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Produce High Quality Hay



Increase Production of Feed Nutrients Per Acre.

WYOMING AGRICULTURAL EXTENSION SERVICE

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REFERENCES

- Miscellaneous Publication Number 363, United States Department of Agriculture.
- Handbook of Official Hay Standards, U. S. D. A., United States Department of Agriculture Bulletin Number 980.
- Measuring Hay in Stacks, United States Department of Agriculture Leaflet Number 72.
- Nebraska Research Bulletin Number 60.
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PRODUCE HIGH QUALITY HAY

by

GEORGE W. BOYD, Extension Agronomist

INTRODUCTION

A liberal supply of the highest quality of hay obtainable can be used to good advantage in the efficient production of livestock and livestock products in Wyoming. The value of the hay crop of Wyoming has been estimated at \$8,250,000 annually.

There is no doubt that millions of dollars are lost each year through unfamiliarity with certain important principles involved in the making of high-grade hay. The opinion appears justified that the feed value of the hay crop could be improved fully 25 percent by cutting at the right stage and by proper curing, handling, and storage to preserve the quality. In many instances the most economical way to increase the farm and ranch feed supply would be to improve and increase the quality and production per acre of hay.

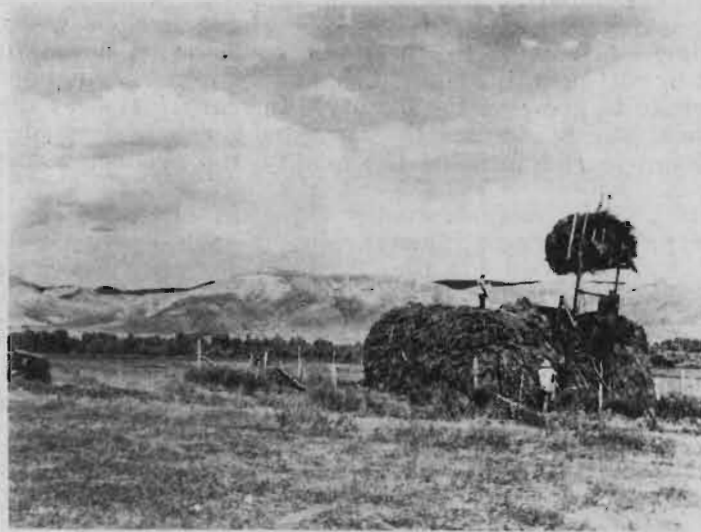
Hay varies more in quality than any other harvested feed crop grown on farms or ranches. In the same locality and under almost identical conditions, there is a wide difference in the quality of hay, due largely to lack of understanding of the fundamentals of good haymaking and to the tendency among growers to give less attention to the hay crop than to cash crops like beets, beans, corn, and small grains. With normal Wyoming weather at haying time, the quality of a hay crop is largely dependent upon the producer's knowing how to grow and produce quality feed.



High quality can be obtained in Wyoming-grown hay.

GOOD HAY IS PROFITABLE

On all farms and ranches a material saving in the cost of producing livestock and livestock products could be made by feeding more high-quality hay per animal unit. The quality of hay produced each year in some sections of Wyoming is so poor that it is useless to expect any appreciable increase in consumption per animal unit unless better hay is made. If the fullest use is to be made of an animal's capacity for utilizing forage, hay should be palatable and nutritious, for a ton of high-grade hay supplies more digestible nutrients than a ton of low-grade hay of the same kind.



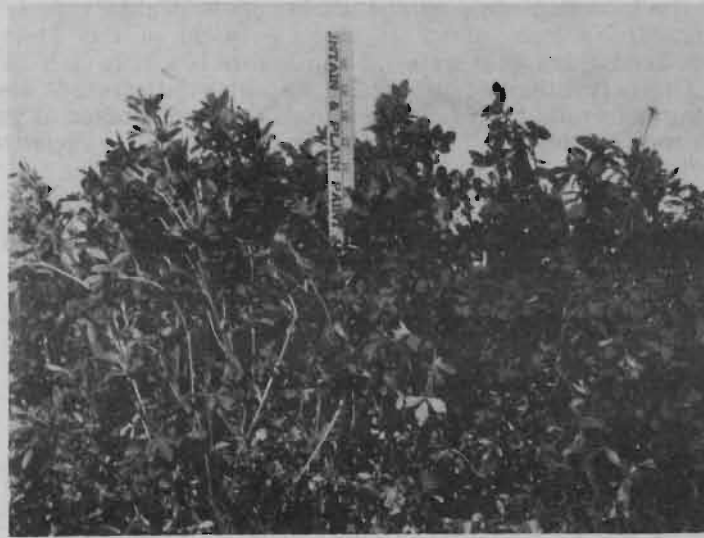
Grass and legume mixtures are adapted to high altitudes.

