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DRY MATTER, DIGESTIBILITY AND CRUDE PROTEIN LOSSES FROM HAY MADE AS FODDER ROLLS, ROUND BALES AND RECTANGULAR BALES STORED IN THE OPEN

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Summary

Hay was made into fodder rolls, round bales and rectangular bales from a *Lolium perenne* - *Trifolium subterraneum* pasture. The hay was weighed and sampled immediately after baling, and after storage in the open for three, six and nine months.

In vitro dry matter digestibility and crude protein determinations were made on the samples. Losses during storage were calculated.

It was found that about half the material was lost from each type of bale after storage for nine months, and that fodder rolls had no advantages over the other types of bales. However, it was concluded that the digestibility and crude protein values of the remaining material would still be superior to that of similar pastures conserved as standing crops.

I. INTRODUCTION

In southern Australia, excess spring pasture growth is frequently conserved as hay to supplement subsequent summer, autumn and winter paddock grazing, and to serve as a drought reserve. However, the haymaking process can result in significant fodder losses. Lanigan (1966) suggested that losses of 15 per cent of the dry matter occurred under favourable Australian conditions, and losses of up to 35 per cent would occur when conditions were moderately unfavourable.

The costs of haymaking can be reduced if the hay is stored in the paddock after baling, rather than in a covered shed, but losses are increased, particularly with rectangular bales. However, if rectangular bales are stooked, losses are no more than for unstooked round bales (Lanigan 1966).

Recently, equipment has been developed to roll up a swath of hay into large round bales (fodder rolls) weighing up to 250 kg each. These rolls are stored in the open. Smith (1969) suggested from visual assessment that storage losses of 10 per cent might have occurred from two year-old fodder rolls. However, the precise losses of yield, digestibility and crude protein associated with the field storage of fodder rolls have not been established.

This paper describes an experiment to record the losses from fodder rolls, round bales and rectangular bales when stored in the open for nine months

II. MATERIALS AND METHODS

A factorial randomised block experiment was established with three bale types, four sampling dates and nine replications. The hay was baled at Bordertown, South Australia, from a perennial ryegrass (*Lolium perenne* L.) - subterranean clover (*Trifolium subterraneum* L ssp yanninicum Katzn et Morley cv. Yarloop) pasture on October 27 1970. This date coincided with ear emergence of the perennial ryegrass.

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The mown crop was randomly divided into three areas which were baled either as fodder rolls using an "Econ Fodder Roller" (R. & N. Statham, Newcastle, N.S.W.), as round bales using an "Allis Chalmers Rotobaler" (Allis Chalmers Manufacturing Co., Milwaukee, U.S.A.) or as rectangular bales using a conventional rectangular baler (Massey Ferguson (Australia) Ltd., Sunshine, Victoria).

Immediately after baling, 36 bales of each type were identified with numbered aluminium tags and weighed. Six 500 g samples were taken at random from each of nine bales in each treatment, the fodder rolls and round bales being unrolled, and the rectangular bales being broken open for sampling. The remaining bales were transported to a drained clay rise for open storage, the fodder rolls and round bales being stored singly and the rectangular bales in paired pyramidal stooks each containing five bales. One stook in each pair contained a randomly placed non experimental bale to complete the formation. At three month intervals, a further nine rectangular bales from a pair of stooks, nine fodder rolls and nine round bales were weighed and sampled.

All samples were dried at 90°C for four hours and the dry matter percentage calculated. The samples were then ground in a Wiley mill to pass a 1 mm screen. Duplicate two stage *in vitro* digestibility analyses (Tilley and Terry 1963) and Kjeldahl crude protein determinations were made on the ground samples using the techniques previously described (Radcliffe and Newbery 1968). Losses of dry matter, digestible dry matter and crude protein during storage were calculated, and the data examined by analyses of variance.

Rainfall data during the storage period were taken from the Bureau of Meteorology rainfall station No. 25501-Bordertown Post Office, located 1 km from the storage site.

III. RESULTS

Data are given in Table 1 for the dry matter, digestible dry matter and crude protein percentages of the three types of hay at baling and after storage for three, six and nine months. Significant differences ($P<0.001$) in dry matter percentage were attributable to both bale type and storage time, but differences in digestible dry matter percentage and crude protein percentage were due to the effect of storage time alone.

The losses in dry matter, digestible dry matter and crude protein, expressed as a percentage of the original weights of these components baled, are given in Table 2. There were significant (X0.001) differences due to both bale type and storage time for each parameter.

The cumulative rainfall totals three, six and nine months from the start of the storage period were 165, 312 and 428 mm respectively.

