LOSSES OF NUTRITIVE VALUE FROM BIG ROUND BALES, COMPRESSED STACKS OR RECTANGULAR BALES STORED IN THE OPEN

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SUMMARY

In two experiments hay was made into compressed stacks, big round bales or rectangular bales and stored in the open. In experiment 1 cereal hay was made and stored in the open in an area with an annual rainfall of 400mm. Small losses of digestible dry matter occurred in the large round bales and stacks of rectangular bales over the 9-month storage period while significant digestible dry matter losses (26.8%) occurred in the compressed stacks as a result of wind damage. In experiment 2, hay was made from a perennial pasture in an area with an annual rainfall of 865mm. Losses of digestible dry matter in the compressed stacks were 17.4% and 22.6% after 4.5 and 8 months storage respectively. The big round bales lost only 16.9% of the digestible dry matter after 4.5 months of storage over summer, but deteriorated over winter and lost 38.5% after 8 months storage.

INTRODUCTION

Machinery capable of producing large hay packages as either compressed stacks or 500 kg big round bales is becoming popular in Australia because less labour is required for handling the large packages compared with 25 kg rectangular bales and the manufacturers claim that the packages are suitable for storage in the open. Lechtenberg et *al.* (1974) in Indiana, U.S.A. found that grass hay packaged in big rolls or compressed stacks of over 400 kg weight lost 8.2% and 8.8% digestible dry matter respectively when stored in the open for 5 months over summer. In the Mediterranean climate of southern Australia where the summer rainfall is less than the 330mm recorded in Indiana, the losses may be smaller. Losses through the wet, mild winters in southern Australia also needed to be examined.

In two experiments hay was stored in the open as compressed stacks, big round bales or stacks of conventional bales. In experiment 1, cereal hay was stored in a cereal growing area having a 400mm annual rainfall. In experiment 2 pasture hay was stored in a grazing area having a 865mm annual rainfall.

MATERIALS AND METHODS

Experiment 1

A randomised block experiment was established with three package types, three storage times and eight replications. The hay was cut from a barley (*Hordeum vulgare*) crop at the milk stage on October 9, 1977 at the Northfield Research Centre, South Australia. The stacks were made with a "Hesston 10 Stakhand", round bales with a "Gehl R.B. 1500" baler and rectangular bales with a "New Holland 279" conventional baler. Immediately after baling, 24 compressed stacks, 24 round bales and 576 rectangular bales were weighed, core sampled (Alexander *et al.* 1969) and stored in the open. The rectangular bales were stacked in groups of 24, consisting of 3 layers of 6 bales and covered by a pyramid constructed from 6 bales.

At three-monthly intervals, 8 compressed stacks, 8 round bales and 8 stacks of rectangular bales were manually separated into weathered and unweathered fractions. The weathered fractions consisted of the outer mouldy and weather damaged hay. Each fraction was then weighed and grab samples were taken.

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Samples were analysed for dry matter (DM), digestible dry matter (Tilley and Terry 1963) and Kjeldahl nitrogen and the losses of dry matter, digestible dry matter and crude protein during storage calculated and examined by analysis of variance.

Experiment 2

A randomised block experiment was established with three package types,' two storage times and seven replications. The hay was cut on November 21, 1977 from a perennial pasture consisting of perennial ryegrass (*Lolium perenne*), Yorkshire fog (*Holcus lanatus*) and subterranean clover (*Trifolium subterraneum*) at Hindmarsh Tiers, South Australia. The date of cutting coincided with flowering of the grass species. The crop was packaged as compressed haystacks, made with a "Hesston 10 Stakhand", big round bales made with a "New Holland 850" baler, or rectangular bales, made with a "New Holland 69" conventional baler. Immediately after baling, 14 compressed stacks, 14 round bales and 420 rectangular bales were weighed and sampled as described in Experiment 1. Rectangular bales were stacked in groups of 30. After 4.5 and 8 months storage in the open the hay packages were weighed and sampled.

RESULTS

Experiment 1

The cumulative rainfall after 3, 6 and 9 months storage was 65mm, 104mm and 307mm respectively. Densities for the compressed stacks, round bales and rectangular bales at the start of the experiment were 76, 137 and 141 kg DM/m3 respectively. There was no change in the density of the compressed stacks after 9 months of storage but the density declined to 119 and 121 kg DM/m^3 ($P<0.01$) in the big round bales and rectangular bales respectively.

The percentage of dry matter, digestible dry matter and crude protein at storage was 76.1, 61.2 and 10.1 respectively and did not significantly change in the unweathered portion of the hay during storage. The initial package weights and total percentage loss of dry matter, digestible dry matter and crude protein are given in Table 1. The amount of hay that remained unweathered in the compressed stacks, round bales and rectangular bales after 3 months storage was 88.9%, 98.9% and '95.5% respectively, butdeclined significantly ($P<0.01$) to 66.2%, 81.7% and 75.2% respectively after 9 months storage. The digestible dry matter percentage of the unweathered hay did not change during storage.

