



# Different Ratios of Alfalfa Hay to Corn Silage on Lactation Performance of Holstein Dairy Cattle



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## RATIONALE & OBJECTIVES

- Alfalfa and corn silage are the predominant forages fed to dairy cattle in the US, although production of corn silage is increasing while alfalfa has declined.
- Intensification in the dairy industry has driven greater reliance on corn silage at the expense of soil carbon, and benefits of alfalfa for soil health, N fixation, and sustainability may not always be valued appropriately.
- Alfalfa and corn silage are nutritionally complementary forages due to their differing fiber characteristics, protein content and degradability, lysine content, and starch content and fermentability.
- Potential exists to optimize their ratio within a lactation diet to boost rumen microbial protein production and milk component output.
- Economic, environmental, and social considerations are encouraging use of higher fiber, higher forage diets and we need to reconsider alfalfa for ration formulation and nutrient planning programs.

### Objectives:

Identify the ratio(s) between dietary alfalfa and corn silage that optimize the output and production efficiency of milk true protein and milk fat in Holstein cows.

## RESEARCH DESCRIPTION

- 105 cows (45 primiparous, 60 multiparous), 2 enrollments, were used in a randomized complete block design study with 1-wk covariate and 4-wk experimental period.
- Five total mixed rations were fed with 62% forage (dry matter basis) and 5 ratios of alfalfa to corn silage (photo of diets in Figure 1):
  - 10:90
  - 30:70
  - 50:50
  - 70:30
  - 90:10

**Figure 1.** Total mixed rations containing 5 ratios of alfalfa hay to corn silage.



- Alfalfa hay was chopped with a Haybuster forage processor (3-and 2-inch screens), and diets were formulated to provide similar metabolizable energy and protein. Composition of the alfalfa and corn silage is shown in Table 1. Dietary ingredients and nutrient composition are summarized in Table 2.

**Table 1.** Composition of the alfalfa hay and corn silage fed in the study.

	Alfalfa hay	Corn silage
Dry matter (DM), %	89.3	31.6
Crude protein, % of DM	21.7	9.0
aNDFom <sup>1</sup> , % of DM	34.1	37.4
30-h NDF digestibility, % of NDF	39.7	52.0
Acid detergent lignin, % of DM	6.3	3.0
Starch, % of DM	3.4	35.8
7-h starch digestibility, % of starch	---	61.3
Sugar, % of DM	8.0	0.7

<sup>1</sup>Neutral detergent fiber measured using amylase and reported on organic matter basis.

**Table 2.** Dietary ingredients and nutrient composition for diets differing in ratio of alfalfa and corn silage.

Ingredients	Alfalfa-to-corn silage ratio (DM basis)				
	10:90	30:70	50:50	70:30	90:10
Corn silage	56.4	43.5	31.0	18.6	5.7
Alfalfa hay	5.7	18.6	31.0	43.4	56.4
Concentrate	37.9	37.9	38.0	38.0	37.9
Diet composition					
Dry matter (DM), %	45.0	50.0	52.5	59.4	60.4
Crude protein, % of DM	15.7	15.6	16.4	17.1	17.6
aNDFom <sup>1</sup> , % of DM	30.6	29.3	28.3	26.7	25.5
Starch, % of DM	26.5	27.9	26.3	26.2	26.0
Sugar, % of DM	5.6	5.3	5.6	5.6	5.6
Fat, % of DM	5.1	4.6	4.6	4.9	4.6

<sup>1</sup>Neutral detergent fiber measured using amylase and reported on organic matter basis.

- Water was added to the 50:50 (8% as fed), 70:30 (10% as fed), and 90:10 diets (25% as fed) to keep all rations within a range of moisture content typically seen in practice.
- Cows were housed in a pen with sand-bedded free stalls, milked 3x/day, and milk composition was measured from six consecutive milkings weekly. Dry matter intake and milk yield were measured daily. Rumination was monitored and recorded every 2 hours and was summarized daily.

## RESULTS

- Varying the ratio of alfalfa to corn silage from 10:90 to 90:10 did not affect dry matter intake, energy-corrected milk, or efficiency of milk production (Table 3). *High levels of dairy performance can be obtained over a wide range of alfalfa to corn silage ratios in the diet.*

**Table 3.** Feed intake and milk yield for varying ratios of alfalfa to corn silage.

	Alfalfa-to-corn silage ratio (DM basis)				
	10:90	30:70	50:50	70:30	90:10
Dry matter intake (DMI), lb/d	58.0	58.7	58.9	59.1	58.2
DMI, % of body weight	3.82	3.85	3.86	3.91	3.91
Energy-corrected milk (ECM) yield, lb/d	105.6	107.4	106.3	103.6	106.5
ECM/DMI, lb/lb	1.82	1.83	1.81	1.76	1.83

- Changes in milk true protein output and milk urea nitrogen indicate *an optimal ratio of 30:70 to 50:50 of alfalfa to corn silage*, likely reflecting greater microbial protein synthesis for these diets (Table 4).

**Table 4.** Milk composition for varying ratios of alfalfa and corn silage.

	Alfalfa-to-corn silage ratio (DM basis)				
	10:90	30:70	50:50	70:30	90:10
Fat, %	4.08	4.06	4.02	4.01	4.22
Fat, lb/d	3.97	4.01	3.95	3.86	4.04
True protein, %	3.01	3.07	3.01	3.02	3.05
True protein, lb/d <sup>a</sup>	2.93	3.02	2.98	2.89	2.93
MUN, mg/dl <sup>b</sup>	9.8	8.5	10.4	11.0	12.0
De novo FA, g/100 g FA <sup>b</sup>	24.76	25.86	25.82	25.22	25.58
Rumination time, min/d <sup>c</sup>	499	477	462	449	396

<sup>a</sup>Significant cubic effect ( $P \leq 0.05$ ); <sup>b</sup>Significant quadratic effect ( $P \leq 0.05$ ); <sup>c</sup>Significant linear effect ( $P \leq 0.05$ ).

- Milk fat and milk true protein content were in desirable ranges for all diets.
- The de novo fatty acid content of the milk fat was greatest for the 30:70 and 50:50 diets indicating that these diets contributed to rumen conditions that enhanced fiber fermentation.
- These results agree with previous research that concluded that avoiding extremes in either alfalfa or corn silage content results in best lactation performance.

## CONCLUSIONS

- Higher alfalfa to corn silage ratios may be fed than is commonly practiced within the US dairy industry with an *optimal combination of approximately 30:70 to 50:50 alfalfa to corn silage (equivalent to 20 to 35% of dietary dry matter as alfalfa)* to maximize milk component yield for 62% forage rations.
- Factors in addition to response to diet will determine optimal amounts of corn silage and alfalfa grown or purchased and fed on a farm. These factors include: cost of production for alfalfa versus corn silage, agronomic considerations and water usage, variability in nutrient profile across cuttings, and relative costs of protein sources and other feed ingredients.
- Sustainable dairy-forage programs could include a higher alfalfa to corn silage ratio than is commonly fed in the US dairy industry.*