MEETING DEFICITS IN FEED SUPPLY BY PASTURE CONSERVATION

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ABSTRACT

Evidence is presented to show that supplementation with conserved pasture can overcome constraints on animal production caused by the seasonal nature of pasture growth. Comparisons of production between animals offered hay and silage were reviewed and no firm conclusions could be drawn. Factors affecting silage quality were discussed and silage making appeared to be the preferred system in terms of cost. It was concluded that conservation should take second priority to pasture management as a method for overcoming seasonal constraints on animal production. The need for an integrated research effort aimed at overcoming these constraints was stressed.

INTRODUCTION

Seasonal fluctuations in pasture growth and seasonal requirements in pasture demand by different classes of stock have been indicated earlier in this session. In general, pasture surpluses occur in late spring and early summer and deficits in mid summer/early autumn and in winter. The amount of surplus and deficit herbage within any animal system will be governed largely by level and fluctuations in stocking rate in addition to any seasonal changes in pasture growth and per animal requirements. Overcoming the constraints on animal production, arising from seasonal fluctuations in pasture quantity or quality by conserving surpluses is one of the oldest management practices in agriculture, dating back at least 3000 years to the ancient Egyptians (Schukking, 1976). Alternative methods of overcoming these constraints, by management of pasture *in situ*, or by the integration of, or complete replacement by, arable crops onto the farm, are also being discussed in this session. Inevitably comparisons between these various alternatives for overcoming animal production constraints will be attempted. Sound comparisons between these three strategies for any one animal production system require each option to be tested under its respective optimum conditions. To the author's knowledge such comparisons have not been made; indeed, it is unlikely that the optimum conditions for any of the alternative methods in any one animal system have been defined.

Before adopting any one of these methods the option of choice must first show that it is capable of supporting the required per animal production during periods of pasture scarcity. In the case of conservation only genuine surpluses should be harvested so that maximum benefit is obtained by less expensive grazing management techniques. The extra costs incurred by conserving surpluses must also be covered by the extra animal production obtained, at least in the long term. The main objectives of this paper are to examine whether conservation can lead to increased animal production during periods of pasture scarcity and to indicate how conservation methods compare in terms of animal production, DM losses and costs.

INCREASING ANIMAL PRODUCTION THROUGH CONSERVATION

It is unlikely that supplementation with conserved pasture would be practised if it failed to improve immediate or longer term stock performance, carrying capacity or seasonality of production. The effect of supplementation of beef cattle with a good quality wilted silage on live and carcass weight gains is shown in Figure 1. In this experiment pasture allowance was restricted to about maintenance requirements on all treatments. Figure 1 clearly shows that conserved pasture can markedly increase beef production when pasture allowance is restricted, and that the increased production is directly proportional to the amount of supplement DM offered and eaten. In this trial about 1 kg of carcass was obtained from each 10 kg silage DM eaten. Supplementation with pasture silage to ewes and to dairy cows (Table 1) on restricted pasture allowances has also been shown to increase live-weight gains and milk-fat production respectively. These and other experiments have, therefore, established that feeding of conserved pasture can lead to increased animal performance during periods of pasture scarcity. However, supplementation with conserved pasture may not always lead to higher animal production for reasons such as the complete substitution of conserved material for pasture (Rattray *et al.*, 1978b), or because animals may largely, or even completely, reject an unpalatable supplement. Furthermore some supplements may contain production-suppressing compounds. An example of this is in the flushing of ewes where high levels of coumestan, or other oestrogenic compounds in conserved legumes result in reduced ovulation rates (K. T. Jagusch pers. comm.). Low contents of essential amino acids in some silages have also been thought to limit ovulation rate in some instances in ewes (Rattray *et al.*, 1978a). Such peculiar situations might be avoided by supplementary feeding with safer foods.

Having established that supplementation with conserved pasture can lead to improvements in animal production the effect of conservation product on this response will be discussed. Conservation methods can be broadly classified into field-cured haymaking and silagemaking; there is little artificial drying of pasture for stock feeding in New Zealand.