QUALITY IN HAY

Quality in hay really means feed value. Thus, when the different factors of quality are measured, we are determining the feed value of the hay. High quality, of course, means hay having the physical and chemical characteristics that are associated with a high degree of palatability and a liberal supply of essential feed constituents.

The important physical factors of quality that can be readily gauged in a practical way are:

1. Stage of maturity or ripeness when cut.
2. Percentage of leaves.
3. Percentage of natural green color.
4. Percentage of foreign material.
5. Condition as to soundness.
6. Size and pliability of stems.
7. Aroma.



Tonnage and quality can be combined by proper cutting.

Quality in hay, from the chemical standpoint, refers mainly to its protein, carbohydrate, mineral, and vitamin content. Protein is necessary in the animal's ration, to build tissue. Legume hay has a higher protein content than nonlegume hay. Carbohydrates in hay supply energy. Phosphorus and calcium have an influence on the growth, production, and reproduction of livestock. Legume hays always contain sufficient calcium for the animal's requirements but grass hays do not always contain enough. Vitamins have a broad influence on the efficiency of the ration, and help to prevent nutritional diseases.

The quality or feed value of hay is really measured by the growth, gains in weight, and reproductive ability of the animals; and the production of meat, milk, and other products.

STAGE OF MATURITY

The stage of maturity at which grasses and legumes are cut for hay has a considerable influence on the tonnage of hay and the yield of protein per acre, on the percentage of crude fiber in the hay, the percentage of leaves in the case of legumes, and the percentage of natural green color. The time of cutting also makes a great difference in the palatability and digestibility of hay. A common fault is to delay cutting too long. The quality of many excellent crops of grasses and legumes is virtually sacrificed because they are not cut early enough. Even with perfect curing weather, it is impossible to make high-quality hay from late-cut grass and legume crops.

The yield of hay per acre for most hay plants increases at a rapid rate during the early stages of growth, is fairly constant

during the blooming stage, and then begins to decline rapidly. For example, alfalfa loses about as much in yield of hay from half bloom to seed stage as it gained from before bloom to half bloom.

The percentage of protein in hay plants decreases and the percentage of crude fiber increases from the early stages of growth to maturity (table 1). The yield of protein per acre increases up to a certain point, then begins to decrease



Alfalfa ready to be cut, leaves extending to bottom of stems, yields the greatest amount of feed units.



Grass hay should be cut before seed heads mature to yield highest amount of feed units.

The proportion of leaves to stems in all kinds of legumes is usually closely correlated with the stage of maturity, early-cut hay having a relatively high percentage of leaves whereas the late-cut hay has a low percentage.

The natural green color in the leaves and stems of hay plants is reduced as they approach maturity. Considerable color is lost in the normal curing of hay and early cutting assists materially in maintaining the color in cured hay.

Table 1.—Relation of stage of maturity of alfalfa to chemical analyses*

Stage of maturity	Ash	Protein	Fiber	Fat	Nitrogen-free extract	Samples
	Percent	Percent	Percent	Percent	Percent	Number
Bud stage.....	10.33	19.61	28.02	2.40	39.56	39
Initial to 1/10 bloom.....	10.16	18.07	30.09	2.40	39.28	45
1/3 to 1/2 bloom.....	9.57	16.87	32.60	2.63	38.33	10
Full bloom.....	9.71	15.89	33.25	2.14	38.99	52
Seeds ripe.....	8.52	14.57	35.29	2.10	39.54	33

