alfalfa for forage

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ALFALFA FOR FORAGE

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Hay, cubes and seed are the most important products of more than 250,000 Texas alfalfa acres. The crop also is dehydrated, grazed, fed as greenchop, put up as silage, used as a honey crop and utilized for soil improvement. When harvested at the proper growth stage, alfalfa is one of the most palatable and nutritious forage crops grown. The forage is highly digestible and is high in protein, minerals and vitamins.

Alfalfa, a perennial legume with purplish flower clusters on slender stems, reaches a height of 2 to 3 feet at blooming time. New stems arise from the crown buds at the base of the plant every 4 to 6 weeks during the growing period, allowing several forage harvests in one season. The tap root may reach a considerable depth in permeable soil. When plants are properly inoculated, nodules containing bacteria form on the smaller roots. The bacteria convert nitrogen from the air into a usable form for the growing plant.

Expansion of the feedlot industry and intensification of dairy operations have increased the demand for alfalfa hay and other alfalfa products.

SOIL ADAPTATION

Alfalfa grows best on deep, fertile, medium-textured soils that are well drained and neutral to alkaline. Infertile but otherwise suitable soils require large amounts of fertilizer. Acid soils must be limed before alfalfa can grow satisfactorily. Avoid soils infested with cotton root rot and those with a high population of root knot nematodes.

Highly saline soils (those with excessive soluble salts) prevent satisfactory alfalfa production unless proper internal soil drainage is maintained. Established alfalfa plants are moderately salt tolerant, but seedlings often are killed by medium-to-high salt concentrations in the soil. Some stands are obtained on saline soils by frequent irrigation until the plants are well established.

Actively growing alfalfa plants die on soils that are waterlogged or flooded for several days, but dormant plants can withstand a longer flooding period. Hardpans and claypans hinder the penetration of water and plant roots. When such pans are more than 3 feet below the soil surface, alfalfa may grow satisfactorily if the soil does not become waterlogged from rainfall or too much irrigation. Plowpans (compacted layers usually less than 12 inches below the soil surface which result from cultivation and heavy equipment) may be broken by chiseling during seedbed preparation. This allows young plants to become established and roots to penetrate to a sufficient depth to keep the soil open.

VARIETIES

Varietal selection is based primarily on cold hardiness and disease and insect resistance. Varieties adapted to an area generally will be quite similar in yield and quality. Some characteristics

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Table 1. Characteristics of certain alfalfa varieties.

Variety*	Characteristics			
	Cold hardiness	Insect resistance	Disease resistance	Adapted areas in Texas
Buffalo	Moderately hardy	None	Bacterial wilt	North and West
Cody	Moderately hardy	Spotted aphid	Bacterial wilt	North and West
Dawson	Very hardy	Spotted aphid and pea aphid	Bacterial wilt	North and West
Kanza	Moderately hardy	Spotted aphid and pea aphid	Bacterial wilt	North and West
Lahontan	Moderately hardy	Spotted aphid	Stem nematodes Bacterial wilt	North and West
Zia	Moderately hardy	Spotted aphid	Bacterial wilt Fusarium wilt	North, West and Central
Mesilla	Moderately hardy	Spotted aphid and pea aphid	Bacterial wilt Fusarium wilt	North, West and Central
Washoe	Moderately hardy	Spotted aphid and pea aphid	Stem nematodes Bacterial wilt	North and West
Moapa	Non-hardy	Spotted aphid	None	South, West and Central
Sonora	Non-hardy	Spotted aphid	Some mildew resistance	South, West and Central
African	Non-hardy	None	None	South
Indian	Non-hardy	None	None	South
Hairy Peruvian	Non-hardy	None	None	South

*Other varieties and blends are available that would be expected to perform satisfactorily, but Experiment Station data on these are limited.

of several adapted varieties are given in Table 1. Due to limited information, varieties and blends of private seed companies are not included. Such information can be obtained from company representatives.

Creeping or pasture-type alfalfas such as Nomad, Rhizoma and Rambler have not performed well under Texas conditions. These have shown little or no tendency to creep and have produced extremely low forage yields. Their best adaptation appears to be in the high, cold regions of the United States where other alfalfas are less suitable.

ESTABLISHMENT

Seedbed Preparation

The ideal seedbed is mellow but firm enough for the soil particles to be in close contact with the seed. Because most Texas alfalfa is seeded in the fall, seedbeds should be prepared during the summer. Precede alfalfa with small grains or other crops that could be harvested before mid-summer to allow time for seedbed preparation and settling before seeding alfalfa. Where moisture is limited, results may be better if no crop is planted the previous fall or spring.

Where wind erosion is a problem, alfalfa may be seeded into a dead stubble of sorghum, sudangrass or small grain. If cultivation is necessary to control weeds, use implements that allow shallow, sub-surface tillage with the stubble left on the soil surface.

When alfalfa is to be flood irrigated, land preparation must be part of the seedbed preparation. Proper land grading, construction of levees or borders and provision for drainage pay dividends in more efficient water distribution, higher yields and lower labor costs. Low, broad levees may be crossed with machinery and can be seeded to allow maximum land use. Levees not seeded usually require grass and weed control.

Seeding

Good-quality seed is necessary for good stands. Use certified seed when available.

