FORAGE QUALITY OF ROUND BALES STACKED DIFFERENT WAYS

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SUMMARY

This study evaluated the effects of stacking methods on nutritional quality of stored meadow hay baled in round bales. The first stacking method was pyramid stacks with the bottom row containing three bales; the second method was end-to-end stacks (singles); the third method was one-on-one stacks with the bottom bale positioned on end and the top bale resting on its side on top of the bottom bale. All stacks were uncovered and allowed exposure to weather. Cores of round bales were taken after the first winter of storage and again after the third winter of storage. No differences were seen in nutritional quality after the first year of storage. However, a general trend of decreasing nutritional quality with increasing core depth was noticed in all stacking methods after the third year of storage. Pyramid stacks had the greatest decrease in nutritional quality (as exhibited through an increase in acid detergent fiber [ADF] content) as compared to single stacks and one-on-one stacks after the third year of storage. Acid detergent fiber values increased nearly 10 percent in the pyramid stacks after three years of storage compared to ADF values after only one year of storage and compared to other stacking arrangements (49.90 vs. 40.05 percent, 40.04 and 40.49 percent; pyramid stack second year, pyramid stack first year, single stack second year, one-on-one stack second year, respectively). Thus, in semi-arid regions, stacking arrangements make little differences for the first year of storage. However, careful consideration should be given to stacking arrangements when round bales are to be carried over for the next years.

INTRODUCTION

Putting up hay in large round bales is a popular method of harvesting in the West because of ease of handling and reduced labor costs. With the large quantities of hay produced, inside storage is not economically feasible as in the Midwest and East. However, losses from round bales stored unprotected from weather can result in substantial reductions in quality and quantity of hay (Belyea et al., 1985; Laflame, 1989; Rodriguez et al., 1994). Likewise, round bales stacked for numerous seasons can also undergo large losses of quality and quantity. Additionally, round bales stacked in different arrangements also seem to vary in amount of storage losses. Thus, the objective of this study was to evaluate changes in hay nutritional quality over time and stacking method for round bales stored for several years.

METHODS

Large round bales of meadow hay (1994 hay crop) were baled using plastic twine and stacked in three different arrangements. All stacks were uncovered and allowed exposure to weather. Round bales were stacked in long, end-to-end stacks with spaces between rows (single stacks), in pyramid stacks with the bottom row containing three bales, or in one-on-one stacks, with the bottom bale positioned on end and the top bale resting on its side on top of the bottom bale. Round bales were core sampled for forage quality after the first winter (spring 1995) and again in the spring of 1997. Hay cores were taken at 0-18" and 18"+ in 1995. After sampling began in 1997, it was determined that more sampling depths were needed because of excessive rotting of the outside layers of the bales. Thus, cores at depths of 0-3", 3"-6" and 6"-18" were taken. In 1995, hay cores were taken at the side on the single stacks; at the side on the second row and bottom bales for the pyramid stacks; and at the side of the top bale and at the top of the bottom bale for the one-on-one stacks. Hay cores in 1997 were taken at the top and side on the single stacks, and at the side on the top bale and top and bottom of the one-on-one stacks. Hay cores for the pyramid stacks were taken at the side on the top bale, and on the interior and exterior sides of the second row and bottom bales. Forage quality analysis included crude protein (CP), acid detergent fiber (ADF) and dry matter.

RESULTS AND DISCUSSION

Forage quality analysis showed no differences or trends after the first year of weathering (Table 1). Crude protein values for the pyramid stacks ranged from a low of 6.09 percent for the 0-18" depth for the bottom bale to a high of 7.75 percent for the 0-18" depth for the second row bale. Crude protein values for single stacks were 7.17 percent for the 0-18" depth and 7.26 percent for the 18"+ depth. One-on-one stacks' protein values ranged from a low of 5.96 percent for the top bale at 18"+ depth to a high of 6.96 percent for the bottom bale at the 0-18" depth.

Table 1. Forage quality of meadow hay baled in round bales stacked three different ways and stored for one winter.

		Depth	
		0-18"	18"+
Pyramid Stacks			
2nd row bale	CP	7.75	6.59
	ADF	40.05	41.27
bottom bale	CP	6.09	6.38
	ADF	41.90	42.00
Single Stacks	CP	7.17	7.26
	ADF	40.97	40.02
1 on 1 Stacks			
Top bale	CP	6.71	5.96
	ADF	41.75	41.35
Bottom bale	CP	6.96	6.53
	ADF	39.16	40.44