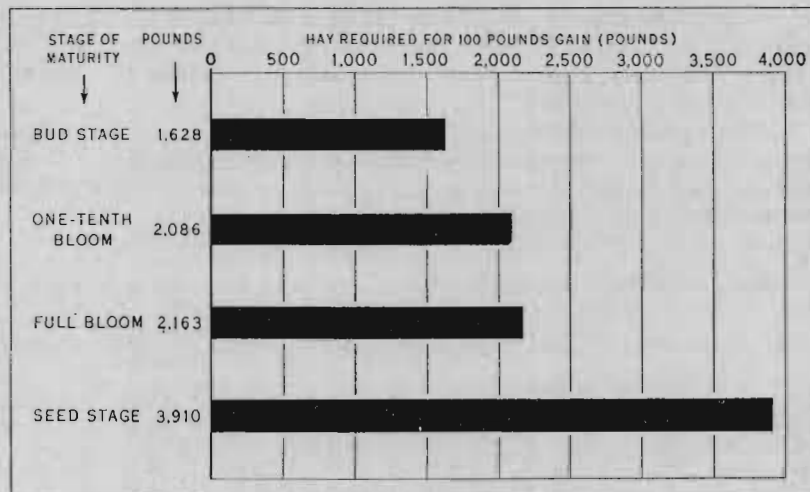
* A compilation of analyses made on alfalfa cut at various stages of maturity and calculated to a moisture-free basis.

Practical feeding work confirms what most feeders know—that the average animal will eat early-cut hay in greater quantities than late-cut hay. Early-cut hay is finer stemmed than late-cut hay, and the stems of the former are usually much softer.

The cutting of grasses and legumes is usually delayed until the heaviest tonnage of hay per acre can be obtained. But usually the stage at which hay plants yield the greatest tonnage is not the stage that gives the greatest quantity of digestible nutrients per acre. These nutrients are the important thing to the feeder.

Ordinarily, grasses and legumes should be cut for hay at the stage of maturity that will give the greatest number of pounds of protein per acre. At this stage not only is there a greater quantity of nutritive elements, but the hay is more palatable and digestible than if the plants stand until they are too mature. Early-cut hay may contain as much as 20 percent more digestible nutrients than hay cut in the late-bloom or seed stages. The Kansas Agricultural Experiment Station found that it required more than twice as many pounds of alfalfa hay cut at the seed stage to produce 100 pounds of gain in steers as it did of alfalfa hay cut in the bud stage (fig. 1).

The proper stage of maturity at which the various kinds of hay should be cut varies slightly in different sections of the country. Based on research and the practical experience of farmers, alfalfa should be cut when it is about one-tenth in bloom (figs. 2 and 3), or about the time the basal shoots appear. In those areas in which alfalfa blooms sparingly or does not send up basal shoots it should be cut when the foliage shows a yellowish tinge indicating the slowing up or stopping of growth. Alfalfa should not be cut too early and too frequently, or the stands will be injured.



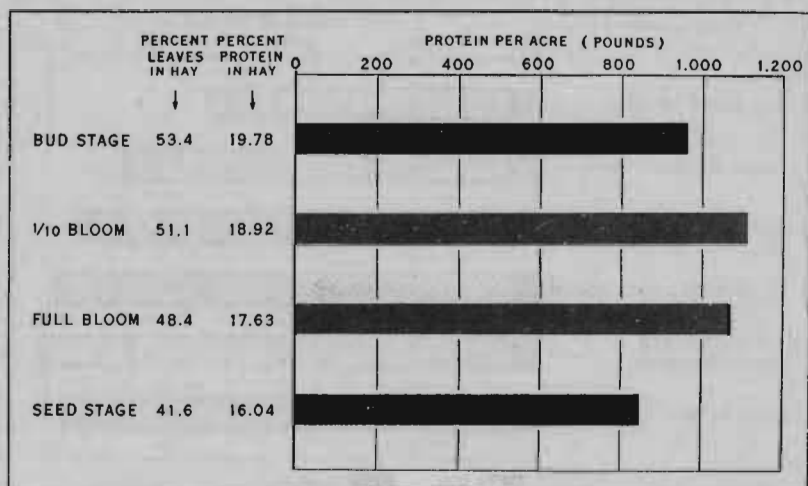
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FIGURE 1.—GAINS IN WEIGHT OF STEERS AFFECTED BY THE MATURITY OF THE ALFALFA FED.