Time. Fall seedings generally are best in Texas. Successful plantings can be made at other seasons of the year, but weeds and weedy grasses usually are worse in spring seedings. Climatic conditions are also less favorable, and spring plantings do not yield a full crop the first growing season.

The best seeding time is early fall when temperatures begin to cool. Plantings made too early can fail because of hot, dry weather. Late fall plantings in Northwest Texas may be killed by cold weather before the seedlings become established.

Method. Alfalfa may be seeded with an alfalfa drill, a grain or grassland drill equipped with a small seed hopper or with a cultipacker-seeder. Broadcasting the seed is less desirable because the seed often is neither distributed evenly nor covered at the time of seeding. Broadcast seed may be covered by light harrowing, rolling or dragging. Regardless of the method, firm the soil around the seed with a cultipacker or roller immediately after seeding.

Rate. Seeding rates necessary for good stands depend on the soil, condition of the seedbed and seed quality. A good stand usually is assured with 15 to 20 pounds of seed per acre. Poor seedbed conditions justify increasing the seeding rate by 2 to 5 pounds per acre.

Depth. Alfalfa seed must be in moist soil to germinate, but young seedlings often cannot emerge if planted too deep. Cover the seed ¼ to ½ inch in heavy soils and ½ to ¾ inch in sandy loam soils.

Inoculation. Always inoculate seed just before seeding with the alfalfa strain of bacteria. This insures adequate nodulation for maximum nitrogen fixation. Adding molasses, milk or some other energy source helps to achieve proper inoculation and to keep the inoculant stuck to the seed.

Keep inoculated seed shaded and plant immediately after inoculation. Seed inoculated 24 hours before planting should be reinoculated before seeding. Plant seeds treated with chemicals for disease control within 2 hours after inoculation.

Nurse crops. Although nurse crops may be used with alfalfa under certain conditions, they compete with the alfalfa seedlings for light and moisture. Occasionally, light-rate seedings or alternate drill-row seedings of small grains may protect the alfalfa seedling where wind erosion is a problem.

Reseeding old stands. Most overseeding attempts fail to improve old stands. Competition from established plants for moisture and sunlight kills the seedlings. The young are also more susceptible to diseases. Stands should be plowed up when they become thin, weedy and unproductive. After destroying old stands, grow non-legume cultivated crops on the land for 2 to 4 years before reseeding alfalfa.

PLANT NUTRIENT AND FERTILIZATION REQUIREMENTS

Alfalfa is best adapted to soils high in calcium with a pH of 6.8 or above. Most current production is on soils inherently alkaline with pH values ranging from 7.0 to 8.5. Acid soils should be limed adequately to increase the pH value to above 7.0. If the subsoils are acid, however, it is not possible to adequately raise their pH values. This factor causes profitable alfalfa production to be impractical on many acid subsoil areas in East Texas.

Alfalfa has an unusually high plant nutrient requirement. For example, 8 tons of air-dry forage contain approximately 460 pounds of nitrogen (N), 80 pounds of phosphorus (P_2O_5) and 360 pounds of potassium (K_2O). Thus, proper fertilization practices are essential for profitable, high-quality yields.

Nitrogen. The use of 20 to 30 pounds of nitrogen generally is recommended for establishing seedlings until nodules are formed. If the seed are properly inoculated and planted in a moist soil to insure inoculum survival, further nitrogen applications for maintenance are not beneficial.

Phosphorus. Because of the high phosphorus requirement, 80 to 120 pounds or more per acre of P_2O_5 are recommended where moisture is adequate. Less is required where moisture is limited.

A soil test is a useful guide for determining phosphorus needs. For establishment, incorporate the phosphorus material into the plow layer before seeding. For maintenance, broadcast similar rates each winter or early spring before growth starts. Annual applications are sufficient.

Table 2 shows the effect of three phosphorus sources using two application techniques on a Portales (high lime) soil in West Texas.

Potassium. Because alfalfa requires more potassium than most forage crops, a soil test is an important guide for determining the initial potassium level before establishment. Subsequent tests should be made every 2 years to monitor existing levels. Rates for deficient soils under adequate moisture conditions may range from 80 to 160 pounds of K_2O for establishment. Apply similar rates early each spring for maintenance. An additional mid-season application of 80 to 120 pounds of K_2O is recommended on irrigated, permeable, deep sands that are very low in potassium. Lower rates are required under limited moisture conditions.

Secondary and micronutrients. Although there may be isolated incidences of deficiencies of secondary and micronutrients in some areas of Texas, none have been verified in major alfalfa production areas. If unusual symptoms characteristic of these disorders are suspected, obtain agronomic assistance.

IRRIGATION

In establishing alfalfa, irrigate the seedbed after land preparation is completed before seeding. This provides good sub-zone and germination moisture and settles the seedbed. Avoid loose seedbeds where stands are to be irrigated up. Seed are easily covered too deep during irrigation. Soil crusting also can prevent good stand establishment when watering up. With sprinkler irrigation, crusting can be minimized by keeping the soil surface moist until seedlings emerge.

