Comparison of strategies to remoisturize alfalfa in the windrow for baling

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Introduction

Having the correct amount of moisture in harvested alfalfa at the time of baling is critical to maximizing economic return. In many of the areas of the western U.S., moisture levels of alfalfa hay in the windrow can dry to the point that leaves and stems will shatter during the baling process. As a result, producers typically bale at night and early morning, relying on dew to provide needed moisture. The drawback to this strategy is the window at time of baling can be short and, often, unpredictable. In recent years, equipment that injects moisture into the windrow during the baling process has created an option for producers to bale when natural dew is not present. The purpose of this study was to test two different technologies to remoisturize alfalfa in the windrow and their effect on yield, quality, and economic return.

Materials and Methods

Studies were conducted in two cuttings during the 2020 growing season on a producer's farm near Milford, UT. The farm has two Staheli Dew Point steamers in use and many alfalfa fields under pivot irrigation. Alfalfa stands had good density and vigor and were well managed in terms of weed and insect control, soil fertility, and irrigation. During 2nd and 3rd cutting, alfalfa was cut and conditioned according to normal practice on the farm. Several days later, fields were raked in the morning with dew to prevent leaf loss. In raking, two windrows were combined into a single large windrow between 1.5 to 1.75 tons/acre. A different field was used for each cutting due to the difficulty in predicting the speed of alfalfa dry down and the need to coordinate the logistics of the experiment several weeks in advance.

The experiment took place in the evening of the day that the field was raked. The dates were July 14 (2nd cutting) and August 12 (3rd cutting). Treatments included four different remoisturizing methods: 1) steamer (Staheli West Dew Point applying 95% steaming capacity), 2) treat and bale (Harvest Tec Dew Simulator treating at 16 GPM), 3) treat and wait (Harvest Tec Dew Simulator treating at 18 GPM), and no treatment (dry). Treat and bale consisted of baling approximately 5 seconds after treating with the Dew Simulator. Treat and wait consisted of baling approximately 10 minutes after treating. Baling for both harvests occurred between the hours of 9 pm and 1 am with wind speeds averaging 8 mph. The hay was baled with a 3x4 AGCO baler equipped with a Dew Point steamer and maintained 45 to 50 flakes per bale at an average speed of 8 mph. The same baler was used for all treatments but the steamer was only used to treat the windrow for its designated treatment. The four treatments were randomly assigned to windrows within a single pivot span. After those four windrows were baled, the treatments were re-randomized and applied to windrows in a second pivot span. Five to 7 bales were made of each treatment; the first 2-4 bales made were not included in the evaluation to allow for pre-run adjustments. Three consecutive bales from each run were then tagged for later identification and coring.

A total of 6 bales were evaluated per treatment (2 runs x 3 bales). Bale moisture was recorded from the Gazeeka moisture meter on the baler. The following morning, the moisture of each bale was measured with a Delmhorst moisture probe. Individual bales were sampled following the NFTA recommendations for coring (a composite of 6 cores, three per end on a diagonal) and run thru NIR analysis at Dairyland laboratory to test fiber (NDF and ADF), relative feed value (RFV), and crude protein. The length of windrow that it took to make each bale was marked and measured. The area required to make each bale was calculated as the length and width represented by the hay in the windrow. Bales were individually weighed on an electronic scale. The measured area and bale weight were used to calculate yield. Statistical analysis was conducted by ANOVA using ARM and means separated using the LSD method at P=0.10.