More than twice as many pounds of alfalfa hay cut in the seed stage was required to produce 100 pounds of gains in steers than alfalfa cut in the bud stage.

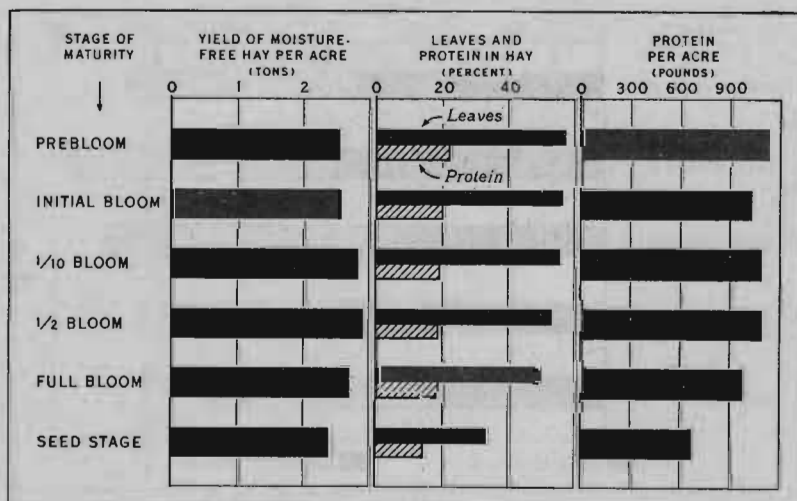


Alfalfa cut at this bloom stage yields the most feed units.



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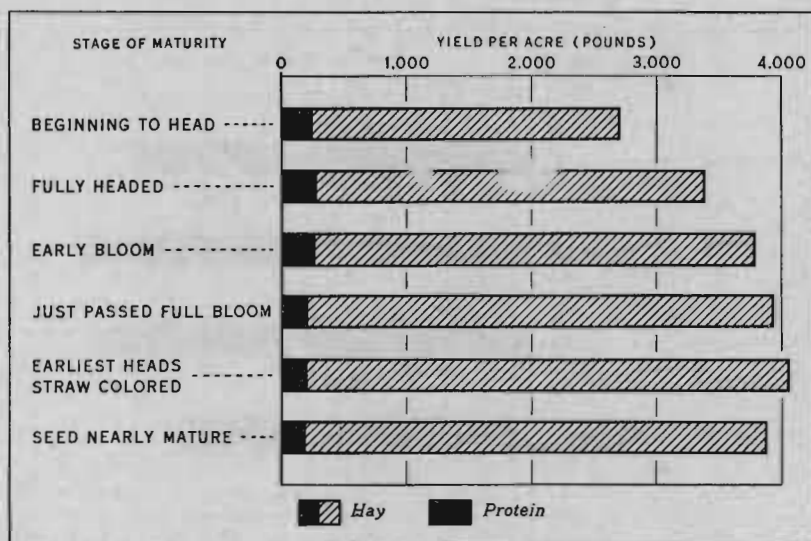
FIGURE 2.—THE MORE LEAVES IN ALFALFA THE MORE PROTEIN
There is a definite relation between the percentage of leaves in alfalfa and the percentage of protein.



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FIGURE 3.—YIELDS OF HAY AND PROTEIN PER ACRE AND PERCENTAGES OF LEAVES AND PROTEIN IN HAY FOR ALFALFA CUT AT VARIOUS STAGES OF MATURITY.

