Bale Density Effects on Baleage Quality

This Research Spotlight examining bale density and its effect on baleage quality confirms attention to forage maturity, moisture, timely wrapping and density result in quality baleage.

Baleage is a fermented forage in a large bale package that allows producers an opportunity to harvest high quality forage at greater moisture levels than dry hay. Baleage can have several advantages over dry hay but also poses some production challenges.

Keys for Successful Baleage Production

The chances of successful baleage production can be increased by applying best management practices. Some management practices that will help ensure optimum quality baleage include:

1. Bale at Proper Moisture Content

Proper moisture levels at baling ensure that fermentation will occur after the bale is wrapped and oxygen is eliminated from the bale. Generally, the optimal moisture for baleage is between 45-60%.

Moisture (%)	Fermentation	Management Practice
<30%	Possible, but not ideal for fermentation. Some mold growth could occur	Add at least 2 more layers of wrap to ensure oxygen exclusion
30-45%	Possible, but not ideal for fermentation. Some mold growth could occur	Add at least 2 more layers of wrap to ensure oxygen exclusion
45-60%	Ideal for baleage production and fermentation	Wrap bales with at least 6 layers of 1 mil polyethylene plastic film
60-70%	Possible, but the high levels of moisture can result in spoilage and low palatability	Add at least 2 more layers of wrap to ensure oxygen exclusion
>70%	Too wet for proper fermentation; baleage production is not recommended	Wait for the forage to dry down further before baling

Figure 1. Moisture levels of forage and subsequent management practice in accordance with bale moisture at baling.

2. Mow at Correct Stage of Forage Maturity

As forages mature, the nutritive value of the forage declines (Figure 2). Low quality forage for the class of livestock to be fed cannot be corrected through fermentation. It is essential to harvest baleage at the correct stage of maturity in accordance to the species and class of livestock that to be fed. If the highest quality feed is essential, earlier in the growth period would be ideal. However, if yield is a priority, harvesting later in the growth stages would be ideal.

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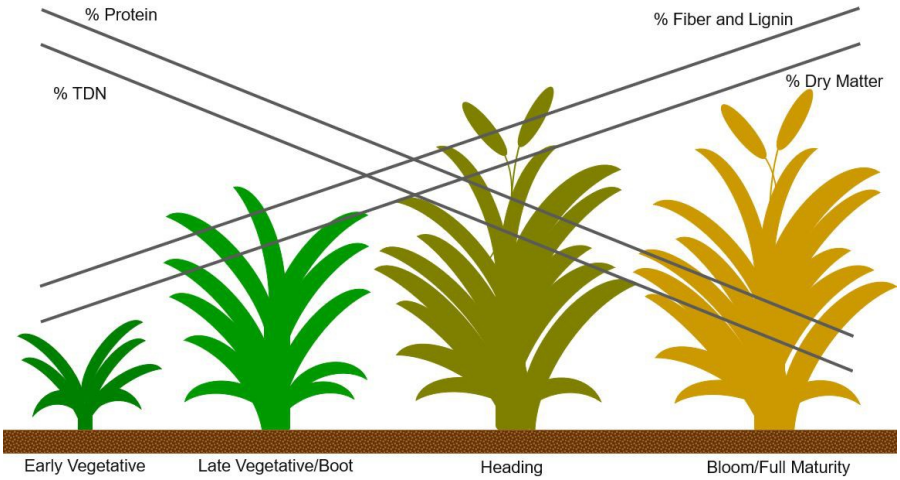

Figure 2. Forage nutrient values and composition changes as stage of maturity changes.

3. Wrap the Bale as Soon After Baling as Possible

Ensuring the internal bale temperature does not exceed 120°F helps ensure the available protein is optimal. The elimination of oxygen from the bale as quickly as possible after baling is the best management practice to ensure the internal bale temperature is kept lower than 120°F. The correct number of plastic layers (wraps) is also paramount to keeping the bale temperature as low as possible and eliminating oxygen quickly to initiate the fermentation process by anaerobic bacteria. A minimum of 6 wraps (6 layers of 1 mil plastic) should be applied to each bale, but 8 wraps is preferred.

4. Make the Densest Bale Possible

Experimental Methods

A study evaluating the effects of bale density on baleage quality and bunk life was conducted at the Pennsylvania State University's Russell E. Larson Agricultural Research Center. This study evaluated four different balers set to bale at maximum density traveling at 3 different speeds – 4, 8, and 12 mph. Bales were wrapped within 4 hours after baling at a minimum of 6 mil of wrap on each bale, ensuring the elimination of oxygen and an internal temperature below 120°F. Thermocouples were inserted into the bales 4h after wrapping to monitor internal temperature for the duration of the study. After 28d, bales were unwrapped, and forage samples were collected from each bale to determine forage nutritive value. Bales were then allowed to sit in the external environment and internal temperature was monitored until bales reached 2°F warmer than their baseline temperature at the time of unwrapping, at which point the bale was considered spoiled and unfit to feed.