Results and Discussion

In both cuttings, moisture was higher in treated bales than those baled dry (Tables 1 and 2). Differences in moisture between those windrows which received the moisture treatments were inconsistent. As would be expected, the weights of treated bales were generally higher than the control (dry). Within treatments, bales from the steamer were heavier than those of the treat and wait in both cuttings, but the steamer was not different from the treat and bale in first cutting and was different in second. In first cutting, higher bale moisture under all remoisturizing treatments translated into higher yields on a per acre basis compared to the untreated control (dry). In second cutting, no differences were measured between bales made from dry or remoisturized hay. When moisture was removed and yields expressed on a dry matter basis, no statistical differences were measured between any of the treatments. The lack of difference in dry matter yield was surprising due to expected losses due to leaf and stem shatter by baling alfalfa with a moisture content of around 8%. Perhaps this is due to the ability of modern balers to handle such a large amount of hay so quickly that a large percentage of the shattered alfalfa is still able to be captured and packaged into the bale. It is important to note that bales produced with both the Dew Point and Dew Simulator (leaves intact and attached) had a much better appearance than those baled dry (shattered leaves and stems, dusty) and would appeal to hay buyers (Figures 1-3).

No differences in forage nutritive values were detected in this study (Table 3). Although numerically, the dry bales trended toward lower quality (lower CP and RFV, higher ADF and NDF), the differences were not statistically significant. The fact that the lack of moisture during baling did not adversely impact forage quality is surprising. This suggests that, although shattered and unattached, the leaves in the dry bales were largely captured during the bailing and coring process. The visual appearance of the bales produced using moisturizing systems may influence marketing, but that evaluation was not made in this study.

Table 1. Bale moisture, bale weight, yield of alfalfa of 3 x 4 ft bales treated with different technologies to remoisturize alfalfa windrows during second cutting near Milford, UT in 2020.

	Bale			Yield	
Treatment	**On-Baler Moisture Meter**	**Hand-Held Moisture Probe**	**Weight**	**With Moisture**	**Dry Matter**
	---------------------%-------------------		lb	-----------Ton/acre------------	
Steam	13.0 b[a]	11.2 b	1473 a	1.47 ab	1.28
Treat and bale	14.1 a	12.3 a	1443 a	1.54 a	1.32
Treat and wait	12.5 c	10.5 b	1400 b	1.53 a	1.34
Dry	8.3 d	9.2 c	1333 c	1.39 b	1.27
LSD	0.5	0.8	34	0.1	NS[b]

[a] Numbers in the same column with the same letter designation are not statically different (P=0.10)
[b] Not statistically different

Table 2. Bale moisture, bale weight, yield of alfalfa of 3 x 4 ft bales treated with different technologies to remoisturize alfalfa windrows during third cutting near Milford, UT in 2020.

	Bale			**Yield**	
Treatment	**On-Baler Moisture Meter**	**Hand-Held Moisture Probe**	**Weight**	**With Moisture**	**Dry Matter**
	--------------------%------------------		lb	-----------Ton/acre------------	
Steam	12.3 ab[a]	11.3 a	1507 a	1.29	1.14
Treat and bale	12.7 a	12.2 a	1443 b	1.34	1.17
Treat and wait	11.7 b	11.9 a	1423 bc	1.33	1.18
Dry	7.6 c	8.0 b	1390 c	1.26	1.16
LSD	0.7	1.2	41	NS[b]	NS[b]

[a] Numbers in the same column with the same letter designation are not statically different (P=0.10)

[b] Not statistically different

Table 3. Crude protein, ADF, NDF, and RFV of 3 x 4 ft bales treated with different technologies to remoisturize alfalfa windrows over two cuttings near Milford, UT in 2020.

Treatment	Protein		ADF		NDF		RFV	
	2nd cut	3rd cut	2nd cut	3rd cut	2nd cut	3rd cut	2nd cut	3rd cut
	-----------------------------------%-----------------------------------							
Steam	21.90	21.84	30.00	31.44	37.78	39.22	161.6	152.7
Treat and bale	22.15	22.08	29.76	31.41	37.49	38.84	163.1	154.6
Treat and wait	22.06	22.16	29.86	31.35	37.47	38.88	163.0	154.5
Dry	21.66	21.77	30.08	32.00	38.06	39.88	160.1	149.5
LSD	NS[a]	NS	NS	NS	NS	NS	NS	NS

[a] Not statistically different

Economic Analysis

The economic analysis of these different remoisturizing alfalfa technologies utilizes only variables that are statistically significant. In this analysis, bale weight was the variable that was found to be statistically significant. The average bale weight from the two cuttings for the dry bale was 1,361.5 lbs., the Dew Simulator was 1,443, and the Steamer was 1,490. The Dew Simulator averaged an 82 lb. difference and the Steamer a 129 lb. difference in bale weights. Based on the trial data which averaged 1.79 bales per acre, we estimate that the Steamer will have an additional 258 lbs. per acre and the Dew Simulator an additional 217 lbs. per acre.