Alfalfa production is best where high soil moisture levels are maintained. Although yields normally increase with increasing amounts of water, increase water applications only when the additional production has a value greater than the irrigation costs. Twenty-four to 30 inches of water normally produce 6 to 7 tons of alfalfa per acre. Profitable yields can be grown with smaller quantities of water and even under dryland conditions where the annual rainfall is at least 24 inches.

Apply only enough water to refill the effective-soil root zone during individual irrigations. A 4- to 5-inch irrigation normally wets moderately dry clay and loam soils adequately. More frequent 2- to 3-inch applications are best on sandy soils, especially where sprinkler irrigation is required. Evaluate the depth of water penetration by examining soil samples taken with soil probes or augers. Unusually dark green leaves and slow plant growth

Table 2. Fertilizer effects on yield, phosphorus and protein content of irrigated alfalfa grown on a Portales silt loam in Deaf Smith County.*

Phosphorus source	P_2O_5 applied (lb./A)	Total yields for 3 yr. (tons/A)	Phosphorus content of forage (percent P)	P_2O_5 equiv. removed in 3 yr. (lb./A)	Percent crude protein	Protein produced in 3 yr. (lb./A)
0-0-0		8.57	0.13	54.9	18.0	3093
	each yr.					
0-20-0	80	18.13	0.18	161.9	17.8	6495
0-45-0	80	17.93	0.19	163.0	17.8	6395
21-53-0	80	17.63	0.18	157.9	17.9	6324
	first yr. only					
0-20-0	240	18.69	0.20	182.7	17.9	6712
0-45-0	240	19.62	0.20	191.8	18.0	7107
21-53-0	240	18.62	0.19	171.4	17.8	6570

*Pope, Alex. 1961. **Effect of Application Schedule and Source of Phosphorus Fertilizer on Forage Yield, Phosphorus Content and Protein Content of 12 Cuttings of Irrigated Alfalfa.** Texas Agricultural Experiment Station Progress Report 2214.

indicate inadequate moisture. Irrigation has been delayed too long if plants wilt early in the day.

Too much irrigation water may be more costly than too little. When more water is applied than the soil can hold, the extra water moves below the root zone and takes plant nutrients with it. Where the underground water table is high, apply only optimum quantities of water to prevent the water table from rising into the root zone.

Alfalfa should have high soil moisture when it emerges from winter dormancy in early spring. Irrigate if rainfall does not supply adequate moisture. Alfalfa fields also should be irrigated as soon as the hay crop has been removed following cuttings. One irrigation between cuttings provides good alfalfa production on deep loam and clay soils. A second irrigation may boost production during periods of extremely high temperatures and low rainfall. Two or three lighter irrigations between cuttings may be beneficial on sandy soils with lower water-holding capacities.

When using center-pivot sprinkler systems, completing a circle in 3 to 4 days normally provides adequate moisture early and late in the season when alfalfa water requirements are low. A slower ground speed, requiring 7 to 8 days to complete a circle, provides adequate water during peak requirement periods in mid-summer.

Irrigate early enough before cutting to prevent compaction of the soil with hay equipment. Continuous equipment traffic on wet soils limits water infiltration and penetration into the soil root zone, particularly on clay soils where water intake is low.

WEED CONTROL

A thick stand of healthy, vigorous alfalfa is a highly competitive crop. Frequent mowing and the plants' heavy shade usually control most weeds. Maintenance of a good stand is the best insurance against weed infestation. Plow under thin stands when they become weedy and unproductive. Proper seedbed preparation, fertilization, harvesting and insect and disease control favor alfalfa growth and stand maintenance, thereby increasing its ability to compete with weeds.

Fall planting usually enhances effective weed control. Mowing generally controls weeds in spring plantings. Some herbicides can aid in weed control, especially during alfalfa establishment. Many effective weed control chemicals, however, cannot be used on alfalfa because they are not cleared for use on forage to be fed to livestock. Detailed information on chemical weed control may be found in publications available from county Extension agents.

INSECTS

The alfalfa weevil is the most serious insect attacking Texas alfalfa. Spotted alfalfa aphids, pea aphids, grasshoppers, three-cornered alfalfa hoppers, alfalfa caterpillars, lygus bugs and thrips also cause alfalfa damage.

Refer to Table 1 for information on insect resistance of particular alfalfa varieties.

For descriptions of alfalfa insect pests and control information, see Extension publication MP-1014, *Texas Guide for Controlling Insects on Legumes and Grasses.*

DISEASES

Two types of diseases attack alfalfa. Root diseases may kill the plants, causing reduced stands and yields. Foliage diseases attack the leaves and stems, lowering yield and quality of the forage.

Root Diseases

Cotton root rot. Probably the most destructive alfalfa disease in Texas, cotton root rot fungus may attack plants at any stage of development from seedling to maturity. This disease is more active

in warm weather and is recognized by the circular spots of dead or dying plants. The bark of infected taproots rots and dies. The plant then can easily be broken at the soil surface. The brownish fuzzy strands of the fungus frequently appear on affected roots. No effective control is known, but incidence of cotton root rot may be reduced by growing non-susceptible crops such as grasses for a season or more before planting alfalfa. Avoid root-rot infested land for alfalfa production. Handle alfalfa grown on infested soil as an annual hay crop.