Results and Discussion

Across all balers and speeds, results indicated that bale density directly impacts baleage quality. The greater the bale density, the lower the pH and sugar content of the fermented bale. This indicates proper fermentation of the sugars available under anaerobic conditions. As forages ferment, anaerobic bacteria convert sugars to acids as a byproduct of the fermentation process. A low pH is desired in any ensiled forage as this is an indicator of proper fermentation and stabilization of the forage as long as oxygen is eliminated (Figure 3).

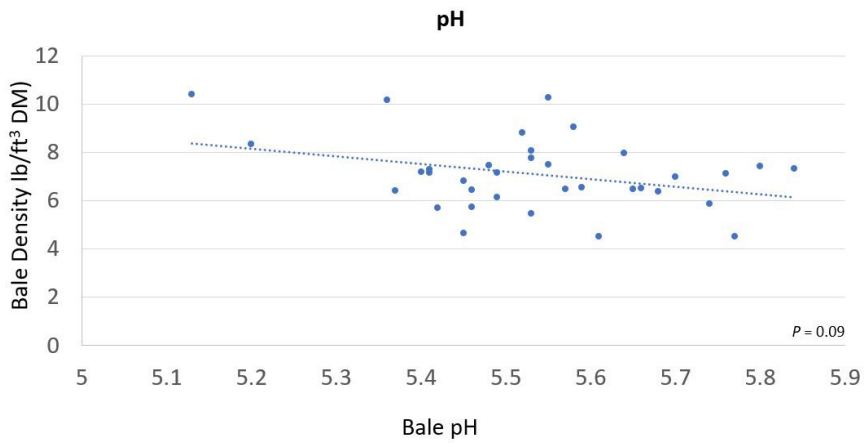

Figure 3. Baleage pH decreases as bale density increases, indicating proper fermentation and prolonged stability of the forage.

Total acid production, including lactic and acetic acids, were greater in bales with greater densities. Greater acid production is desired in ensiled forages because it ensures the stabilization of the forages and indicates better forage quality and feeding value of the fermented forage. As bale density increased, lactic acid, acetic acid, and total acid percentages increased.

Whole bale bunk life is increased as the density of the bale increases. A bale is considered spoiled when it reaches 2 degrees F above the baseline temperature of the bale. At the point of spoilage, it is no longer suitable for livestock consumption. Results indicate as density of the bale increases, the longer that forage can sit in a feeder without spoiling or becoming unfit for livestock to eat (Figure 4).

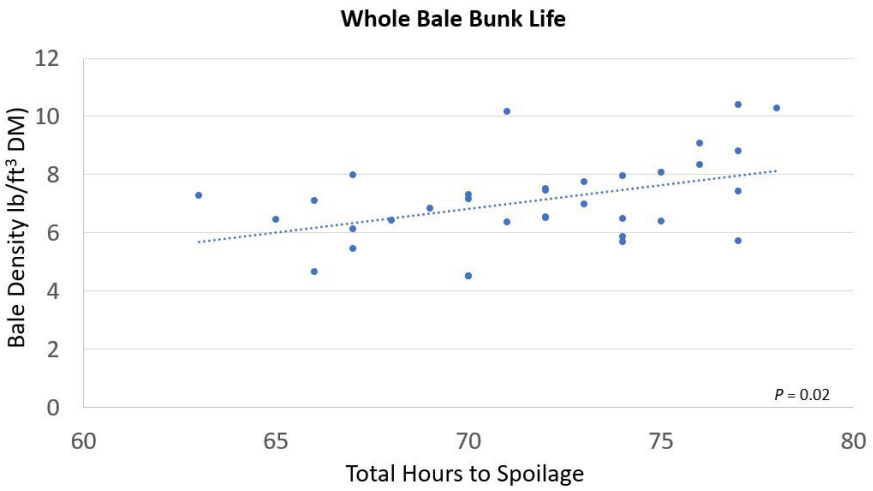

Figure 4. Whole bale bunk life increases as bale density increases, prolonging the quality of the bale and longevity of the feed in bales with greater density.

Conclusions

Best management practices for baleage production can ensure that the highest quality forage is being produced. By ensuring the forage is harvested at the correct stage of maturity, baled at the correct moisture, wrapped quickly, and baled at the maximum density setting on the baler, optimal forage quality can be achieved! Baling at the maximum density setting can help ensure proper fermentation of the baleage, improving feeding value and prolonging bunk life.

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