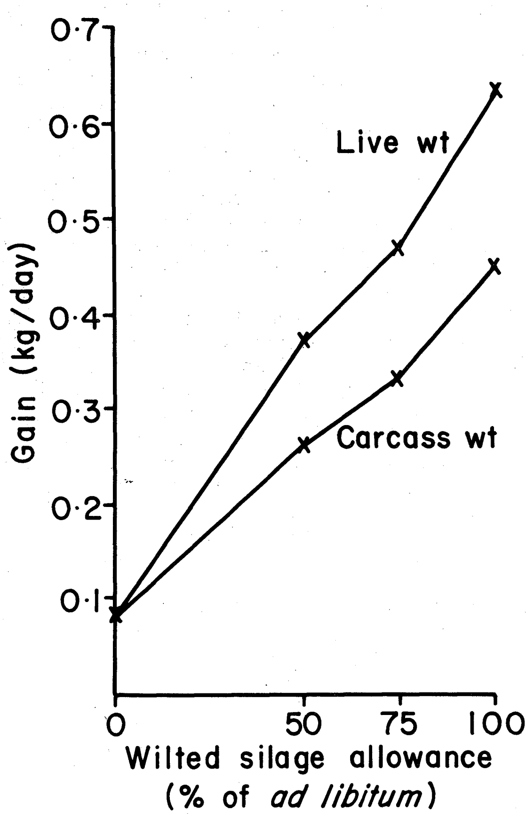
HAY VERSUS SILAGE

Early comparisons of hay with silage could be justifiably criticised on the grounds that the two

TABLE 1. Effect of supplementation with different silages on production by sheep and dairy cows offered restricted pasture.

	Animal	Supplement DM Intake	Type	Production Unsupple-mented	Production Supple-mented	Units
Rattray (1977)	Ewes	380	LW gain	- 15	11	g day^{-1}
		710			60	g day^{-1}
		990			83	g day^{-1}
Rattray *et al.* (1978a)	Ewes	600	LW gain	- 12	61	g day^{-1}
		1000			75	g day^{-1}
		1000			100	g day^{-1}
		1200			102	g day^{-1}
Rattray *et al.* (1978b)	Ewes	1000	LW gain	-139	71	g day^{-1}
Hutton and Douglas (1975)	Cows	3.1	Milk fat	0.66	0.72	kg day^{-1}
Bryant (1978)	Cows	7.8	Milk fat	0.35	0.51	kg day^{-1}
		8.8			0.52	kg day^{-1}

Figure 1: Effect of level of supplementation on beef production.



products were confounded with maturity, or type of original crop. In recent years several studies abroad have been carried out in which hay and silage have been made from the same crop at the same time.

In general, DM intake of hay by sheep or cattle has been found to be greater than that of unwilted silage when offered as sole diets, although differences were not always large (Waldo *et al.*, 1966, 1969; Sheehan and Fitzgerald, 1977). When hay was compared with wilted silage, hay DM intakes still tended to exceed those of silage DM, but differences were often negligible (Brown *et al.*, 1963; McCarrick, 1966; Forbes and Irwin, 1968; Bishop and Kentish, 1970b). However, Valentine and Wickes (1978) found lactating dairy cows ate less hay DM (103.6 g (kg LW)$^{-0.75}$) than untreated silage (126.7 g (kgLW)$^{-0.75}$) formaldehyde treated silage (114.0 g (kgLW)$^{-0.75}$) or wilted (31% DM silage (133.7 g (kgLW)$^{-0.75}$).

Valentine and Wickes (1978) found no difference in milk fat (0.62 kg day^{-1}) or milk protein (0.54 kg day^{-1}) production between the hay and wilted silage fed cows, but the cows offered wilted silage gained daily 0.86 kg live weight compared with only 0.04 kg by cows offered hay. Cows offered the untreated and formaldehyde treated silages produced less milk fat (0.58 and 0.61 kg day^{-1} respectively) less protein (0.47 and 0.50 kg day^{-1} respectively) and gained less weight (0.16 and 0.35 kg day^{-1}) than wilted silage fed cows. In the U.S.A. Brown *et al.* (1963) showed an unwilted silage treated with an additive supported a greater fat-corrected-milk yield than hay in two experiments out of three, but in all three experiments live-weight gain of cows was greater on the hay. Clearly more comparisons are required in order to draw firm conclusions on the relative feeding values of hay and silages for milk production and live-weight gain in cows.