Seed rot and seedling blight. Poor stands resulting from damping-off diseases are common. Seed rot and seedling blight are caused by soil-inhibiting fungi and are favored by cool, wet weather. Soft, rotting tissue dries out and causes the death of affected seedlings.

Treat seed with a fungicide to prevent seed rot and seedling blight. If sown within 2 hours after inoculation, the treated seed may be inoculated with nitrogen-fixing bacteria.

Foliar Diseases

Blackstem. Usually occurring in Texas during the spring, blackstem is most serious in cool, humid climates. Blackstem may occur on any part of the plant from the upper taproot to the seed pods. It causes irregular, dead spots on stems and leaves which gradually enlarge and merge with other dead spots until the entire stem is girdled. Plants usually are not killed unless the disease spreads to the crown. The fungus overwinters on growth from the previous year.

Rust. Rust causes rapid loss of leaves in humid areas and under sprinkler irrigation. Rust can be recognized by the reddish-brown, raised spots on leaves.

Other leaf diseases. Downy mildew and common leafspot are other leaf diseases. Common leafspot may cause considerable loss of leaves as yellowing and dropping of leaves occurs on infected plants. Downy mildew causes the leaves to curl and turn yellow. The underside of the leaves becomes covered with purplish, felt-like growth. Downy mildew is systemic and will reappear with favorable conditions. Using clean seed on new ground prevents downy mildew.

Control. If foliar disease is serious, harvest the hay crop before leaf loss occurs. New growth developing under more desirable conditions may be free of diseases. Refer to Table 1 for information on disease resistance of specific varieties.

ALFALFA CULTIVATION

Cultivating drilled or broadcast stands used for forage offers no advantage when the stand is good and the plants are making good growth. Tillage may be helpful, however, if the soil has been compacted by grazing livestock or machinery or if heavy silt deposits were left by overflows or irrigation. Implements such as alfalfa tillers or harrows should be used to loosen the soil without seriously injuring the plants. Avoid using implements which split the crowns and rip out plants.

ALFALFA AS AN ANNUAL CROP

Although usually limited to a single season in areas where cotton root rot is severe, alfalfa still may be one of the best forage crops available. The non-hardy varieties grow fast and produce good yields the first season, even when spring seeding is necessary. These types should be spring-seeded in Northwest Texas and in the northern part of Central Texas.

Where long-lived alfalfa stands do not fit into the cropping system, alfalfa can be used as an annual or a short-term perennial.

OTHER USES

Alfalfa for Soil Improvement

Alfalfa is an excellent soil-improving crop. In rotational studies at the Texas A&M Iowa Park Station for 12 years, the greatest increase in acre-value of crops occurred when cotton and grain sorghum followed 2 years of alfalfa. The value of crops produced on each acre with this rotation showed an increase of 25 percent over the value

of crops tested in other rotations without alfalfa. A 3-year rotation of alfalfa, cotton and oats increased the acre value 20 percent over a rotation of cotton, oats and grain sorghum. Similar and even greater responses have been obtained at other locations with crops following alfalfa.

Alfalfa Seed Production

Seed production is an important enterprise in some areas. Specific information on seed production is available from Extension agronomists and county Extension agents in areas of the state where seed is produced.

ALFALFA FORAGE HARVESTING

Because alfalfa is a perennial plant, stands generally represent a long-term investment. Maximum returns are obtained by maintaining dense, productive, long-lived stands.

Management is the key to stand maintenance. Dense, healthy stands resulting from good management practices are better able to ward off diseases, weeds and winter injury than are stands weakened by poor management. Production considerations such as soil adaptation, fertility, moisture and control of insects, diseases and weeds are most important in establishing and maintaining productive stands.

Harvesting management also can greatly affect the life of a stand. Poor practices result in reduced stands, yield, quality and profit. Methods of harvesting, handling and marketing alfalfa forage vary considerably. Carefully plan harvesting, for it represents a sizeable investment. Consider the total system of production, harvesting and marketing for maximum efficiency.

STAGE OF GROWTH TO HARVEST

Cut established alfalfa stands in the 1/10 to 1/4 bloom stage. Harvest at this stage gives the best combination of yield, quality and stand maintenance. A field is at the 1/10 bloom stage when flowers are present on one out of 10 stems. The first cutting on new stands should be delayed until plants are in the 1/2 bloom stage.

Earlier stages of growth at harvest generally produce higher quality and lower yields. Yield increases and quality decreases with advanced stages of growth at harvest. Hay cut in the prebloom stage has a higher percentage of leaves, finer stems and higher carotene or Vitamin A content. Continued cutting at this prebloom stage, however, shortens the life of the stand.

Alfalfa plants make regrowth on food reserves stored in the roots for about 3 to 4 weeks following cutting and in the spring. After this, the plants manufacture more food material than needed for growth and the root reserves begin to rebuild. Food reserves start building up in the roots when the plants reach the bud stage, and the buildup continues rapidly until the plants reach the 1/10 to 1/2 bloom stage or until new shoots arise from the crown. Continued cutting in the prebloom stage keeps the food reserves depleted in the plant roots, weakens the plants and results in a loss of stand.

