A STUDY OF METHODS USED BY FARMERS IN DETERMINING OPTIMUM CONDITIONS FOR BALING ALFALFA HAY AND THE EFFECT OF THESE METHODS ON THE QUALITY OF HAY

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INTRODUCTION

There is believed to be no rapid practical test that farmers can use to determine the optimum moisture content of alfalfa hay for baling. Farmers have gained experience by making observations over a span of many years with regard to the proper conditions under which hay can be baled or stored safely. Often the quality of hay is injured by overcuring as a result of farmers' attempting to avoid the danger of spoilage due to undercuring. Furthermore, the quality of the hay is lowered when the producer disregards the fundamental principles of good haymaking.

It is generally agreed that millions of dollars are lost annually as a result of growers being unfamiliar with certain important principles involved in the production of high quality hay. In addition it has been estimated that the yearly losses in this country through farm fires caused by spontaneous combustion of hay have been as high as $30,000,000. The greater part of this huge loss is due to the storage of hay containing an unsafe amount of moisture. Most of these losses can be avoided and the quality of hay improved by cutting at the right stage and by proper curing, handling, and storage.

Although high grade alfalfa hay always has commanded premium prices, much of the hay marketed today is of low quality. The full value of alfalfa hay was not appreciated by the feeder until recent shortages of proteinaceous feeds. Now feeders are generally recognizing the importance of green color, vitamins, and leafiness which are associated with high grade hay.

Hay probably varies more in quality than any other harvested crop grown on American farms. In the same locality and under almost identical conditions, there may be wide differences in the quality of hay. This variation is due largely to the fact that there is a tendency among farmers to give less attention to the hay crop than to cash crops such as cotton, corn, and wheat that require attention during haying time. Where time is not the limiting factor the quality of any hay crop is largely dependent upon the farmer's knowledge of haymaking practices and the care he exercises in the curing, handling and storing of the crop.

The climatic conditions in Oklahoma afford excellent opportunities for the production of high quality alfalfa hay, since alfalfa escapes much of the drouth by producing its forage in spring and early summer.

Alfalfa is one of the principal hay crops in the United States and has been one of the major agricultural crops in Oklahoma for many years, yet it has received less attention with regard to experimental and research work than other important crops.

The objectives of this investigation were to study the causes of the wide variation in hay quality and the uncertainties of the methods employed by farmers in producing alfalfa hay and to make recommendations as to the most desirable method to be used in the production of high quality alfalfa hay.

REVIEW OF LITERATURE

Optimum moisture content for storing alfalfa hay

The methods used by most farmers in determining the moisture content of alfalfa hay appear to be too variable to insure production of good quality hay that will not spoil or lose much of its green color and nutritive value while in storage.

Hay that is allowed to remain in the field after being fully cured loses color and leaves. Henson (4)[/1] reported that in one community in Iowa the moisture content of samples taken from hay being baled varied from 14 to 42%. He found that 30% was the maximum moisture content at which hay could be stored without loss of green color. McClure (12), working in Illinois, found that samples of supposedly cured hay which were taken from farmers' barns at the time of storage contained from 15.1 to 33.1% moisture. He reported that hay with 25% moisture could be stored satisfactorily if precautions were taken to provide ventilation.

Lewis and Willard (11), working in Ohio, found that hay bearing external moisture from rain or dew appeared to develop higher temperature in storage than hay with a similar amount of natural moisture. After the hay was placed in the mow, they found the optimum time for baling was when it was "coming out of the sweat" and had soft stems and clinging leaves. Lewis and Willard stated that field baled hay must be decidedly drier (probably as low as 22% moisture) than hay that is stored in a mow. Kiesselbach and Anderson (9) concluded that 30%

/1 Figures in parenthesis refer to "Literature cited", p. 19.

was the maximum moisture content at which hay could be stored safely in Nebraska. They found that the moisture content of hay sufficiently cured for storage averaged 23%.

Parker and Hosterman (16) of the United States Department of Agriculture found that newly mown alfalfa had a moisture content of 70% or more and thoroughly air-dried hay about 12%. They stated that alfalfa hay is ordinarily dry enough to bale safely when the moisture content has been reduced to 25%. Kreizinger and Law (10), working under Washington conditions, found alfalfa hay must contain not more than 25% moisture to be stacked without undue danger of spoilage.