More information is available on live-weight gain comparisons between hay and silage with sheep and growing cattle. In all comparisons sheep gained more live weight on hay than on silage (Bishop and Kentish, 1970a; Barry, 1975; Sheehan and Fitzgerald, 1977) but results from cattle experiments were more variable, with some showing greater gains from hay (Waldo *et al.*, 1966; Wellman, 1966; Forbes and Irwin, 1968; Bishop and Kentish, 1970b), some from silage (Waldo *et al.*, 1969; Bishop and Kentish, 1970b), and some with little or no difference (McCarrick, 1966; Forbes and Irwin, 1968; Waldo *et al*., 1969; Bishop and Kentish, 1970b). However, in many of these comparisons hay was barn dried after partial field drying (Waldo *et al.*, 1966, 1969; Wellman, 1966; Forbes and Irwin, 1968; Sheehan and Fitzgerald, 1977). Since barn drying can lead to improvements in digestibility compared with field curing, particularly if field cured hay has been subjected to rain (Strickland, 1967; Demarquilly and Jarringe, 1970), this could favour intake, and hence live-weight gain. However, a comparison in Ireland failed to detect a substantial live-weight gain advantage with barn dried over tripod made hay (McCarrick, 1966). Of greater significance from this Irish work was the observation that cattle fed hay had markedly lower killing-out percentages, due to greater gut fill, than cattle offered silage; an observation confirmed recently at Ruakura (Marsh and Ward, 1978). This turned an apparent advantage of hay over silage, in terms of live-weight gain to a substantial disadvantage when measured in terms of carcass gain basis (Sheehan and Fitzgerald, 1977). Thus for meat-producing stock, if allowances are made for possible benefits from barn drying and the fact that much of the live-weight gain advantage is not reflected in carcass gain, then the superiority of hay over untreated silage, made from the same crop, is not great.

IMPROVING SILAGE QUALITY

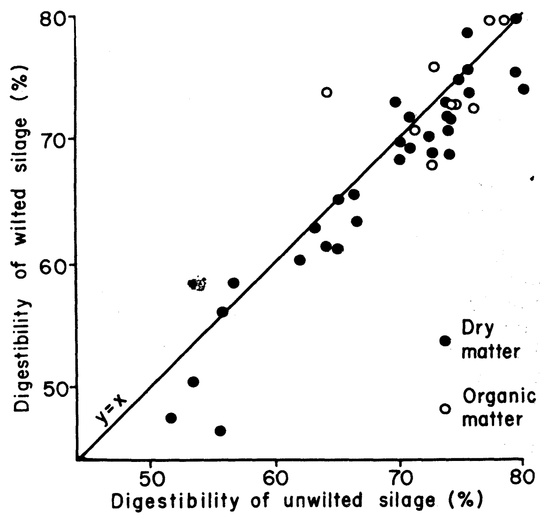
There are several management practices which can lead to improvements in the properties of silage and thereby further reduce the apparent superiority of hay over silage. In Europe and the USA the use of additives has been evaluated in some detail and information on this aspect of silage quality can be obtained from reviews by Owen (1971), Wilkinson *et al.* (1976) and Waldo (1977). The feeders' margin in New Zealand is considerably less than in the more cost intensive systems of Europe and the USA and as a consequence additives are not generally used here. However, wilting also improves fermentation (McDonald and Edwards, 1976) and leads to substantial increases in DM intake when the product is offered as a sole diet to sheep, beef and dairy cattle (Table 2). Recent research at Ruakura found similar results when silages were offered as supplements to a restricted pasture allowance (Table 3). The effect of wilting on digestibility is variable (Figure 2), with a tendency for a reduction which increases with degree of wilt.

TABLE 2. Effect of wilting on DM intake of silage when offered as a sole diet.

Animal	Increase in intake (%)	Range of response (%)
Sheep	44	-18 to 179
Growing cattle	31	-1 to 97
Dairy cows	25	19 to 33

Source: Marsh (1978), *Journal of the British Grassland Society 33:* (In press).