Experiment 2

The cumulative rainfall after 4.5 months and 8 months of storage was 167mm and 634mm respectively. Densities of the compressed stacks, round bales and rec- 'tangular bales were 67, 134 and 97 kg DM m^{-3} respectively. Densities of the compressed stacks and round bales did not significantly alter after 8 months storage. The stacks of rectangular bales collapsed during storage and consequently densities were not measured.

The percentage of dry matter, digestible dry matter and crude protein of the hay at storage was 85.2, 60.8 and 11.1 respectively. The initial hay package weights and percentage losses of dry matter, digestible dry matter and crude protein after storage are shown in Table 1. The amount of unweathered hay remaining after 4.5 months storage in the compressed stacks and round bales was 84.1% and 85.2% and after 8 months storage this had declined to 74.1% ($P<0.05$) and 58.4% ($P<0.01$) respectively. The digestible dry matter percentage of the unweathered portion of the compressed stacks did not change during storage but in the round bales after 8 months storage it had declined to 55.3% ($P<0.05$).

TABLE 1 Total losses associated with storing cereal hay packages in a 400mm rainfall zone for nine months and pasture hay in an 865mm rainfall zone for eight months

	Attribute and storage time	Compressed stacks	Round bales	Stacks of rectangular bales	LSD between subclasses (P = 0.05)
Cereal - 400mm rainfall zone					
	Initial weight (kg)	765	485	622	
Dry matter loss (%)	3 months	10.2	-0.8	2.9	
	6 months	20.2	10.2	7.5	6.8
	9 months	27.3	12.8	12.6	
Digestible dry matter loss (%)	3 months	9.7	-0.1	1.2	
	6 months	18.9	3.7	6.1	9.7
	9 months	26.8	9.1	11.8	
Crude protein loss (%)	3 months	4.0	-2.9	-5.2	
	6 months	20.4	15.9	-0.2	10.6
	9 months	18.9	9.8	2.2	
Pasture - 865mm rainfall zone					
	Initial weight (kg)	737	500	497	
Dry matter loss (%)	4.5 months	13.3	10.0	13.4	8.3
	8 months	20.8	29.7	50.9	
Digestible dry matter loss (%)	4.5 months	17.4	16.9	19.9	8.3
	8 months	22.6	38.5	66.2	
Crude protein loss (%)	4.5 months	12.7	15.3	19.0	ns
	8 months	12.2	26.4	24.0	

DISCUSSION

The cereal hay in experiment 1 was made in the cereal-sheep zone of South Australia where such hay is the main fodder crop conserved (Leonard 1980) for feeding to livestock from mid summer and during winter when the availability of paddock feed is low. In this experiment the sampling times coincided with mid summer (3 months), mid autumn (6 months) and mid winter (9 months). The non-significant loss in digestible dry matter in the round bales during 9 months of storage indicates that storing these bales in the open for feeding through to mid winter may be an economic proposition. Although the small stacks of rectangular bales had lost a significant amount of digestible dry matter by mid winter, the small cost of the hay lost may still render this type of hay storage economical compared with other methods available. Cochrane and Radcliffe (1977) demonstrated that in the same environment there were negligible losses in digestible dry matter when conventional bales were stored under cover so the weight of hay lost during storage in the open can be directly compared with the extra cost of a hay shed and the handling required for stacking the hay under cover. The high loss of digestible dry matter in the compressed stacks of cereal hay was due to wind blowing off the tops during the first month of storage before the tops had settled to form a "thatch". This damage was also recorded in cereal hay by Rowley (1976).

The pasture hay in experiment 2 was made in a high rainfall area where perennial pasture is the major crop conserved as hay (Leonard 1980) for feeding during late summer (4 months after conservation) and during mid winter (8 months after conservation) when the paddock feed available is low. The similarity of the loss in digestible dry matter during summer for both the round bales and the compressed stackssuggeststhat both types of package are suitable for storage in the open for feeding in late summer. However by mid winter, the compressed stacks of pasture hay had not deteriorated as much as the round bales and consequently was a better form of packaging for outside storage. This may be attributed to a higher infiltration of moisture into the round bales than the compressed stacks and thus a significant reduction in the amount and the digestibility of the unweathered hay available for feeding to livestock. The stacks of conventional bales were constructed from bales which were a lower density than would be expected. Consequently the storage data does not represent the deterioration that could be expected with well made bales.

Although the two experiments cannot be directly compared, a number of observations can be made. The compressed stacks of pasture hay did not suffer wind damage probably because they were stored next to a line of trees in a protected gully. This type of site which is often found in this environment, is uncommon in the cereal areas. The higher losses of digestible dry matter in the round bales in the high rainfall area may have been due to the rain soaking well into the tops of the round bales. Lechtenberg et *al.* (1976) concluded that rainfall, humidity and other climatic factors contribute to the losses in large hay packages.

It is concluded that compressed stacks stored in the open require protection against damage by high winds. However, in the high rainfall environment where the compressed stacks were protected, they provided a better form of outside storage until mid winter than round bales. The round bales are, however, becoming more popular because they are of lower weight and easier to transport than compressed stacks. Round bales are suitable for storage in the open until mid winter in the cereal zone but in the higher rainfall areas some alternative method of storage is needed.

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