Make the last cuttings in North Texas and most of Central Texas at least 30 days before the first expected killing frost. This will permit the plants to build up food reserves in the roots. Vigorous new growth will come from these reserves the following spring. In South Texas and Central Texas, alfalfa may make some growth several times during warm winter periods. This growth tends to exhaust the root reserves and leaves the plants in a weakened condition for spring growth. The first spring cutting under such conditions should be delayed until plants have reached the 1/2 bloom stage.

HARVESTING, PRESERVATION AND UTILIZATION METHODS

High-quality alfalfa forage is green, fine-stemmed, leafy and harvested at the 1/10 bloom

stage. It is free of molds, weeds and other foreign material. The leaves contain a much higher proportion of feed nutrients than do the stems. Thus, the best harvesting method is one that saves most leaves with minimum exposure to sunlight, dews and rain.

Harvesting and preservation methods vary throughout the state and are influenced by the size of the operation and utilization and marketing considerations.

Hay

The principal method of harvesting and utilizing Texas alfalfa is as hay. Harvesting operations after cutting should attempt to retain leaves and preserve forage quality. Overdrying is probably the most common cause of leaf loss. Leaves shatter easily from handling hay when it is too dry. Prolonged exposure to sunlight bleaches its color, and heavy dews and rain on cut plants leach their nutrients. Rainfall causes more damage on partially cured hay than on newly mowed hay.

Alfalfa cut at the proper stage (1/10 to 1/4 bloom) contains 70 to 80 percent moisture. Reduce the moisture content to not more than 20 percent by curing before baling, loose stacking or field chopping. Low moisture content is necessary for proper storage. A moisture content of 12 percent or less is required for satisfactory cubing. Alfalfa hay is generally handled by cutting, conditioning and windrowing and then allowing it to cure in the windrow. Both self-propelled and power-takeoff equipment are available to do this in one or more operations. In conditioning, the stems are crushed or crimped for faster drying and greater leaf retention. To insure maximum leaf retention, handle hay as little as possible before it is picked up from the windrow.

Cutting, conditioning and allowing the hay to wilt in the swath may be necessary before windrowing for completion of the curing process in humid areas or when cuttings are heavy. Wilting in the swaths speeds curing, but the hay should be windrowed before the leaves begin to shatter. Where equipment permits, the size of the windrow can be regulated to enhance curing even with heavy crops under unfavorable weather conditions. If necessary, windrows may be turned with a rake for uniform drying.

The time required for curing will depend on weather conditions, windrow size and whether hay will be baled, cubed, chopped or stored as long hay. Over-curing results in loss of leaves, color and dry matter. Under-curing may result in moldy, dark hay and excessive storage heat.

Hay that is rained upon in windrows should be turned gently just before baling or other processing. With low humidity, sunshine and wind, rained-on windrows may be baled without turning.

No entirely accurate, practical method exists for determining the moisture content of hay before baling or other processing. Meters to check the moisture content can be used as a guide, but haymaking experience is the best predictor of when hay is ready to process and store. Experienced hay makers often twist a small amount of hay in the hands. If the hay is tough and moisture oozes from the stems, the moisture content is considered too high for baling. Another method is to scrape the stems with the thumbnail. If the outer layer is easily scraped off, the moisture content is probably too high for safe baling.

Baling. Although several methods exist for harvesting and storing alfalfa hay, baling from the windrow is still a common practice. Ordinarily, hay is safe to bale when moisture has dropped below 20 percent. Baling in early morning, late afternoon or night when humidity is higher will minimize leaf loss caused by shattering.

High moisture and humidity sometimes produce brown hay. Such conditions usually occur in the first cutting. Hay baled at a higher than normal moisture content (20 to 25 percent) creates heat within the bale and results in brown hay.

When properly cured, brown hay is often more palatable than green hay, but its appearance is less desirable.

Handling baled hay is often an expensive and burdensome chore. Labor-saving equipment, however, makes this phase more efficient and economical. Bale-handling equipment includes automatic bale loaders, wagons and bale conveyors.

Cubing, pelleting and wafering. Mechanical processing of hay into small, compact cubes, pellets or wafers has been practiced for several years. After compacting, the hay can be handled more conveniently and transportation costs are reduced. Cubing, currently the most popular process, is gaining rapidly in use due to development of field cubing machines. Self-propelled cubing machines utilize windrowed alfalfa and produce a compact alfalfa cube suitable for mechanized handling.

Field cubing in Texas is limited to the western area where alfalfa hay can be readily dried to 12 percent moisture or less with minimum handling. For successful cubing in humid areas of the state, use a stationary cubing or pelleting machine. In this process, the alfalfa forage is harvested and cut into short lengths by a field forage harvester before being moved to a drying facility. The alfalfa is artificially dried to 12 percent moisture or below and compacted through the stationary machine. Stationary cubing is normally a more expensive process than field cubing, primarily because of the added artificial drying cost.

In field cubing, the alfalfa is generally cut, conditioned, windrowed with self-propelled windrowers or swathers and field-dried to 12 percent moisture or less. In the cubing process, some moisture is added back to the hay for a uniform desired moisture level. The moist, hot cubes which come out of the machine are hauled to a curing and storage area and placed in shallow piles for 2 to 3 days for cooling and drying.