Understanding Partial Budgeting

Partial budgeting is a decision tool to help analyze financial impacts of changes to an operation. Partial budgeting only includes resources that will change such as adding remoisturizing technology in an alfalfa operation. The cost of baling will remain fixed and the financial impact of including remoisturizing technology will be analyzed. The four key components to a partial budget are increased income, reduction or elimination of costs, increased costs, and reduction or elimination of income. The net impact will be the positive changes minus the negative changes. Table 1 helps to identify these changes.

Table 4. Partial Budget Categories

Added Income:	**Added Costs:**
Increased bale weights from incorporating steam technology. Steamer: Additional 258 lbs. per acre Dew Simulator: Additional 217 lbs. per acre Additional income = Additional lbs. per acre * hay price	Increased costs are associated with including the steam technology. Steamer: Annual Ownership cost + Operating Cost = Total Cost Dew Simulator: Annual Ownership cost + Operating Cost = Total Cost

Annual ownership cost is estimated by utilizing the capital recovery method. The capital recovery method utilizes the purchase price, salvage value, useful life, and a discount rate to estimate the annual ownership cost. The discount rate represents the opportunity cost of capital and accounts for owning the piece of equipment over multiple future periods. The operating cost is estimated by utilizing the fuel used per hour, labor cost, and repair costs on an annual basis. Utilizing the information from Table 1, we can analyze the net financial impact assuming 1,000 acres of alfalfa, a fuel price of $2.50/gallon, and an alfalfa price of $200/ton.

Table 5. Economic Analysis Summary Table

Steamer Annualized Cost of Ownership	$44,170.59
DS Annualized Cost of Ownership	$14,608.49
Total Steam Operating Cost	$12,600.00
Total DS Operating Cost	$7,066.67
Total Baling Cost	$39,040.00
Total Cost Steam	$56,770.59
Total Cost DS	$21,675.15
Steamer Benefits per Acre	$25.78
DS Benefits per Acre	$21.70
Steamer Costs per Acre	$14.19
DS Costs per Acre	$5.42

Steamer Net Benefits per Acre	$11.59
DS Net Benefits per Acre	$16.28

These numbers are based on one certain scenario so caution must be used when drawing specific conclusions from them. The Steamer has a higher ownership cost which drives the cost per acre up. This cost is reduced as the number of acres increases. These results also assume that both steam technologies are utilized over 100% of the acres. Decreasing the usage will impact the results for both technologies. A producer should utilize the partial budgeting methodology to analyze the results for their specific operation.

Conclusion

In this study, both technologies tested to remoisturize alfalfa hay were successful in increasing bale weight. The weight increase was due to increased moisture content in the bale and not an increase in dry matter yield. Forage nutritive values of individual bales were not improved by remoisturizing hay in the windrow. The visual appearance of the bales produced using moisturizing systems compared to those baled dry were much more attractive and may influence marketing, but that evaluation was not made in this study. A partial budgeting strategy can be used to analyze the potential return of these technologies, the results of which will depend on the size and needs of a specific operation. It is important to note that the data presented in this report represent only two cuttings and a single year. Additional data generated in the years to come will help to refine these results so that they are repeatable over space and time.

Figure 1. Bale produced while using a Staheli West Dew Point steamer.

Figure 2. Bale produced while using a Harvest Tec Dew Simulator.

Figure 3 Bale produced without added moisture.