Hienton and Hilton (6), working in Indiana, concluded from three years' observations that hay did not heat enough to destroy the green color if it did not have more than 19% moisture when stored. Hay with 20 to 30% moisture browned badly while hay with 30% or more moisture was classed as sample grade.

Dexter, Sheldon and Rose (2) reported that in Michigan immature hay holds more moisture at any given relative humidity than mature hay, and hay which is stored in relative humidities greater than 85% will must or mold regardless of the moisture content.

Methods used in determining proper conditions for baling

Little information is found in the literature with reference to a quick determination of the moisture in alfalfa hay as it is being stored or baled. Farmers have always used rule-of-thumb methods in determining when hay is cured sufficiently for storage.

Arny (1), McRostie and Hamilton (13), Vinall and McKee (22) and Odland and Garber (14) reported a method of determining moisture content of hay by piling lots of hay on canvas to simulate field methods of curing. These lots of hay were weighed at intervals and the losses in weight were used to approximate the moisture content of hay in the field.

Kiesselbach and Anderson (8) placed bags of hay in the windrow and swath and by weighing these at various intervals were able to approximate the moisture content of hay under field conditions in Nebraska. Parker (15), of the United States Department of Agriculture, reported that the proper condition for stacking or baling may be determined when the alfalfa leaves are dry and the stems show only slight toughness when twisted. Grandfield and Throckmorton (3) reported that in Kansas alfalfa hay with dry leaves and slightly tough stems contained about 25% moisture and could be safely stacked or baled.

Kreizinger and Law (10) reported from experiments conducted in Washington that hay is dry enough to stack or bale if no moisture can be forced out of the hay by tightly twisting a handful together. Lewis and Willard (11) found that in Ohio, the best way to determine when alfalfa is ready to bale is to twist a wisp of hay in the hand. If the twisted hay is tough and there is evidence of moisture where the stems are broken, the hay is considered unsafe for storage. If the stems are slightly brittle when broken and there is no evidence of moisture when the stems are twisted the hay can be stored without danger of spoilage. Another method is to scrape the outside of the stem with the finger or thumb nail. If the epidermis can be pulled from the stem, the hay is considered undercured, whereas if it does not peel off, the hay is usually dry enough to stack or bale.

According to Henson (4), working in Iowa, soft hay with over 27% moisture will cake in a pick-up baler and will not expand and fill the wires as the bale emerges from the baler. This characteristic may enable an operator to judge the degree of curing of the hay. With normal tension of the baler any hay baled without caking could be stored satisfactorily.

Effect of moisture content on leafiness and protein

"Save the leaves" is a very frequent warning in literature concerning the general subject of hay making. Zink (26) reported that leaf losses became more severe as the hay approximated 30% moisture and he observed that after 6 p.m. there was a noticeable tendency for leaves to toughen and losses to decrease although there was no marked change in the total moisture content. He concluded that humidity, temperature, and ground moisture are the probable factors influencing the brittleness of alfalfa hay. Willard (25), Westover (24), Kiesselbach and Anderson (8) and Higgins (7) have recently studied leaf function in curing hay and generally agree that leaves do not draw moisture from the stems of curing alfalfa plants.

Henson (4) reported losses of leaves resulting from handling overcured hay were as much as 20%. Salmon, Swanson, and McCampbell (19) found the loss of leaves resulting from harvesting and baling to vary from 2.3% to more than 34%. Headden (5) stated that when conditions were unfavorable and the hay was handled carelessly, half the total weight of alfalfa hay and more than half of the feeding value was lost.

Pollock and Hosterman (17) stated that the quantity of leaves, especially in the case of legumes, is probably a better gauge of the actual feed value of hay than is any other physical factor. Leaves of alfalfa contain about two and one-half times as much protein as the stems and, therefore, are important in determining feed value. Lewis and Willard (11) reported that leaves compose from 35 to 55% of the total hay and contain twice as much protein as do the stems.

Sotola (21); Salmon, Swanson, and McCampbell (19); Singleton (20); and Lewis and Willard (11) reported data on the effect of maturity on protein content and leafiness. The data show that the percentage of leaves and protein are highest at pre-bud stage and generally decrease with the maturity of the plant. Sotola (21), and Salmon, Swanson, and McCampbell (19) concluded that the percentage of leaves and protein decreases with each consecutive cutting.