Cubing machines are expensive and must be operated near capacity. Economical operation requires several hundred acres of alfalfa per year. Although many producers cannot use this harvesting and processing method because of the cost, custom cuber operations are common in some concentrated alfalfa production areas. Operators may purchase the crop as it stands in the field or in the windrows.

Feedlot cattle feeders who can use wafers, cubes or pellets through feed handling equipment usually pay a premium above baled hay prices. Dairymen also obtain satisfactory results in feeding wafers and cubes, but sometimes long hay must be added to the ration to maintain butterfat production. This is especially true when feeding finely cut, dense pellets.

Loose stacking. Loose hay stacking in Texas generally is limited to grass hay where cattle are allowed to eat hay from the stack. With the increased demand for alfalfa hay by feedlots in Northwest Texas, the use of loose stacking has increased. Hay is generally stacked in a corner or edge of the field and later ground or chopped before delivery to the feedlot. Completely mechanized stacking requires minimum labor but a relatively high financial investment in machinery. Each stack usually contains 4 to 6 tons. Because of the machinery investment, a large quantity of hay must be handled for this method to be economical. Custom operators in some areas operate the mechanized stackers to meet the needs of smaller producers. Although some small producers can justify the use of rather inexpensive front-end tractor-mounted stackers, such equipment requires additional labor for forming the stack.

Field chopping. A field chopper picks thoroughly cured hay from the windrow, cuts it into short lengths and blows it into trucks or wagons for delivery to the storage area. Field chopping normally is practical only when alfalfa hay is to be used on the farm where it is produced. The following points are major advantages of chopped hay.

- Chopped hay lends itself to self-feeding, which decreases labor.

- Less forage is lost from waste because the stock refuse fewer stems.
- Less storage space is required than for baled hay.
- Baling expenses are eliminated, and hauling and labor costs may be reduced.

Because chopped hay packs tightly, it must have a low moisture content during storage. Chopped hay has little chance for further moisture loss after storage. Complete curing is required before storage to prevent heating, spoilage or spontaneous combustion. Chopping into longer lengths lessens the possibility of heating but takes more space.

Dehydration

Dehydration offers growers near dehydration plants another market for their alfalfa. The alfalfa usually is bought standing on the basis of hay yield and price. Alfalfa to be dehydrated usually is cut in the pre-bud or bud stage of growth. Only one or two cuttings per year are taken for dehydration from a field, and the remainder are harvested for hay. Limiting such immature harvests prevents damage to the stands as long as the other cuttings are harvested for hay or seed. If alfalfa is used in short rotations, prebloom cuttings are not likely to damage stands.

Silage and Haylage

Although little is handled in Texas, alfalfa silage is a feed of excellent quality. Making good silage from alfalfa requires more care and consideration than making silage from corn and sorghum. Because the protein content of alfalfa is high and the carbohydrate level is low, proper bacterial action and fermentation require the moisture content to be near optimum.

Cut alfalfa for silage at the same time as for hay. It should be finely chopped (¼ to ⅜ inch) and packed in the silo. For proper ensiling, the crop should be wilted to a moisture content of 65 to 68 percent. If the moisture content is higher, add a preservative to allow for proper fermentation and formation of quality silage. A preservative generally is added because wilting requires extra field operations. Molasses, ground corn, small grain and corn and cob meal may be used as preservatives. The amount depends to some extent on the percentage of moisture in the silage.

Alfalfa can also be harvested and stored as haylage. Haylage is low-moisture silage with a 40 to 60 percent moisture content. The alfalfa is partially field-dried to this moisture content. Compared to silage, less storage losses due to seepage occur with haylage, aroma is improved and less weight needs to be handled per ton of dry matter stored. Haylage requires extra field operations because partial drying is necessary. Close attention to packing and sealing or using air-tight silos also is necessary. The exclusion of air in packing silage or haylage is critical. Haylage is drier than silage and does not pack as well. Nearly all types of silos, however, can be used to store haylage if proper packing and sealing techniques are used.

One method of estimating the moisture content of alfalfa is a simple squeeze test. Squeeze a handful of chopped forage into a ball and hold for 30 seconds. Quickly release your grip and examine the condition of the forage. The following guide can be used to estimate the moisture content.

Approximate moisture content (%)	Condition of forage ball
Greater than 75	Ball holds shape, considerable free juice
70 to 75	Ball holds shape, little free juice
60 to 70	Ball falls apart, no free juice
Less than 60	Ball falls apart readily

Green-chop

Green-chop (soiling) is a method of harvesting where the alfalfa is chopped, blown into trucks or wagons and hauled to feed bunks. A daily harvest is involved for alfalfa cut at the hay stage. Advantages of soiling include the following.

- Forage and nutrient losses are minimal, with little loss from trampling or refusal.

- Alfalfa stands are subject to less damage than when grazed.
- No inside fences are required.
- Per-acre animal production usually is higher than when pastured.
- The incidence of bloat is reduced (though not eliminated).

Major disadvantages are the following.

- A considerable investment in equipment is required.
- Equipment failure or unexpected rains can cause interruptions.
- Daily harvesting is often inconvenient.
- Irrigation is almost a necessity to provide a continuous forage supply.
- Alfalfa management may be a problem unless the entire field can be harvested in a relatively short time.
- Soil must be sufficiently dry to avoid compaction with harvesting machinery.