Figure 2: Effect of wilting on digestibility of silage

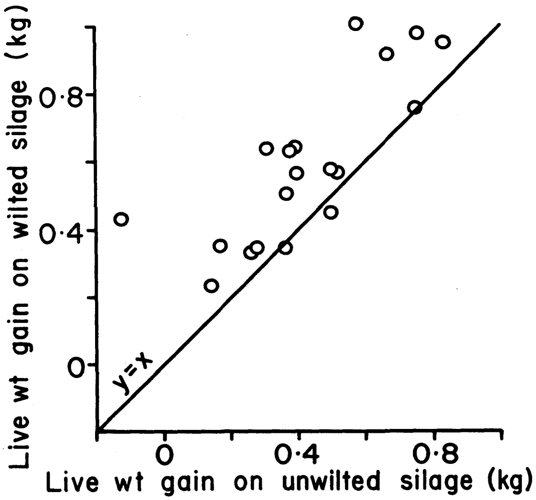


Overseas studies have found the net effect of increased intake and possible decreased digestibility, results generally in an increase in live-weight gain by cattle compared with that from unwilted silages when both are offered *ad libitum* (Figure 3). This has been supported by Ruakura data for sheep and beef cattle at pasture (Table 3). In an experiment with dairy cows (Bryant, 1978) no positive response was found, but in that experiment the difference between unwilted and wilted silage DM content and digestibility was small (19 *v.* 26% and 75 *v.* 74% respectively).

TABLE 3. Effect of wilting on daily DM intake of silage (kg) and gains by ewes (g, fasted weight) and beef cattle (kg, unfasted weight) offered restricted pasture allowances.

		Dry Matter Intake		Live Weight Gain	
	Animal	Unwilted	Wilted	Unwilted	Wilted
Rattray (1977)	Ewes	0.38	0.71	11	60
Rattray *et al* (1978a)	Ewes	0.60	1.0	61	75
Marsh and Ward (1978)	Beef Cattle	3.26	4.63	0.62	0.65
	Beef Cattle	4.26	5.40	0.60	0.81
Marsh (unpublished)	Beef Cattle	3.80	4.93	0.37	0.55
	Beef Cattle	4.37	4.88	0.44	0.51

Figure 3: Effect of wilting on liveweight gain by cattle



Type of forage harvester may also be considered as a management variable affecting silage quality. A review of this topic has recently been completed in which it was found that stock, particularly sheep, ate more silage DM as the material was more finely chopped. In cattle, the response was lower and little evidence was found to justify very fine chopping (< 25 mm). In terms of animal production, responses to fine chopping were not large for growing cattle, dairy cows or sheep. So until there is firm evidence to the contrary it is suggested that a chop length of 50-100 mm would be sufficient to ensure an adequate intake for most classes of stock and still be suitable for machine and manual handling.

It should be remembered that hay or silage, is not offered *ad libitum* to stock in New Zealand, especially during maintenance periods. Therefore factors which improve intake, such as wilting, fine chopping or haymaking, might not be considered important. In these circumstances it may be that choice of conservation system will depend on other factors such as relative DM losses, quality and cost of conservation, and ease of feeding. However, the management factors that improve intake are often the same as those that improve quality and reduce losses. So a case can still be made for wilting pasture to about 28% DM, apart from any beneficial effect it has on increasing intake (Jackson and Forbes, 1970). Field losses due to wilting *per se* are not large. Daily rates of loss of 2-3% have been quoted (Dijkstra, 1957; Kormos and Chestnutt, 1966). At Ruakura we have not detected losses above 2% due to wilting for up to 48 hours. Since DM losses from effluent (average 6%; Watson and Nash, 1960) cease between 25 and 30% DM (Murdoch, 1954; Castle and Watson, 1973) this would more than compensate for the smaller field losses. In terms of quality, wilting tends to restrict fermentation so that wilted silages contain more readily digested soluble sugars than unwilted silages (McDonald and Edwards, 1976). Furthermore, clostridial fermentation, which causes breakdown of amino acids and formation of butyric acid, is inhibited above 28% DM (McDonald and Whittenbury, 1973). Therefore wilted silage would still seem preferable to unwilted material even for restricted feeding systems, but whether the conservation system should be based on this type of silage or on hay is not possible to define for all situations. The decision will probably be affected by other factors such as cost, or to circumstances peculiar to individual farms or farmers such as equipment on hand, personal prejudice etc.

