	–	10.8	25–29
Low quality	9.0	32	55	–	9.6	>25
4. GRASS SILAGE[2]						
High quality	13.4	27	55		10.3	>28
Medium quality	12.6	34	62		9.2	18–28
Low quality	9.5	42	71		8.3	<18

[1] International Forage Grassland (1987)
[2] Sapienza (1990)

Relative feed quality of grasses, lucerne, maize silage and grass silage as influenced by maturity are shown in Table 3. Variation in feed quality between and within silage sources have a significant effect on the amount of loss incurred and on livestock performance. For example, in a comparison of beef cattle fed silages made from a range of different crops and pastures (Calder *et al.*, 1976), maize and barley silage produced highest gain (1.0 kg LWG/day; feed:grain conversion 6.2) which was twice that of grass silage (0.5 kg LWG/ha; feed:gain 10.0). Another study with dairy cattle in Wisconsin (USA) illustrates the effects of changes in quality within the same pasture type on animal performance (Table 4). As lucerne quality declined with age, milk production fell by 34%. Supplementing lucerne hay with concentrate reduced the rate of decline in milk production to a threshold of 54% concentrate in the ration. Beyond this level, supplement could not overcome the loss in production due to conserving lucerne at advanced maturity (Table 4).

Table 4: Daily yield (kg) of 4% corrected milk from lucerne hay fed with different levels of concentrate (Source: Kawas, 1983).

CONCENTRATE % of DM	LUCERNE MATURITY (BLOOM) Pre	Early	Mid	Full
20	36	30.9	26.0	23.6
37	37.7	31.4	28.4	25.1
54	39.5	35.0	29.3	25.9

For cattlemen, the choice of plant material for silage also affects ADG and feed:gain conversion rate. A recent review of beef feeding experiments (Berger, 1991) showed a similar decrease in LWG with maturity of grain sorghum silage; for late-milk stage to ripe grain stage, LWG declined from 1.1 to <1.0 kg/day and feed:grain ratio rose from 7.7 to 8.8. However, this effect of maturity could be countered by processing which raised the quality of ripe grain sorghum silage to be equivalent to late milk stage silage. Cattle growth rate was also improved by processing silage. Both these examples highlight the value of selecting forage at vegetative to pre- flowering stages for conservation.

FORMULATION OF RATIONS

Maturity of forage used for silage can affect rations formulated for dairy and beef cattle. For example, in Table 5, three dairy rations were formulated to meet requirements and recommendations for a cow producing 288 kg butterfat. The rations were formulated based on combination of basal ingedients (grass,

Table 5: Ingredient ratios and relative costs averaged over the full lactation for cows fed rations of different quality.

QUALITY OF BASAL INGREDIENTS	RELATIVE FEED COSTS[1]	BASAL INGREDIENTS	
		Quantity	(Grass, Lucerne, Maize)
		kg DM	%
High	100	21.23	(46,23,31)
Medium	104	21.23	(41,23,36)
Low	112	21.23	(41,23,36)

[1] Includes basal ingredient costs of production plus purchase price of supplements

maize, and lucerne) plus complementary feeds. There was a 12% increase in relative feed cost or a 12% reduction in income over feed cost as the quality of the ingredients used in basal ration decreased (Table 5). The cost increase resulted from combining forage ingredients with advancing maturity.

Productivity can also be evaluated by setting a target herd feed requirement (*eg.* 545 t DM/80 cow unit); then calculating the area (in ha) required to grow this amount of feed.

The end result of a low yield of TFM is reduced profitability caused by either lowered animal production per unit of land or from higher expenditure to provide concentrate feed to livestock.

IMPACT OF SILAGE ON AUSTRALIAN FARMS

On a dairy property in Victoria, for example, the producer increased productivitty and profit by incorporating silage into his feed inventory. Over ten years, the enterprise has grown from 50 cows producing 7331 kg butterfat to 125 animals producing 28476 kg, a more than doubling of per animal productivity. Pasture is the basis for the feeding program which is complemented with pasture silage feeding beginning in January. Purchased oats is fed (2 kg/cow/day) to milkers in early lactation. The producers attributes his success to maintaining cows in good condition and achieving good growth in replacement heifers. The enterprise has been so succesful that it is expanding to include beef cattle which will be fattened and finished on rations with a silage component.

The use of sorghum silage to complement pasture has enabled a New South Wales farm to expand from a 130 dairy cow herd averaging 950 kg milk/herd/day to a larger, more diverse and more productive enterprise. After 20 years, the farm herd has increased to 150 cows with average production exceeding 1200 kg milk/day with such consistency that the farm has been able to take full advantage of the increased income potential of supplying milk to a Sydney dairy on a weekly quota. The enterprise now includes 55 head of beef cattle and 1500 sheep.