Pasture

Alfalfa provides grazing of excellent quality and palatability. Grazing is common during the fall and winter after the hay season. Although some stockmen pasture pure alfalfa stands throughout the growing season, others are reluctant to graze pure stands because of the potential bloat problem in ruminants. Alfalfa and grass are sometimes grown together to reduce the bloat possibility. Proper feeding of bloat retardants such as poloxalene can largely reduce the hazard. Alfalfa is one of the most desirable pasture plants for hogs.

When pasturing alfalfa, the plants need a recovery period to accumulate reserve food material. With close, continuous or frequent grazing, plants do not have sufficient time to build a reserve food supply and plants will die. If alfalfa is to be grazed throughout the growing season, utilize rotation or daily-ration (strip-grazing) grazing systems. For maximum production of high-quality forage, 25 to 30 days are needed between each grazing period. A system with adequate stocking to rapidly graze off an area and then move to a new area is most satisfactory. Dairymen and others have successfully used the strip-grazing system which allows cattle only the amount of pasture they will eat in one day. Portable, temporary fences used to confine the cattle are moved each day. Because all available forage is rapidly consumed, this system keeps forage wastage to a minimum. It also favors good regrowth of alfalfa as a result of quick livestock removal. Strip-grazing requires more labor for moving fences than other grazing systems.

A successful bloat prevention program requires that each animal consume the required amount of poloxalene daily. It is available in block form with other feed ingredients and salt to limit the intake to the animals' daily needs. Place blocks in the grazing area near water facilities. Closely follow instructions regarding the number of blocks that should be available. Poloxalene is also available in dry form to mix with concentrate feeds and in a liquid mix.

The following precautions help avoid bloat.

- Never turn hungry animals into a lush growth of alfalfa before giving them a fill of dry grass hay or other dry forage.
- Allow animals to graze only a short period each day until accustomed to the pasture.
- Provide dry hay or straw, salt and water.
- Hold the animals on grass pasture or other area at night.

Mowing strips of alfalfa to provide dry feed and overseeding with adapted annual grasses or a mixture with perennial grasses helps reduce bloat. Animals normally do not bloat when grazing a mixture of 50 percent grass.

DETERMINING QUALITY

As a forage, alfalfa is unsurpassed in its potential for providing feed nutrients for livestock. Protein and energy represent major nutrient values in hay and other forms of alfalfa. Although its

potential feed value is high, quality and value of the end product can vary considerably depending upon how the alfalfa is produced, harvested and handled before feeding.

Knowledge of alfalfa quality for proper feeding in accordance with animal requirements is important to those who feed alfalfa hay, cubes or other products. Buyers and sellers of hay should be aware of the quality of each load or lot handled. Such knowledge encourages the establishment of prices in accordance with the actual feeding value of the product.

Consider many factors in evaluating alfalfa hay. Many desirable characteristics can be determined visually. Hay should be harvested at the desired stage of maturity, as indicated by flower development. The hay should have small, pliable stems and a high percentage of leaves in relation to stems with leaves attached. It should be free from weeds, wire, must, mold and excessive heating. Look for bright green hay, although color is usually less important than other characteristics. The inside of bales must be examined for proper visual evaluation.

A chemical analysis (forage test) in combination with a visual appraisal gives a more reliable estimate of hay value. Crude protein percentage is the most common chemical determination. Digestible protein is calculated from the crude protein content, and energy values can also be determined. Chemical analyses give accurate measures of the nutrient content, but they do not indicate musty, moldy, shattered, weathered or other objectionable features. Use both chemical and visual methods to determine the feeding value and acceptance of each hay cutting.

MARKETING

Opportunities for improving marketing are available through the improved cooperation of alfalfa producers and a centralized marketing, storing or contracting organization. Alfalfa grown on

Table 3. Estimated costs of alfalfa establishment per acre, irrigated.

Item	Unit	Quantity	Cost per unit	Subtotals	Totals
Cash costs					
Seed	lb.	20.0	$ .50	$10.00	
Fertilizer					
Available N	lb.	30.0	.10	3.00	
Available P_2O_5	lb.	100.0	.10	10.00	
Available K_2O	lb.	80.0	.05	4.00	
Irrigation operating	ac.-in.	12.0	.69	8.28	
Machinery operating	hr.	.8	1.99	1.59	
Labor	hr.	3.0	1.75	5.25	
Total operating costs				$42.12	
Interest on operating capital	mo.	4.0	.08	1.12	
Total cash costs					$43.24
Non-cash costs					
Fixed costs on farm machinery	ac.	1.0	$ 3.22	$ 3.22	
Fixed cost on irrigation system	ac.	1.0	10.48	10.48	
Total non-cash costs					13.70
Total specified establishment costs					$56.94

livestock farms is usually marketed in the form of meat or milk, and emphasis is on handling and storage efficiency to minimize costs.

Cash marketing usually involves moving hay, cubes or other products into an intensive beef or dairy production area.

Marketing procedures resulting in the highest net prices to producers include the following.