TABLE 4: Comparison of DM losses and costs for two hay and two silage making systems.

	Hay		Silage			
	Conventional Bales	Big Bales	Flail Unwilted		Precision-Chop Wilted	
DM Yield available for harvest (kg ha^{-1})	3000	3000		3000		3000
Losses – picking up (%)	2	2		0		1
– wilting	11	11		0		2
– storage	3	2		15		8
	16	15		15		11
DM available for feeding (kg ha^{-1})	2520	2550		2550		2670
Costs – Mow/crimp	$15.00	$15.00	Harvest	$22.50 h^{-1}	Mow/crimp	$15.00
Condition 2 x	$ 6.66	$ 6.66	Transport	$32.00 h^{-1}	Harvest & Transport	$48.00 h^{-1}
Rake	$ 3.33	$ 3.33	Stack & Roll	$15.00 h^{-1}	Stack & Roll	$20.00 h^{-1}
Bale	$27.72	$28.35	Rate	1.4 ha h^{-1}	Rate	1.22 ha h^{-1}
Cart and stack	$30.24	$14.18				
Total ha^{-1}	$82.95	$67.52		$49.35		$62.00
c kg^{-1} DM available to feed	3.29	2.65		1.94		2.32

COSTS AND LOSSES

To give an indication of the range of comparative losses and costs of different systems of conservation, a simple comparison of two haymaking systems (conventional bales and big bales) and two silagemaking systems (flail cut, unwilted and precision chopped, wilted) has been made in Table 4. To compare like with like the same DM yield was assumed (about 4500 kg ha^{-1} above ground level) and all machines were assumed to harvest to a similar height (about 5 cm). Picking-up losses were also assumed figures, agreed between the author and a contractor. Wilting and haymaking losses are from data obtained at Ruakura, and storage losses a consensus figure from the literature assuming good storage conditions.

Total losses are remarkably similar between systems, with a slight advantage for wilted silage. Similar differences were given by Dijkstra (1957) but in his study total losses were 4-5 units higher on all systems. Costs of conservation were based on typical Waikato contractors' charges for the 1977/78 season and assume hay was conditioned twice and raked once before baling. A conventional bale of hay was assumed to contain 20 kg DM and a 'big bale' 450 kg DM. Silage systems were based on 4-man teams and all systems included labour costs of storage. Plastic sheeting would add an additional 0.3-0.4 cents kg ha^{-1} silage DM stored. Hay barn costs over 20 years, assuming total storage capacity was used, would be about 0.25 c kg^{-1} DM excluding maintenance.

There was no real difference between the two haymaking systems up to baling, but the 'big bale' system was less than half as expensive to transport and stack. Silagemaking was cheaper than either haymaking system with the direct cut/flail method being about 16% cheaper than the precision chop/wilted system. The difference in prices will have to be offset against any advantages in feeding value and subsequent handling costs. Mechanical developments in silage and 'big bale' handling equipment are likely to lead to increases in these systems of conservation particularly for large scale enterprises.

CONCLUSIONS

The evidence presented has shown that supplementation of stock with conserved pasture products can be an effective, if expensive, means of overcoming constraints on animal production in times of insufficient pasture supply. Although monetary returns from the extra animal production can exceed costs of conservation (Bryant, 1978; Marsh, unpublished data) the margin is lower than that obtained if more complete utilization of the spring and early summer growth was affected. It is emphasised that for any of the animal systems effort should first be directed at maximum utilization of pasture *in situ* and only then should genuine surpluses be conserved by the most technically and economically efficient means.

Agronomists can assist in overcoming the seasonal constraints on animal production from pastures by determining the effects of different grazing and conservation management practices on immediate and subsequent pasture production and quality. For example what is the optimum yield at which pastures should be grazed or conserved at different times of the year and how does this and post harvesting yield affect subsequent production, quality and persistency of the sward? Although it might be argued that much of this work has already been done in small-plot-trials the need now is to determine whether the same results occur in larger scale grazing and conservation situations. This calls for closer co-operation between pasture agronomists, grassland management scientists and animal nutritionists. Only when all three disciplines are simultaneously attacking the cause of restricted animal production at pasture will significant advances be made.

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