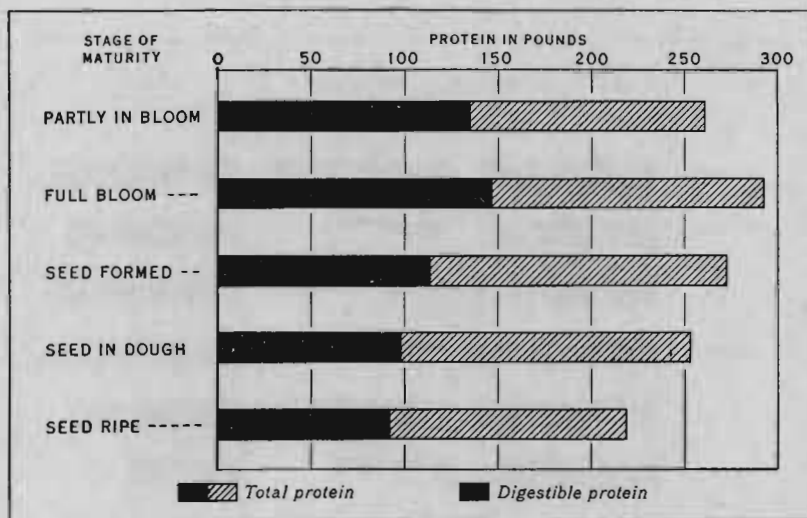
Both yields and percentage of protein decline rapidly after alfalfa reaches half bloom and are materially reduced when alfalfa is not cut until the full-bloom stage. Loss of leaves that contain the larger proportion of protein causes these lower yields.



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FIGURE 4.—YIELDS OF HAY AND PROTEIN PER ACRE OF TIMOTHY CUT AT DIFFERENT STAGES OF MATURITY.

Maximum yields of protein per acre for timothy are obtained at the fully headed and early-bloom stages of maturity. Very little increase in yield of hay occurs after the plants reach the early-bloom stage of growth.



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FIGURE 5.—TOTAL AND DIGESTIBLE PROTEIN IN TIMOTHY AT DIFFERENT STAGES OF MATURITY.

Timothy should be cut not later than full bloom. The maximum quantities of total and digestible protein are present in timothy hay at about the same stage of maturity. The digestible protein in relation to total protein declines rapidly after full bloom.



Thick, luscious grass hay grown on fertile soil of the plains.

VALUE OF LEAVES IN HAY

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. Persons trained in the application of the United States standards for hay are able to ascertain the percentage of leaves in legume hay with a fairly high degree of accuracy. Leafiness is one of the important physical factors used in determining the grade of hay.

Alfalfa leaves contain, on the average, 24 percent of crude protein and 14.4 percent of crude fiber; the stems contain, on the average, only about 10.6 percent of crude protein and 38.3 percent of crude fiber. In other words, the leaves of alfalfa have about two and one-half times as much protein as the stems and, therefore, are very important in determining feed value. The protein in the leaves is more digestible also than that in the stems.

More calcium and phosphorus are found in alfalfa leaves than in the stems. Morrison reports that alfalfa leaves contain 2.25 percent of calcium and 0.23 percent of phosphorus, whereas the stems contain only 0.79 percent of calcium and 0.14 percent of phosphorus.

Analyses of several of the other common legume hays indicate that about the same variation exists in the protein content of the leaves and of the stems of these hays as in alfalfa.

A study made by the Agricultural Marketing Service with timothy hay showed that when timothy was cut just after full bloom the leaf blades contained 11 percent of protein, the leaf sheaths 6.2 percent, and the stems 3.2 percent. This study also indicated that the proportions of the various parts of the timothy plant changed as the plant approached maturity. The phosphorus and calcium in some of the grass hays have been determined (fig. 6).

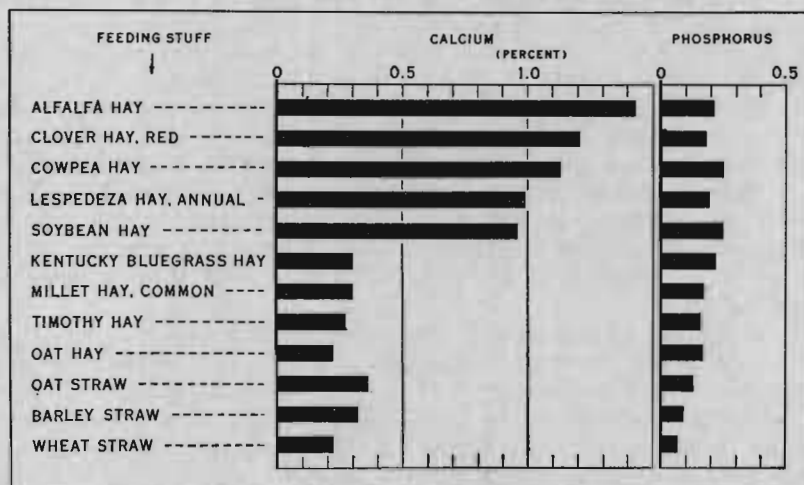
Usually the grass hays are lower in phosphorus and calcium than the legume hays. Apparently no data are available regarding the mineral content of the various parts of grass-hay plants, such as leaf blades and leaf sheaths.