Kiesselbach and Anderson (9) studied the correlation between leaves and protein in Nebraska. After analyzing 253 samples of alfalfa hay, they obtained a correlation coefficient of $.721 \pm .02$.

MATERIALS AND METHODS

A total of 280 samples of alfalfa hay used for this study were obtained during the summer of 1946, from 12 farms near Stillwater, Oklahoma (Table 2, Appendix). Five to ten samples of approximately 3 pounds each were collected from the various fields visited during the time of baling. Each sample was taken from the windrow just prior to baling, placed in a 20 pound paper bag and labeled. Then samples were weighed on a Toledo gram scale to determine the green weight. After the green weight was determined, samples were placed in a Dispatch electric oven (forced draft) at 100° C. for 24 hours.

Three different methods of determining proper conditions for baling alfalfa hay were explained by various farmers as the ones they use and these methods are described in the paragraphs that follow.

The first method, Twisting, Breaking, and Peeling, is used to determine the moisture content of hay by tightly twisting a handful together. If the twisted hay is tough and if there is evidence of moisture where the stems are broken, the hay is considered too moist for safe storage. If the stems are slightly brittle when broken and if there is no evidence of moisture when the stems are twisted, the hay can be stored without danger of spoilage. A high degree of brittleness indicates the hay is harsh, low in palatability, and may lose a considerable amount of its leaves. Peeling is used in combination with twisting and breaking. The moisture content is determined by scraping the outside of the stem with the thumb nail. If the epidermis can be pulled from the stem the hay is considered undercured. If it does not peel off, the hay is usually dry enough to bale. This method was used on farms 1, 2, and 12 and will be known as method A.

The second method of estimating the moisture content of alfalfa hay is Appearance and Feeling. This is the oldest and most widely used guide in this area. It involves picking up handfuls of hay throughout the field and determining the moisture content by feeling of the stems and leaves with the hands. If the hay feels damp or moist to the hands, it cannot be stored safely. If the leaves feel dry and crumble when squeezed and the stems are hard and brittle, the hay has been overcured. If hay has the proper amount of moisture for safe storage the leaves should curl slightly at the ends and feel neither damp nor dry to the touch of the hands. The stems should be neither dry and brittle nor tough and damp, but between these two degrees of curing with allowances toward the making of soft and pliable hay. This method requires much skill which can be developed only after many years of experience and careful observation. This method has been designated as method B and was employed on farms 3, 4, 5, 6, 7, and 11.

A third method of determining optimum conditions for baling is used by commercial balers in this area and has been designated Tension of Baler Plus Other Factors. Observation and experience are important in the application of this method. Hay that is baled with moisture that is considered unsafe for baling will cake in the pick-up baler and will not expand and fill the wires as the bales emerge. This characteristic enables an operator to judge the state of curing of the hay. With normal tension of the baler any hay that can be baled without caking and produces normal tension will store satisfactorily. Allowances should be given to the factors of present humidity of the air, stage of maturity, and the fineness of the stems. This method will be known as method C. It was used on farms 8, 9, and 10.

Mechanical analyses

The percent of moisture was calculated by subtracting the oven dry weight from the green weight and dividing by the original green weight. The result is the percent of moisture driven off by the forced air and represents the amount of moisture in the sample when baled in the field.

Mechanical analyses were run on the alfalfa samples to obtain the percentage of leaves. One hundred grams of the original 3-pound sample was used in making the determination. A separation was made in which the foreign material was removed by hand picking. Then the large stems and leaves were separated. As analyses were based upon weight, all separations were weighed for the purpose of determining the percent of leaves.

After the percent of leaves was determined, the samples were ground with a Wiley grinder and placed in quart jars, mixed, put into an oven at 105° C. for 36 hours, and then cooled in a desiccator in preparation for running protein analyses.

The quality of hay was determined by breaking and examining from 5 to 10 bales of alfalfa from each cutting and method from each of the 12 farms.

Chemical analyses

The protein content of the samples was determined by multiplying the percent total nitrogen by the factor (6.25). The official Kjeldal-Gunning-Arnold method (18) was used in determining the total percent of nitrogen.