- Link production with marketing as interdependent phases of a business.
- Develop effective group marketing or bargaining programs, including trade conditions and terms.
- Consider seasonal price changes and alternatives of storing for later sale or selling at harvest time.
- Forward contract before harvest if satisfactory terms can be arranged. This can stabilize the price and provide an orderly flow from producer to user. (Contract on a group basis.)

Utilize existing facilities, such as a cotton cooperative, as a clearinghouse for orders and for storage.

Marketing information may help farmers negotiate with truckers and buyers. A weekly hay market newsletter, for example, may be helpful.

Successful hay marketing depends upon unified action by producers with timely and accurate market information.

ECONOMICS OF ALFALFA PRODUCTION

Tables 3 and 4 give estimates for establishing a stand of fall-seeded irrigated alfalfa and the annual production costs. Included in the annual production cost estimate is a pro rata share of the establishment cost based on a 5-year stand. Because these costs are not a function of yield levels, they may be used in lieu of more accurate data for individual situations regardless of anticipated production levels or harvesting techniques.

Table 4. Estimated annual costs of alfalfa production per acre, irrigated.

Item	Unit	Quantity	Cost per unit	Subtotals	Totals
Cash costs					
Fertilizer					
Available P_2O_5	lb.	100.0	$ .10	$10.00	
Available K_2O	lb.	80.0	.05	4.00	
Machinery operating	hr.	.3	1.99	.60	
Irrigation operating	ac.-in.	30.0	.69	20.70	
Labor	hr.	8.0	1.75	14.00	
Miscellaneous expenses	ac.	1.0	7.50	7.50	
Establishment cost (1/5)	ac.	1.0	11.39	11.39	
Total operating costs				$68.19	
Interest on operating capital	mo.	6.0	.08	2.73	
Total cash costs*					$70.92
Non-cash costs					
Fixed cost on farm machinery	ac.	1.0	$ 1.22	$ 1.22	
Fixed cost on irrigation system	ac.	1.0	10.48	10.48	
Total non-cash costs					$11.70
Total specified annual costs per acre**					$82.62

*Fertilizer and irrigation costs would be higher for production greater than 5 to 6 tons per acre.
**Does not include any harvesting costs.

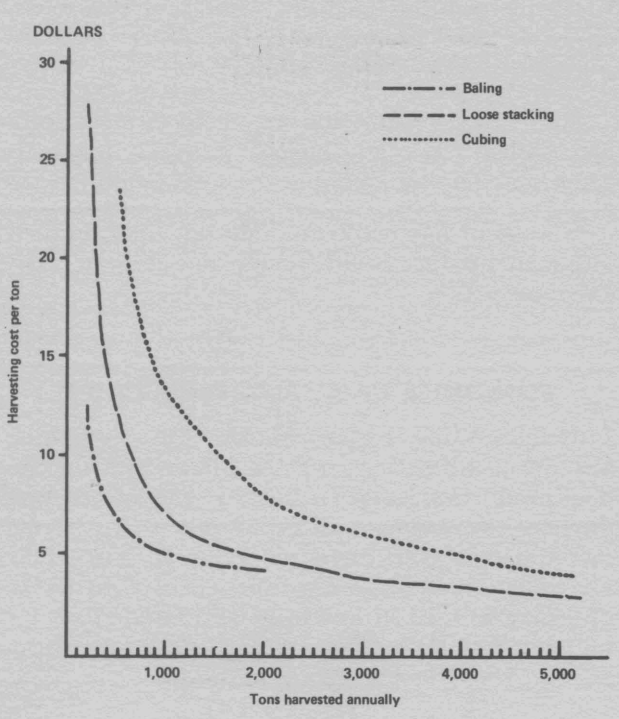

Fig. 1. Estimated per-ton costs of harvesting alfalfa.

Harvesting Considerations

A producer's financial position and preference may determine whether he bales, cubes, pellets, wafers, loose stacks or grazes his alfalfa. A harvesting method, which should be chosen to maximize income, depends upon how the crop is to be marketed. In a given year, a combination of harvesting methods may be employed. Harvesting costs are primarily a function of yield rather than acreage. Estimates of harvesting costs per ton of alfalfa by various methods are shown in Figure 1.

Prices and Returns

The price of alfalfa fluctuates significantly and is inversely related to range and pasture conditions and year-to-year rainfall patterns. The recent development of the cattle feedlot industry in the Southwest, primarily in the Texas Panhandle, provides another market outlet for alfalfa.

Table 5 shows estimated net returns to land and management from alfalfa at various per-acre yields and various per-ton prices exclusive of harvesting costs.

Table 5. Expected per-acre returns from alfalfa.*

Yield tons/A	Price per ton					
	$16	$20	$24	$28	$32	$36
5	$—2.62	$ 17.38	$ 37.38	$ 57.38	$ 77.38	$ 97.38
6	13.38	37.38	61.38	85.38	109.38	133.38
7	29.38	57.38	85.38	113.38	141.38	169.38
8	45.38	77.38	109.38	141.38	173.38	205.38
9	61.38	97.38	133.38	169.38	205.38	241.38
10	77.38	117.38	157.38	197.38	237.38	277.38

*Returns can be interpreted as net to land and management if alfalfa is sold standing in field. Returns should be reduced by harvesting cost if the crop is to be sold after harvest.

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