The way in which hay is made and handled has a great deal to do with its leafiness. In the first place, the percentage of leaves at the time the hay is cut depends to a considerable extent on the maturity of the plant. This was discussed in detail under stage of maturity. The methods of curing, the type of rake used, the method of handling hay from field to storage, weather conditions during curing and baling, and many other things affect the percentage of leaves in legume hays. Because the leaves are all-important in nourishing the animal, every precaution should be taken to prevent the loss of leaves in curing and handling hay.

Over and over again it must be emphasized that hay must be cut early and should be carefully cured and handled in order to save the leaves.

The Marketing Service has studied the leafiness of market alfalfa hay. Several hundred bales of hay from all parts of the country and representing all types of hay were collected, and the leafiness was ascertained by separating the leaves and stems of representative slugs taken from these bales.

The leafiness in these bales was found to vary from 68 percent for the very leafy hay to only 11 percent in the very stemmy hay. The average leafiness of all samples was 38 percent. When these data were divided on the basis of the leafiness required for the several grades for alfalfa hay, in the United States standards, it was found that 11 per cent of the total number of samples fell



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FIGURE 5.—CALCIUM AND PHOSPHORUS CONTENT OF LEGUME AND GRASS HAYS.

The legume hays contain from three to six times as much calcium as the grass hays and straws, and usually as much or more phosphorus.

into the No. 1 Extra Leafy grade; 33 percent into the No. 1 grade; 45 percent into the No. 2 grade, and 11 percent into the No. 3 grade.



Color is a very important factor in quality hay production. Bright green, as would be indicated in well-cured hay, has a high vitamin and carotene content.

GREEN COLOR

The green color of hay is another definite indication of its feed value (table 2). A high percentage of natural green color in hay usually indicates early cutting, good curing, pleasant aroma, palatability, freedom from dust or mold, and a relatively high carotene content. The quantity of carotene in hay is an indication of vitamin A potency and is dependent upon the cause and degree of discoloration of the hay and the length of time in storage. The green color in hay may be lost by bleaching in the sun or by getting wet during the process of curing; by fermentation in the bale, stack, or mow; or when the plants are allowed to become too mature before being cut. The stems of hay that have bleached too long in the sun or are discolored from rain usually are harsh and brittle. As hay plants approach maturity the percentage of green color is reduced.



Grass allowed to stand, ripen and bleach has a very low vitamin and carotene content.

Slight discolorations from sun bleach, dew, or moderate fermentation may not be serious; they do not damage hay as does the loss of green color from maturity, rain damage, or excessive fermentation. If fermentation in hay goes too far, it often results in complete loss of carotene.

Table 2.—Steer-feeding experiment, 180 days, comparing black alfalfa with brown and green alfalfa hay

Factors in experiment	Steers fed on shelled corn, oil meal, and—		
	Good color alfalfa hay, lot 26	Brown alfalfa hay, lot 27	Black alfalfa hay, lot 29
Total gain in weight.....	Pounds 353.8	Pounds 350.1	Pounds 262.1
Total feed consumed:			
Shelled corn.....	1,330.2	1,330.2	1,197.0
Oil meal.....	88.2	88.2	88.2
Alfalfa hay.....	1,407.6	1,407.6	*1,663.5
Feed required to produce 100 pounds gain:			
Shelled corn.....	375.9	379.9	456.6
Oil meal.....	24.92	23.18	33.65
Alfalfa hay.....	397.8	402.01	*634.6
Final cost per hundredweight gain.....	Dollars 9.77	Dollars 9.83	Dollars 10.18
Final value per hundredweight gain.....	10.25	10.35	9.60
Profit or loss per steer.....	3.24	3.55	-3.51

*Calculated to 8-percent moisture basis to compare with alfalfa fed to other lots. Journal of Agricultural Research 18:304.