RESULTS AND DISCUSSION

Effects of methods of determining the conditions for baling on moisture content and quality of hay

Data in Table 1 show the average percentage of moisture, leaves and protein and the condition of the hay in storage from all farms under each method of moisture determination and for each cutting. The hay of method A, first cutting, had an average percentage of moisture, leaves and protein of 22.4, 44.0, and 19.3 respectively, whereas samples from the initial cutting of method B contained an average percentage of 23.3, 42.0, and 17.7 for moisture, leaves, and protein respectively. The first cutting samples from method C averaged 25.8% moisture, 45.0% leaves and 19.1% protein.

In comparing the three methods used in the first cutting, method A was the only one that did not have spoilage.

In the second cutting all methods produced hay without damage, but the quality of hay in storage varied considerably. Hay from method C was the best in quality and the hay from method A was stemmy. The hay of method B was somewhat stemmy although it contained a higher average percent of moisture than the hay of method A.

The hay baled on farm 6, using method B, had a moisture content of 29.8%. This was the only hay of the third cutting that showed indications of damage in storage. Otherwise, the average percent moisture from farms using method B would have been lower than the average percent of moisture from farms using method A or C. These data indicate that method A is more consistent in making hay without damage. The best quality of hay was produced by using method C, providing the weather was favorable for baling. From these studies

Table 1.--Average percentages of moisture, leaves and protein of alfalfa hay; methods of determining the condition for baling hay; and the quality of hay after three months storage.

Method	Farm No.	Average percentage of Moisture	Leaves	Protein	Quality of hay after three months storage
		First cutting			
A (Twisting, Breaking, Peeling)					
	1	24.4	54	20.2	No spoilage; leafy, green hay
	2	20.5	33	18.3	No spoilage; green hay
	Average	22.4	44	19.3	
B (Appearance and Feeling)					
	3	24.4	50	15.4	No spoilage; leafy, green hay
	4	20.3	32	17.2	No spoilage; green hay
	5	16.3	26	15.2	No spoilage; leaves shattered
	6	31.8	51	20.4	Dark brown hay; trace of mold
	7	23.7	51	20.4	No spoilage; leafy, green hay
	Average	23.3	42	17.7	
C (Tension of Baler)					
	8	23.9	54	20.0	No spoilage; leafy, green hay
	9	32.0	51	20.0	Bales musty and moldy, some brown
	10	21.5	30	17.4	No spoilage; green hay
	Average	25.8	45	19.1	
Average (All farms)		23.8	44	18.7	

Table 1.—Continued.

Method	Farm No.	Average percentage of Moisture	Leaves	Protein	Quality of hay after three months storage
		Second cutting			
A (Twisting, Breaking, Peeling)					
	1	10.8	25	14.5	No spoilage; bales very stemmy
	2	13.9	17	16.2	No spoilage; stemmy, green hay
	12	18.7	32	17.4	No spoilage; green hay
	Average	14.4	25	16.0	
B (Appearance and Feeling)					
	3	19.9	33	18.8	No spoilage; green hay
	4	18.6	28	16.5	No spoilage; green hay
	5	15.2	24	14.2	No spoilage; stemmy hay
	6	22.2	40	17.8	No spoilage; green hay
	7	19.6	38	17.7	No spoilage; green hay
	11	15.4	16	13.0	No spoilage; stemmy, green hay
	Average	18.5	30	16.3	
C (Tension of Baler)					
	8	17.2	27	16.4	No spoilage; green hay
	9	19.6	37	18.8	No spoilage; green hay
	10	16.9	24	16.0	No spoilage; green hay
	Average	17.9	29	17.1	
Average (All farms)		16.9	28	16.5	

Table 1.--Continued.