IV. DISCUSSION

The reductions in dry matter digestibility recorded in the first three months of the experiment may have taken place soon after baling when high summer temperatures occurred when the bales were still at a dry matter content near 80 per cent, Under these conditions, losses of soluble carbohydrates may be expected (Greenhill, Couchman and de Freitas 1961). The greatest digestibility losses were recorded from the round bales which also retained the lowest dry matter percentages during the first three months. Lowered digestibility values have been recorded in herbage stored for only 24 hours at 60°C (Noller *et al.* 1966, Cochrane and Brown 1973), a temperature little higher than that which might be recorded on the surface of bales in open storage in summer.

By contrast, the principal crude protein losses did not occur until the hay had been stored for more than three months. This coincided with increasing cumulative rainfall and decreased dry matter percentage in the bales. It is probable that some leaching of soluble nitrogen compounds occurred in this period.

TABLE 1

Percentage dry matter, dry matter digestibility and crude protein for three types of bales after various storage times

	Fodder rolls	Round bales	Rectangular bales
Dry matter %			
At baling	80.9	80.6	78.1
3 mo storage	90.6	85.5	88.9
6 mo storage	78.6	75.5	76.4
9 mo storage	77.5	73.4	70.7
L.S.D. ($P<0.05$) between subclasses=3.4			
Dry matter digestibility %			
At baling	70.4	71.3	71.5
3 mo storage	66.6	62.7	68.4
6 mo storage	65.5	67.3	66.4
9 mo storage	63.6	60.7	63.1
L.S.D. ($P<0.05$) between subclasses=3.9			
Crude Protein %			
At baling	22.4	22.9	22.6
3 mo storage	22.5	23.2	21.5
6 mo storage	17.4	16.3	15.4
9 mo storage	17.0	17.6	16.0
L.S.D. ($P<0.05$) between subclasses=1.4			

TABLE 2

Initial weights of three types of bales, and subsequent percentage yield losses of dry matter, digestible dry matter and crude protein during storage

	Fodder rolls	Round bales	Rectangular bales
Initial bale wt (kg)	136.9	26.5	25.3
Dry matter loss %			
3 mo storage	17.0	26.5	11.6
6 mo storage	25.9	27.6	16.4
9 mo storage	45.0	39.9	47.1
L.S.D. ($P<0.05$) between subclasses = 6.0			
Digestible dry matter loss %			
3 mo storage	21.4	35.2	15.3
6 mo storage	31.2	30.8	20.9
9 mo storage	50.6	48.9	53.1
L.S.D. ($P<0.05$) between subclasses=7.6			
Crude protein loss %			
3 mo storage	16.6	25.4	15.7
6 mo storage	42.5	48.6	43.0
9 mo storage	58.3	53.3	61.4
L.S.D. ($P<0.05$) between subclasses = 7.6			

Despite these changes, the digestibility and protein values obtained during the experiment remained close to those of the material at the time of baling, and would not have fallen sufficiently to impose a severe restriction on animal intake (Blaxter Wainman and Wilson 1961). If the material had been conserved as standing pasture, either with dessicants (Romberg, Pearce and Tribe 1969) or by allowing natural maturation to occur (Radcliffe and Cochrane 1970) the percentage crude protein and digestibility of dry matter values would have been much lower than those recorded from the hay stored in this experiment, and reduced animal production could be expected (Cayley, Bishop and Kentish 1970).

Although having lower moisture absorption at the end of the storage period (Table 1), fodder rolls did not show any advantages over round bales and square bales when stored in the open (Table 2). The loss of half of the nutrients from the fodder rolls over nine months is a far greater loss than the 10 per cent loss after two years previously estimated visually by Smith (1969). Where rainfall is higher or the soil poorly drained, losses could be even higher. Losses from rectangular bales were less than from fodder rolls during the first six months of the trial, but after nine months' storage, the greatest losses were recorded from rectangular bales due to the complete loss by rotting of two of the nine bales sampled at that date.

The farmer has the opportunity of reducing storage losses from round or rectangular bales by protection through stacking in sheds (Lanigan 1966), but this alternative is not readily available with fodder rolls due to their greater size and weight. Hence it would appear that in years when material available for conservation is limited, it is preferable to make hay as either round or rectangular bales for storage in a conventional hayshed. Such years may require earlier feeding back to stock in summer, with reduced opportunities for losses in open storage before feeding begins. However, they will also be the years when the greatest supplementary feeding may be required, and when the farmer can least afford the high losses associated with open storage of hay if the need to reduce stock numbers is to be avoided.

Fodder rolls have a lower cost per weight of fodder conserved than other forms of bales (Smith 1969). However, unless preservatives can be developed for use with fodder rolls, the recorded losses suggest that only in years of pasture abundance would fodder rolls be an acceptable means of conserving excess feed for longer than about three months.

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