A cropping allocation of 61 ha in pasture/pasture silage and 8 ha in maize for silage has allowed another enterprise to feed the entire herd right through a summer drought and consistently meet the weekly quota without having to purchase feed supplies, and without loss in livestock condition.

Harvest time selection is a low cost decision with oftentimes significant profit contributions. The preceding examples show the effect of maturity-related pasture quality on yield, nutritional quality, animal production, and total farm productivity and profitability. It is possible to balance forage crops and feeding systems so that both activities work synergistically. Profit optimisation most often occurs in animal feeding enterprises when strict attention is paid to feeding optimised rations based on low cost, high quality ingredients.

AGRONOMIC PRACTICES

Good agronomic practices should be followed if optimum forage yields are to be realised. The producer must balance the forage crop with the environment to obtain the required yields of TFM.

Soil type, solar radiation, precipitation, availability of irrigation water, temperature, heat units, and humidity are a few of the environmental factors which influence the choice of suitable crops. The dry matter yield , storability (sugar content and buffer capacity), and feedability (nutrient density and nutrient availability) are a few of the animal constraints which influence land allocation to specific crops. Recommendations made by Department of Agricultures and manufacturers should be used to determine soil preparation, seeding rates, hybrid or variety selection, fertilization, herbicides and pesticides. For the animal feeder, however, these recommendations must always be evaluated from the perspective of the herd.

Grasses should be cut for silage at a maturity that is characterised by a high leaf-to-stem ratio usually at the full leaf stage. At this stage there is a compromise between dry matter digestibility, ensiling potential, and total dry matter yield per hectare. Grasses should be re- cut at approximately three to four week intervals to coincide with this optimum stage.

Lucerne should be cut at about 10% bloom or when regrowth at the crown is only a few centimetres high. Lucerne decreases in feed value with maturity (Table 3), but also as dry matter content increases during wilting, harvest losses, especially of leaves, also increases. Wilting to only 30 to 35% dry matter will minimise leaf shatter and will help retain leaves. This will increase silage quality as leaves contain 70% of the plant's protein and 90% of the vitamins and minerals . The higher water content also ensures good fermentation which will result in good silage.

Table 6: Effect of weather conditions on nutrient status of forage sources for silage production.

GROWTH CONDITIONS	GRAIN CONTENT	RELATIVE ENERGY	IN VIVO DIGESTIBILITY
VERY GOOD OR EARLY HYBRID	55% Grain 30-35% DM-WP	100	74
NORMAL	55% Grain	97.9	73
	40-55% Grain	93.8	71
	Under 28% DM-WP	93.8	71
DRY	35% Grain	92.7	70
	30% Grain	90.6	69
	25% Grain	87.5	68
COLD OR A LATE HYBRID	Under 28% DM-WP	88.5	68

The best plant maturity for maize can be estimated by combining ear percentage (>46%) with the green colour of the stover (indicating a high stay-green hybrid) and the content of the milk in the kernels (30 to 50%). Total plant dry matter (ideal is 30 to 35%) can be best estimated by combining kernel moisture with stover moisture. One should not rely on kernel moisture only for dry matter estimates.

Sorghum cultivars are best harvested at 30 to 35% dry matter. For grain sorghum, the grain should be in the early to medium dough stage when ensiled. The leaves at this stage will just be beginning to lose their green colour.

For forages like maize and sorghum, total plant digestibility is strongly influenced by grain content and stover maturity. Changes in energy content and whole plant digestibility of maize silage grown under different growth conditions is shown in Table 6.

ENSILAGE PROCESS

For good silage, the crop should be harvested at the recommended maturity, chopped correctly, and packed into the silo as quickly as possible. Silo size should be matched with herd size and to the daily feeding rate. Filling delays will result in a prolonged Phase I of the ensilage process (Table 7). During this phase, plant cell respiration can produce heat and lessen the availability of plant proteins for livestock. Also, plant respiration can produce excess carbon dioxide and water which can contribute to nutrient losses from the silage .

The silo should be sealed to prevent penetration by air and water into the silage. Phase II to V (Table 7) of the ensiling process are optimised under anaerobic conditions at 30 to 35% dry matter, and, at a minimum, 2.5% water soluble carbohydrates.