Method	Farm No.	Average percentage of Moisture	Leaves	Protein	Quality of hay after three months storage
		Third cutting			
A (Twisting, Breaking, Peeling)					
	1	20.9	34	18.0	No spoilage; green hay
	2	20.7	28	17.1	No spoilage; green hay
	12	21.1	37	18.6	No spoilage; green hay
	Average	20.9	33	17.9	
B (Appearance and Feeling)					
	3	21.0	37	18.9	No spoilage; green hay
	4	21.7	37	18.1	No spoilage; green hay
	5	15.7	26	14.6	No spoilage; stemmy hay
	6	29.8	49	19.1	Leafy; varying shades of brown
	7	20.4	40	18.4	No spoilage; leafy green hay
	11	17.3	21	14.6	No spoilage; leafy green hay
	Average	21.0	35	17.3	
C (Tension of Baler)					
	8	19.9	36	17.5	No spoilage; green hay
	9	20.1	39	18.3	No spoilage; green hay
	10	21.9	34	18.3	No spoilage; green hay
	Average	20.6	36	18.3	
Average (All farms)		20.8	35	17.8	

the condition of hay in storage is shown to vary with the percentage of moisture regardless of the method used in baling. Generally, bales that contained 15% or less of moisture shattered badly and were stemmy. All the bales with moisture content varying from 15 to 20% were good quality, green hay. Most of the bales which had a moisture content of 20 to 25% were leafy, green and high in quality. The bales from farm 6, third cutting, with 29.8% moisture, contained some brown hay and the bales from farms 6 and 9, first cutting, had a moisture content of 31.8 and 32.0% respectively and were musty and moldy.

Effects of methods of determining the conditions for baling on percentage of leaves and protein

On the average, hay of method C, first cutting, contained the greatest percentage of leaves, but it was second in the percentage of protein. Hay of method A had the highest percentage of protein, although the hay of method C contained 1.0% more leaves. This difference may be explained by the fact that the 280 samples of alfalfa were collected from 12 farms and there was considerable variation in the number of samples collected on each farm. The factor of soil variation on each farm and on different farms using the same method may have caused some difference in protein content of the samples.

In the second cutting method C had the highest average protein content and the second highest percentage of leaves. Method B ranked first in the percentage of leaves and second in the percentage of protein, and in the third cutting method C had the highest percentage of leaves and protein. These studies indicate that hay from method C had the highest average percentage of leaves and protein for the three cuttings.

These data show that the first cutting contained the highest percentage of moisture, leaves, and protein. The third cutting contained a higher percentage of moisture, leaves and protein than the second cutting. Hot, dry weather during the period of the second cutting and baling, and ideal hay weather during the third cutting may have been the influencing factors causing these results to be different from the findings of Sotola (21) and Salmon, Swanson, and McCampbell (19). In analyzing these data, the results from farm 6 are the only ones of method B that are consistently high in moisture and farm 6 was the only farm that produced spoiled hay. For detailed studies complete data are listed in Appendix under Table 3.

Correlation and regression studies of leafiness with protein and moisture with leaves

Further studies were made to determine the correlation between the percentage of moisture and leaves, and the percentage of leaves and protein. The procedures used in the correlation and regression calculations are those outlined by Wallace and Snedecor (23). A correlation coefficient of $+ .802 \pm .020$ was obtained between the percent of leaves and protein, and $+ .863 \pm .015$ between the percent of moisture and leaves. Both of these correlation coefficients are highly significant. These findings are in agreement with those of Kiesselbach and Anderson (9).

In these studies it was found that for each 1% increase in leaves there was a corresponding increase of 0.50% in protein and for each

1% increase in moisture there was a corresponding 0.60% increase in leaves.

SUMMARY AND CONCLUSIONS

Studies were conducted in an attempt to find a common method that can be used to determine when alfalfa hay is ready to bale and that can be easily applied to produce better quality hay.

A study was made of the common methods applied by the farmer to determine proper conditions for baling alfalfa hay, and the effects of these methods on the percent moisture, leaves, protein, and on the quality of hay. Data were analyzed on 280 farmers' samples collected in Payne County during the haying season of 1946.

These investigations indicate that none of the methods studied is entirely satisfactory or of practical use to anyone except hay-makers who have had many years of experience in putting up hay.

Under the conditions of this study it may be concluded that hay containing 20 to 25% moisture can be stored without damage. Hay with a moisture content varying from 25 to 30% may turn brown and hay with 30% or more moisture may mold or become musty.

A correlation coefficient of $+ .802 \pm .020$ was obtained between the percent of leaves and protein and $+ .863 \pm .015$ between the percent of moisture and leaves. Both of these correlation coefficients are highly significant.

Regression studies of these data show that for each 1% increase in leaves there was a corresponding increase of 0.50% in protein and for each 1% increase in moisture there was a corresponding 0.60% increase in leaves.