FOREIGN MATERIAL

Weeds are the most common noninjurious foreign material found in hay. They are usually not relished by livestock and when eaten along with the hay have little or no feed value. Hay containing weeds or other foreign material is discriminated against

on the market because weeds represent waste and give the hay a bad appearance. Hay containing weeds is objected to for feeding purposes because the weed seeds that are eaten usually pass through the animal undigested and when the manure is spread on the land it becomes a source of weed infestation. Many noxious weeds are spread in this way. Fanweed, garlic, or similar weeds may be present in hay in sufficient quantities to give milk an undesirable flavor.

Wild barley or foxtail grass is the most common injurious foreign material found in hay. It is found in many alfalfa meadows that have wet spots and thin stands. Wild barley has barbed awns that pierce the tissues of the mouths of animals and continue to work deeper, often causing abscesses.

VITAMINS

Vitamin A is necessary for growth and reproduction in herbivorous animals. Hay is one of the principal sources of carotene from which animals form this vitamin. The carotene content of hay decreases with maturity, so early cutting is important. Loss of green color and leaves during the curing period also reduces the carotene content of hay. Artificially dried hay usually has a higher carotene content than sun-cured hay.

The vitamin A content of milk and its products depends directly upon the quantity of carotene in the feed of the cow. Experiments conducted by the Bureau of Dairy Industry showed that when U. S. No. 1 Timothy, which is a grade of timothy with a relatively high percentage of green color, was fed to dairy cows as the only source of carotene or provitamin A, the cows remained in good health and reproduced normally. When the hay in the ration consisted of U. S. No. 3 Timothy that had lost most of its green color because it was over-ripe or weathered, the cows usually dropped immature, weak, or dead calves if fed this quality of hay for more than 6 months. When milk from cows that received the U. S. No. 3 Timothy was fed to calves that were normal at birth, they did not make normal growth and died within 3 months.

It was also shown that butter color varies definitely with the green color and carotene content of the roughage fed. Butter from cows fed U. S. No. 1 Timothy as the sole roughage had a color value that was approximately twice that of butter from cows that were fed U. S. No. 3 Timothy as the sole roughage.

CONDITION

All newly harvested hay, unless overcured, will go through a light fermentation that is known as sweating. If the moisture content of the hay is less than 20 to 25 percent, the hay usually will dry out before the heat affects the green color. If the hay contains excess moisture, heating will continue until the plant tissues begin to break down and the hay gives off a strong, sour odor. When hay has reached this stage it becomes musty and moldy regardless of any attempt to salvage it.

When undercured hay is baled from the windrow the hay often heats in the bale. The slugs in bales that have heated in this manner may be set or caked and usually are musty and moldy. Sometimes the outside of the bale is green and has the appearance of good-quality hay whereas the center of the bale is discolored, musty, or moldy, caused by excessive heating after being baled.

With the new types of pickup field balers, special care should be taken in baling from the windrow, to make sure that the hay is well cured. A great deal of moldy, black-colored hay is found under field baled conditions.

Moldy hay sometimes produces poisonous effects in livestock when eaten by them. It also imparts disagreeable odors and flavors to milk when fed to dairy cows.

AROMA

Aroma in hay refers to the sweet odor characteristic of new-mown hay or hay that has gone through a normal sweat in the bale, stack, or mow. Aroma, which influences palatability, should be typical of the particular crop from which the hay is made.

CUTTINGS PER YEAR

The number of times certain grasses and legumes are cut for hay each year influences the quality of the hay. The length of the growing season and the kind of crop determines the number of cuttings that may be made during the growing period. Where only one or two cuttings of alfalfa were formerly made per season two and three cuttings are now made. By making the extra cutting the yields of protein per acre are increased and the hay is of higher quality. The feed value of relatively early-cut hay has already been discussed under Stage of Maturity.

In deciding the number of times to cut alfalfa and the time at which the cuttings should be made, good meadow management requires that consideration be given to winter hardiness and insect damage, as well as to yields of high-quality hay. In some areas only one cutting of alfalfa is made during the summer because of the short growing season due to high altitudes or because of lack of moisture in areas where dry farming is practiced. In Wyoming, two cuttings of alfalfa are usually made, depending on the length of the growing season.