During Phase II the silage pH begins to decline, the preservation acids begin to be produced, and silage temperature rises slightly, indicating that the silage enhancement process has begun. It is important that the optimum conditions be established so that the desirable bacteria can establish dominance during

Table 7: Description of phases in the ensilage process showing critical changes in temperature, pH and dominant bacteria. Range in dry matter loss expected in each phases is given for natural and inoculated silage (Source: McCoulough, 1975; Sapienza, unpubl. data).

PHASE	PHASE I	PHASE II	PHASE III	PHASE IV	PHASE V	PHASE VI
BIOLOGICAL PROCESS	CELL RESPIRATION PRODUCTION OF CO2 HEAT AND WATER	PRODUCTION OF ACETIC ACID AND LACTIC ACID ETHANOL	LACTIC ACID FORMATION	LACTIC ACID FORMATION	MATERIAL STORAGE	AEROBIC DECOMPOSITIO N ON RE-EXPOSURE TO OXYGEN
TEMPERATURE CHANGE	20.6°C	32.2°C		28.9°C		28.9°C
pH CHANGE	6.0-6.5	5.0		4.0		7.0
DOMINANT BACTERIA		ACETIC ACID AND LACTIC ACID BACTERIA	LACTIC ACID BACTERIA	LACTIC ACID BACTERIA		MOULD AND YEAST ACTIVITY
FERMENTATION		DRY MATTER LOSS				
NATURAL	1-4%	4-11%				5-14%
INOCULATED[1]	1-2%	3-7 %				3-8%
		TOTAL LOSS: NATURAL 10-19%; INOCULATED 7-17%				

[1] Treated with Pioneer[R] Brand Silage Inoculant

Table 8: Comparison of nutrients in Australian wheat silage made in 1944 and 1990 (Source: Agritech, 1990).

NUTRIENT	1944 SILAGE	1990 NRC
M.E. Ruminant	8.4 MJ/kg	8.6
% NFE	42.4	46.0
% Protein	9.6	10.0
% Fat	3.1	4.1
% Fibre	35.9	33.0
% Ash	9.0	6.9
% Moisture	57.3	-
% N D Fibre	70.9	74.0
% A D Fibre	49.8	44.0

Protein is N x 6.25
All results are on a 'Dry Matter' basis

Phase II. If desirable bacteria dominate the ensiling microbial population, a homolactic fermentation will occur in Phase III, and there will be an efficient conversion of plant sugars into microbial end-products. If heterolactic fermentation by undesirable bacteria takes place, plant nutrients will be lost through inefficient fermentation which will lower silage quality.

Phases IV and V are active and inactive phases of prolonged storage. If dominated by homolactic bacteria, both silage pH and temperature should remain stable.

Phase VI occurs when the silage is exposed to air either at the silo face or in the feed trough. Normally well conserved and intact silage will maintain stable temperature, pH and feed value for one to two years. However, analysis of a sample of Australian wheat silage showed that after 56 years its quality is similar to a 1990 equivalent (Table 8).

After opening, the temperature of the silage can rise and feed value decrease. This is called "aerobic instability". An aerobicly stable silage will normally hold its temperature and feed value for three to five days in the feed trough. The same stability applies to the face of the silo provided it is unloaded properly.

The silo unloading process should not open cracks into the face of the silage and allow avenues for air penetration. Normally air will penetrate up to 20 cm into the silage mass. Cracks can facilitate an even deeper penetration. Air promotes re-fermentation, decreases aerobic stability, and can cause lowering of the feed value of silage. Therefore, the use of non- aggressive silage unloading techniques is encouraged. As a general rule, 10 to 20 cm should be removed from the face daily with no more than three days required to unload the entire face of the silo.

These ensiling phases will occur in grass, legume, maize and sorghum in the same order. These other forages also respond to almost the same consideration as maize: harvest at the correct maturity: wilt to the correct dry matter content; chop; fill; seal; and unload correctly.

SILAGE ADDITIVES

Silage additives can decrease the ensiling losses associated with Phases I to VI (Table 7). In addition, these products can increase animal performance Table 9 summarises thirty beef cattle feeding experiments conducted in USA, France, Italy, and the Netherlands with Pioneer brand inoculants (a commercial source of naturally occurring homolactic bacteria).

ANIMAL FEEDING

Silage dry matter also influences the dry matter intake of livestock, and it is important to strike a balance between the requirements for storage and the requirements for feeding. At 30 to 35% dry matter, livestock should be able to eat *ad libitum*, the high quality silage that can be made and to produce animal products very efficiently, if supplemented correctly.

The most desirable length for chopping maize silage is 10 to 20 cm as this chop length will give ideal compaction and will provide enough functional fibre for normal rumination. Functional fibre provides important benefits to livestock:

- It stimulates rumination and therefore rumen buffering through salivation;
- It promotes acetate and butyrate production in the rumen thereby supplying butterfat precursors to the mammary glands; and,
- It provides for the proper amount of rumen fill which minimises calving difficulties and displaced abomasums.