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APPENDIX

Table 2.—Locations of farms from which alfalfa samples were obtained.

Farm No.	Name	P.O. Address	Location
1	Dye, Carl	R.F.D. #3	Stillwater, Okla.
2	Schroeder, George	R.F.D. #3	Stillwater, Okla.
3	Hinrichs, Herman	R.F.D. #4	Stillwater, Okla.
4	Barnes Dairy	N. W. City	Stillwater, Okla.
5	Stout, Orville	Agronomy Farm	Stillwater, Okla.
6	Schroeder, Herman	R.F.D. #3	Stillwater, Okla.
7	Hurst, Ralph	R.F.D. #1	Perkins, Okla.
8	Bradley, Jess	R.F.D. #3	Stillwater, Okla.
9	Cain, Bert	R.F.D. #1	Perkins, Okla.
10	Seeliger, Oscar	R.F.D. #3	Stillwater, Okla.
11	Focht, Ralph	R.F.D. #3	Stillwater, Okla.
12	Mfaw, C. C.	R.F.D. #3	Stillwater, Okla.

Table 3.--Percentage of moisture, leaves, and protein of 280 samples of alfalfa hay from three cuttings and three methods of determining the conditions for baling.

Cutting	Percentage of	Sample number 1	2	3	4	5	6	7	8	9	10	Average
First cutting	Method A (Twisting, Breaking, Peeling)											
	Farm No. 1											
	Moisture	29.3	24.7	18.6	24.1	27.9	20.3	29.8	24.1	19.9	25.2	24.4
	Leaves	56	58	38	54	59	48	62	56	45	56	54
	Protein	21.2	20.5	18.8	19.8	21.0	19.3	21.3	20.1	19.0	20.8	20.2
	Farm No. 2											
	Moisture	20.1	18.9	23.3	20.8	19.5	20.5	20.8	20.9	22.8	17.2	20.5
	Leaves	28	26	40	34	33	31	34	36	38	23	33
	Protein	17.8	17.4	19.1	18.7	18.4	18.3	18.9	18.7	19.2	16.1	18.3
	Method B (Appearance and Feeling)											
	Farm No. 3											
	Moisture	24.5	27.8	24.9	22.1	22.8						24.4
	Leaves	51	53	48	40	40						50
	Protein	19.7	20.2	18.9	18.5	19.8						15.4
	Farm No. 4											
	Moisture	20.1	20.9	24.9	22.5	21.3	17.9	18.1	20.4	18.7	18.3	20.3
	Leaves	30	33	46	40	38	23	23	32	27	25	32
	Protein	17.3	17.6	19.3	18.6	18.2	15.6	15.8	17.4	16.3	16.0	17.2
	Farm No. 5											
	Moisture	14.6	15.4	15.1	14.7	15.1	15.5	19.9	18.1	16.6	18.7	16.3
	Leaves	23	23	25	24	27	25	32	28	26	29	26
	Protein	13.9	13.9	14.3	14.0	14.6	14.6	17.9	16.5	15.8	16.8	15.2
	Farm No. 6											
	Moisture	29.5	34.0	28.6	32.6	34.1						31.8
	Leaves	56	52	44	54	48						51
	Protein	21.1	20.6	19.4	20.9	20.1						20.4

Table 3.--Continued.