There is a marked variation in the quality of hay from the same cuttings in different localities. Because of these variations and the inability of hay experts to consistently determine the different cuttings, no attempt was made to use "cutting" as a grading factor in Federal hay standards.

A compilation of chemical analyses of first, second, and third cuttings of alfalfa indicates that there is less variation in the chemical composition of the different cuttings than there is in hay cut at different stages of maturity. Stage of maturity

when cut is, therefore, more important in alfalfa hay from the standpoint of nutritive value than is the cutting. In fact, much of the prejudice against certain cuttings of alfalfa is due to the stage at which the particular cutting is made and the weather conditions while it was being cured. When the different cuttings are made at the proper stage of maturity and are cured without damage from weather, usually little or no prejudice is held against the hay. Chemical analyses of the different cuttings made at the same stage of maturity showed that there is very little difference in chemical composition due to the cutting.

CURING

No detailed discussion of haymaking practices is included in this publication, but it seems desirable to comment on certain important principles of haymaking that influence the quality of hay and, barring unfavorable weather, are largely under the farmers' control.

Hay can be no better than the meadow from which it is cut. The seeding of adequate quantities of high-quality seed of adapted varieties on soil that is good as to type, fertility, and freedom from weeds is important if good stands of hay plants are to be expected. Good yields of hay are obtained from meadows with thick stands of plants. Thick stands help to control weeds and the stems of the hay plants are generally of desirable texture.

The relationship of stage of maturity at which hay is cut to the feed value of the hay has already been discussed. If hay is cut at the stage of maturity that will give the greatest quantity of digestible nutrients per acre, the farm feed supply can be materially increased without increasing the hay acreage.

Timeliness is important in the making of high-grade hay. It is not economical to try to grow more hay than can properly be cared for with the labor and equipment available. Farmers who exercise the best judgment do not cut more hay at any one time than can be cured and stored in such manner as to preserve the quality.

Rapid curing tends to minimize damage to hay from dew, rain, and sun bleach. Curing is most rapid while hay is in the swath. Ordinarily hay should be left in the swath until it is well wilted; then it should be windrowed with a side-delivery rake. If the hay is well wilted before it is raked into small windrows the curing will continue at a relatively rapid rate. If hay is raked with a sulky rake, the windrows should be comparable in size to those made with the side-delivery rake. Hay should not be raked too soon after it is cut nor should it be left in the swath or windrow until it is overcured. The practice of raking hay too soon after cutting delays curing and increases the chances of the hay being damaged by weather. In some areas partially cured hay is raked into large windrows or bunches. This practice also delays curing and causes the hay to cure unevenly. By

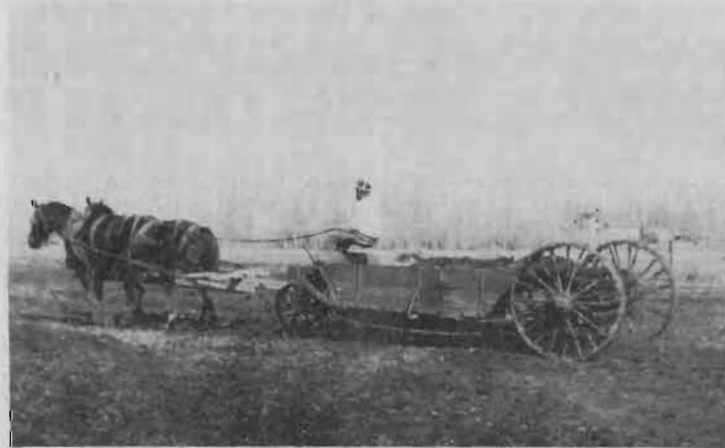
the time the hay on the under side of a large windrow or bunch is dry enough to store the hay on the top side is overcured.

KEEP MEADOWS PRODUCING

The most reasonable way to expect meadows to stay in high production is to give them at least some degree of attention. Applying fertilizer, cultivation, rotation and proper irrigation will keep them producing high quality hay. Only high fertility will produce quality hay.



Periodic cultivation of native meadows improves yields.



Apply barnyard manure for high fertility.