Silage chopped too long may make compaction difficult especially in hollow stemmed crops. Air can remain trapped in silage and heating and spoilage may

Table 9: Performance comparison of beef cattle fed naturally made silage (Control) and silage inoculated with Pioneer(R) brand 7.

		TREATMENT		
PARAMETER	(n)	Control	Inoculated[1]	Significance
Gain/ton forage ensiled, kg	22	173.3	181.3	**
Average daily gain, kg	30	1.06	1.09	*
Feed efficiency	30	8.11	7.85	**

[1] Pioneer(R) brand silage inoculant.
Statistics evaluated using paired t-test
* $P < 0.05$; ** $P < 0.01$; n sample size.

result. In addition, fibre digestion in the rumen may be decreased.

Finally, silage should be fed correctly to gain the full benefit from this form of conservation. The following steps provide a guide for preparing an optimum ration:

- determine dry matter intake of livestock;
- balance energy and protein;
- adjust for functional fibre; and,
- supplement with vitamins, minerals and other feed additives

Cattle cannot produce milk or meat without sufficient dry matter intake. Energy is usually the first limiting nutrient when feeding grassses and legumes, whereas protein is the first limiting nutrient when feeding maize or sorghum. High forage diets, especially when the forage is mature, can lead to high fibre rations and possibly intake depression. Therefore, it is important to combine forages so as not to limit intake and to maintain a low rumen fill factor. A good quality forage blend or basal ration should be :

- greater than 8.6 MJ/kg DM;
- less than 20% ADF; and,
- contain 35 to 40% non-fibre carbohydrates.

This basal ration should be combined with protein sources to supply:

- 17.5% crude protein; and
- 35 to 40% undegradable intake protein with a good amino acid balance.

This may mean combining grain mixtures (barley, oats, maize), commercial concentrates, cottonseeds, meat and bone meal, urea, vitamins, minerals, and other additives.

CONCLUSION

There are no magic feeds and no perfect management programs that will cover all animal types, every environment, and all management conditions. However, the importance of quality forages in animal feeding programs is paramount. Forages are the cornerstone ingredients for low cost rations and these rations are the keystones to profitable and successful animal feeding operations.

Forages must be harvested at their optimum maturity. It is forage quality that most influences ration palatability, animal intake, and nutrient availability; and it is maturity which most influences quality. Therefore, maturity heavily influences the maintenance of animals in their most productive state.

Pasture grazing is a low cost animal production system, but it has a low upper limit on productivity. If this upper limit is too low for the financial expectations of the farmer, then it is time to change to a different system; one which includes conserved feeds.

The crop- by- environment interaction on the enterprise should be evaluated with a local agricultural adviser. However, the conclusion may be reached for that the advantages brought by maize silage make it the choice for the conserved feed to supplement pasture. The energy density of maize silage will complement pasture and pasture silage, while its feed value will help maintain milk yield and composition as well as maintain animals in good physical condition with few health problems. Maize silage also supports cost efficient meat production systsms.

The dairy and cattle producers who will survive the 1990s will choose a management option which optimises the conversion of their resources (land and animals) into marketable products (cash crops, milk and meat). They will choose strategies that lead to production of low cost, high quality, raw materials (pasture and conserved feeds) which will enable them to optimise their income over feed costs and thereby optimise total farm profitability.

ABBREVIATIONS

ADF = acid detergent fibre; CP = crude protein; DM = dry matter; DM-WP = dry matter at wilting point; LW = liveweight; LWG = liveweight gain; ME = metabolisable energy; NDF = neutral detergent fibre; NEL = net energy lactation; NFE = nitrogen-free extract; RFV = relative feed value; TFM = total feedable material.

REFERENCES

Agritech (1990). Agritech Laboratory Services Pty Ltd., contracted analyses of samples.

Berger, (1991). Hay and silage, NIFA

Calder, F.W., Nicholson, J.W.G., and Langille, J.E. (1976). Comparison of silages made from grass, grass-legume and corn fed to steers with and without diethylstilbestrol. *Canadian Journal of Animal Science*, 56:57-63

International Forage Grassland (1987) *Proceedings of Bi-annual Meeting*, Japan.

Kawas, (1983). *Journal of Dairy Science*,

McCloulough, (1975).

Thompson, P. (1988). Improving livestock profitability with pasture and forage crops, Queensland Department of Primary Industry, Toowoomba, Qld.

(Incomplete reference list provided by author)