Cutting	Percentage of	1	2	3	4	5	6	7	8	9	10	Average
		Sample number										
First cutting	Farm No. 7											
	Moisture	25.6	23.9	22.0	24.1	22.9						23.7
	Leaves	56	52	44	54	48						51
	Protein	21.1	20.6	19.4	20.9	20.1						20.4
	Method C (Tension of baler plus other factors)											
	Farm No. 8											
	Moisture	23.4	23.8	24.1	23.8	29.6	22.1	21.7	23.7	23.6	23.3	23.9
	Leaves	50	53	49	61	48	46	56	60	58	56	54
	Protein	19.1	20.0	19.6	20.0	21.2	18.9	18.5	20.8	20.9	21.4	20.0
	Farm No. 9											
	Moisture	35.3	32.8	32.1	28.0	39.5	37.5	29.3	29.4	31.8	25.2	32.0
	Leaves	57	52	49	46	62	59	47	48	50	42	51
	Protein	20.2	20.1	20.3	19.4	21.2	20.8	19.6	20.0	18.8	19.8	20.0
	Farm No. 10											
	Moisture	24.2	19.1	19.8	21.3	22.2						21.5
	Leaves	34	26	27	30	33						30
	Protein	18.6	16.5	16.8	17.3	18.0						17.4
Second cutting												
	Method A (Twisting, Breaking, Peeling)											
	Farm No. 1											
	Moisture	11.2	12.7	10.3	10.3	10.6	10.4	12.6	11.7	10.5	10.0	10.8
	Leaves	28	28	27	20	22	25	26	26	24	24	25
	Protein	14.6	15.5	14.5	13.8	14.0	14.3	15.2	14.8	14.2	14.1	14.5
	Farm No. 2											
	Moisture	13.6	11.9	14.6	14.4	14.4	14.6	14.3	13.5	12.6	14.6	13.9
	Leaves	16	16	18	17	16	20	19	17	16	16	17
	Protein	15.3	15.2	17.1	16.8	16.5	17.6	16.7	16.1	15.1	15.3	16.2

Table 3.--Continued.

Cutting	Percentage of	Sample number 1	2	3	4	5	6	7	8	9	10	Average
Second cutting												
						Farm No. 12						
	Moisture	17.4	19.9	16.5	20.6	19.1						18.7
	Leaves	31	34	26	36	32						32
	Protein	16.2	18.3	15.8	18.8	17.6						17.4
						Method B (Appearance and Feeling)						
						Farm No. 3						
	Moisture	17.8	20.6	20.6	19.9	20.8						19.9
	Leaves	28	36	34	31	38						33
	Protein	17.3	19.2	19.0	18.6	19.7						18.8
						Farm No. 4						
	Moisture	18.1	17.5	20.2	17.8	20.1	16.9	17.2	19.5	20.1	18.5	18.6
	Leaves	27	24	34	25	32	22	23	29	31	28	28
	Protein	16.3	15.9	17.6	16.1	17.4	15.1	15.6	17.0	17.2	16.6	16.5
						Farm No. 5						
	Moisture	15.8	19.5	15.7	16.5	16.2	14.7	13.1	12.9	12.6	14.6	15.2
	Leaves	27	33	26	26	25	23	22	21	20	23	24
	Protein	13.9	16.6	13.8	15.6	15.0	13.7	13.6	13.7	13.9	13.9	14.2
						Farm No. 6						
	Moisture	19.5	23.7	22.7	22.9	26.1	19.9	24.6	25.2	25.1	22.5	22.2
	Leaves	40	38	39	46	34	43	44	43	36	34	40
	Protein	17.0	17.9	17.3	17.6	18.9	17.1	17.9	18.4	18.2	17.2	17.8
						Farm No. 7						
	Moisture	19.0	18.0	21.1	21.8	18.0						19.6
	Leaves	34	33	36	42	46						38
	Protein	17.6	16.4	18.6	19.3	16.8						17.7
						Farm No. 11						
	Moisture	13.4	19.9	18.9	12.5	12.4						15.4
	Leaves	16	18	16	16	16						16
	Protein	11.8	16.7	13.3	12.2	11.2						13.0

Table 3.—Continued.

Cutting	Percentage of	Sample number 1	2	3	4	5	6	7	8	9	10	Average
<u>Second cutting</u>												
	Method C (Tension of baler plus other factors)											
	Farm No. 8											
	Moisture	17.0	17.8	19.7	20.9	16.1	17.8	16.1	14.9	17.5	14.5	17.2
	Leaves	25	29	33	39	23	28	22	21	26	19	27
	Protein	16.1	17.1	17.6	17.9	15.8	16.8	15.9	15.1	16.4	14.8	16.4
	Farm No. 9											
	Moisture	19.0	20.1	20.0	19.7	19.0	19.2	18.0	17.9	23.3	19.3	19.6
	Leaves	33	41	41	39	35	36	32	28	44	37	37
	Protein	18.5	19.8	19.6	19.3	18.9	19.2	18.1	17.5	17.9	19.1	18.8
	Farm No. 10											
	Moisture	17.6	16.5	17.7	16.1	16.7						16.9
	Leaves	26	22	29	19	23						24
	Protein	16.3	15.9	17.3	14.5	16.0						16.0
<u>Third cutting</u>												
	Method A (Twisting, Breaking, Peeling)											
	Farm No. 1											
	Moisture	18.4	20.2	16.5	24.8	22.8	21.5	24.4	23.9	16.9	19.7	20.9
	Leaves	28	34	26	46	38	36	38	40	24	32	34
	Protein	17.7	18.0	16.8	19.7	19.0	18.2	17.9	19.4	15.3	17.9	18.0
	Farm No. 2											
	Moisture	20.2	21.6	23.0	22.6	24.4	20.3	17.8	16.3	19.0	22.1	20.7
	Leaves	26	27	33	28	34	30	22	21	24	32	28
	Protein	16.8	17.1	18.4	17.8	18.3	17.6	15.6	15.2	15.8	18.1	17.1