A general trend was noticed in the 1997 sampling. In general, crude protein and ADF values decreased as the core depth increased for all stack types (Table 2). Although it may appear from the data that the quality increased with age of the stack, visual observations suggest otherwise. Extreme rotting was observed on the inside of the second row and bottom bales of the pyramid stacks. Crude protein values for the inside of the second row bales ranged from 11.41 percent at the 0-3" depth to 7.26 percent at the 6-18" depth. Additionally, ADF values ranged from 49.90 percent at the 0-3" depth to 39.39 percent at the 6-18" depth. These data suggest, along with visual observations, that excessive moisture accumulation occurred between bales. Likewise, the remainder of the samples taken on the pyramid stacks exhibited the same general trend. Forage quality of the single stacks suggest less weathering and better runoff of moisture occurred. Crude protein values ranged from 7.39 percent at 0-3" to 5.65 percent at 6-18" for the top bale. Samples taken at the side of the bale showed crude protein values ranged from 8.59 percent at the 0-3" depth to 6.59 percent at the 6-18" depth. Forage quality data from one-on-one stacks also suggest that less weathering and better moisture runoff occurred compared to the pyramid stacks. Again, the same general trend was also exhibited in the one-on-one stacks. Crude protein and ADF values decreased slightly as core depth increased for the top bale. However, forage quality samples taken from the top and bottom of the bottom bale showed an increase in crude protein at the 3-6" depth as compared to other depths (8.21% at 3-6" vs. 7.52% at 0-3" and 7.75% at 6-18"). Likewise, ADF values also exhibited a slight numerical increase at the 3-6" depth (41.84% at 3-6" vs. 39.06% at 0-3" and 40.26% at 6-18"). Hay cores taken from the bottom of the bottom bale of the one-on-one stack showed an increase in crude protein at the 3-6" depth, but no increase was seen for ADF values at the same depth.

CONCLUSIONS

Forage quality data from 1995 indicate that in semiarid regions, how round bales are stacked makes little difference in nutrient quality if the bales are fed during the year following stacking. However, in years of above average precipitation, some losses in weight and forage quality can probably be expected. When carried over for the next year, stacking method becomes critical.

Just looking at the nutrient quality data in the tables can be confusing as hay near the surface actually had a higher crude protein content than hay in the interior of the bale. Actual observation of the hay stacked by the different methods clarifies the picture. Single rows showed external weathering on the top and sides. The one-on-one stacks had weathering on the top of the top bale and bottom of the bottom bale. This weathering caused some loss of nutrients expressed as an increase in ADF. Acid detergent fiber is a measure of the fibrous portion of the hay: higher ADF levels mean poorer digestibility. When the pyramid stacks were taken apart for sampling, large areas of rot were observed where each layer of bale touched the next layer down. Water obviously ran down the bale and collected in the areas where the bales touched. The highest levels of ADF occurred on the inside of the stack. The most affected row was the middle one, where ADF decreased 10 percent from the outside of the bale compared to 6 to 18 inches inside.

The confusing measure of forage quality is the crude protein data. Crude protein is a measure of total nitrogen multiplied by 6.25. Crude protein levels were high in the weathered portions and highest in the rotted portions of the hay. The rotted portions had molded severely causing the rot. The mold digested the hay and accumulated nitrogen as part of the mold itself and that is what we measured with our crude protein analysis. High nitrogen contents are typical of molded forage samples: the true crude protein content of the hay is found in the samples taken from the internal portion of the bale.

We did not weigh the hay at the beginning and end of the study so cannot judge the amount of dry matter lost per bale. Other workers have reported losses in dry-matter content because of leaching of soluble materials and digestion by mold organisms. Dry matter losses are higher for hay containing alfalfa compared to grass hay and for stacked bales compared to single row.

Our work suggests that if the hay is to be used in the winter season after cutting and stacking, type of stack may not be important in semiarid areas. Stack yard space is usually a consideration. The hay to be fed first could be pyramid stacked and that fed last single rowed or on-on-one stacked. An arrangement like this would decrease area needed for stack yards and still minimize losses. Any hay to be carried over should be single row or one-on-one stacked. If moisture can collect in the stack yard area, the one-on-one may not be advisable as the vertical bale may have a tendency to wick water up the bale. In wet years moisture running off the top bale may cause significant damage to the bottom bale.

Other considerations include alignment of the stack with the prevailing wind to prevent snow drifting between the stack rows and making sure stack yards are on high ground and sloped to the edges to facilitate drainage. Proper adjustment of the baler to insure tight bales is also suggested.

LITERATURE CITED

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Table 2. Forage quality of round bales stacked three different ways and stored for several years uncovered.

Stack Sampling depth (in)	Crude Protein[1]	ADF[2]
Pyramid		
Top Bale	9.14	41.52
Top Bale	8.35	39.60
Top Bale	6.79	38.89
2nd row inside	11.41	49.39
2nd row inside	7.97	44.31
2nd row inside	7.26	39.83
2nd row outside	10.4	41.90
2nd row outside	8.45	41.28
2nd row outside	8.03	39.39
bottom row inside	10.82	43.88
bottom row inside	10.14	44.73
bottom row inside	8.17	41.15
bottom row outside	10.05	41.88
bottom row outside	8.46	39.62
bottom row outside	7.39	38.83
Single		
Top	7.39	40.04
Top	6.65	38.07
Top	5.65	39.08
Side	8.59	43.34
Side	6.94	42.56
Side	6.59	37.81
1-on-1		
Top bale	7.78	40.49
Top bale	7.04	39.76
Top bale	6.67	38.64
Bottom bale	7.52	39.06
Bottom bale	8.21	41.84
Bottom bale	7.75	40.26
Bottom bale bottom	8.12	44.02
Bottom bale bottom	8.41	40.66
Bottom bale bottom	7.38	37.95

[1] CP: crude protein; [2] ADF: acid detergent fiber