Table 3.--Continued.

Cutting	Percentage of	Sample number 1	2	3	4	5	6	7	8	9	10	Average
<u>Third cutting</u>												
	Method A (Twisting, Breaking, Peeling)											
	Farm No. 12											
	Moisture	20.9	21.1	21.6	23.2	18.8						21.1
	Leaves	36	38	39	44	30						37
	Protein	18.4	19.1	19.4	19.0	17.0						18.6
	Method B (Appearance and Feeling)											
	Farm No. 3											
	Moisture	20.9	21.1	21.3	22.9	18.9						21.0
	Leaves	33	38	40	43	30						37
	Protein	18.6	19.1	19.6	17.6	19.4						18.9
	Farm No. 4											
	Moisture	19.6	22.1	20.4	24.0	22.9	21.5	18.9	18.2	25.9	23.4	21.7
	Leaves	31	36	32	46	39	34	28	26	52	44	37
	Protein	17.2	18.4	17.6	19.2	18.6	18.1	16.9	16.5	19.8	18.8	18.1
	Farm No. 5											
	Moisture	15.4	14.8	14.9	15.6	15.4	16.1	17.3	15.4	14.1	14.4	15.7
	Leaves	25	23	24	26	25	27	28	27	26	28	26
	Protein	14.8	13.7	13.9	15.0	14.5	15.6	15.7	15.0	13.2	14.7	14.6
	Farm No. 6											
	Moisture	32.8	29.2	32.6	27.1	26.7	29.2	17.6	26.8	33.8	33.2	29.8
	Leaves	54	50	52	44	40	49	46	42	57	50	49
	Protein	19.4	19.2	19.3	18.3	18.0	19.4	18.8	18.1	20.1	19.8	19.1

Table 3.--Continued.

Cutting	Percentage of	Sample number 1	2	3	4	5	6	7	8	9	10	Average
Third cutting												
	Method B (Appearance and Feeling)											
	Farm No. 7											
	Moisture	23.1	20.2	22.1	20.0	16.7						20.4
	Leaves	49	41	44	38	29						40
	Protein	19.8	18.2	19.2	18.0	16.8						18.4
	Farm No. 11											
	Moisture	17.3	16.6	15.8	18.1	19.0						17.3
	Leaves	21	19	18	22	24						21
	Protein	14.6	14.1	13.2	15.5	15.9						14.6
	Method C (Tension of baler plus other factors)											
	Farm No. 8											
	Moisture	20.6	18.6	19.8	19.9	17.6	19.7	21.7	21.0	23.2	16.6	19.9
	Leaves	40	31	36	38	26	33	44	41	49	23	36
	Protein	17.8	16.9	17.5	17.7	16.6	17.2	18.3	18.1	19.0	16.1	17.5
	Farm No. 9											
	Moisture	19.8	20.1	21.5	19.5	21.1	20.7	23.7	18.1	17.5	19.9	20.1
	Leaves	37	40	46	35	45	44	49	30	26	39	39
	Protein	18.1	18.4	19.3	17.8	19.1	18.8	19.4	17.4	16.6	18.3	18.3
	Farm No. 10											
	Moisture	23.9	26.5	20.0	21.8	17.5						21.9
	Leaves	36	44	32	34	24						34
	Protein	18.7	19.2	18.4	18.6	16.8						18.3

Typist: Mary Wallace Spohn