CHAPTER ONE

SITE SELECTION

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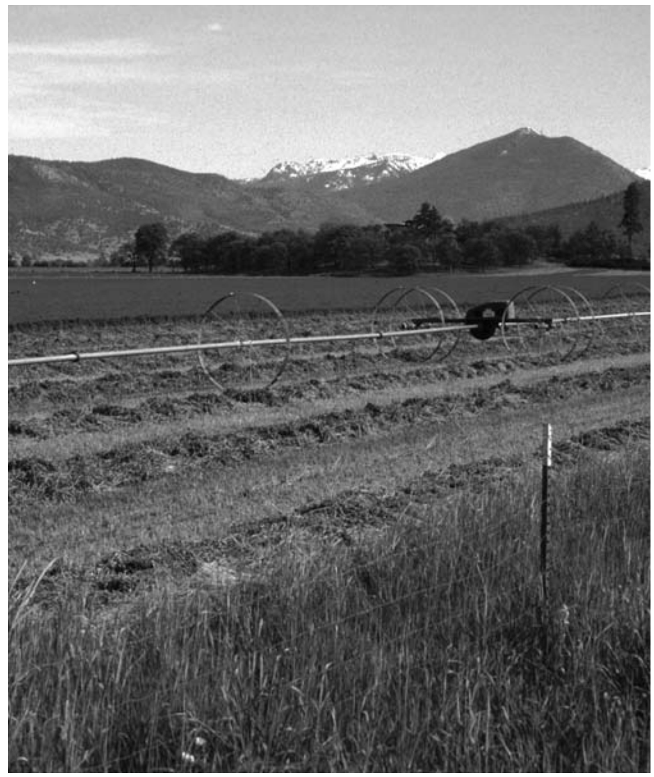

Alfalfa can be grown on a variety of sites in the Intermountain Region of California. Since site conditions often limit both yield and profit potential, a grower should pay particular attention to site selection. Some site limitations can be overcome or reduced, but the cost may be high, affecting future profitability. If site conditions are poor, alfalfa production may be unprofitable even under optimum management.

When selecting a site for alfalfa production, consider the physical and chemical properties of the soil, the likelihood of waterlogging, the topography, and the quantity and quality of available irrigation water (Table 1.1).

When alfalfa is grown on sites that provide adequate rooting depth, nutrition, aeration, and water, and do not present excess salts or alkali problems, growers using good management practices can produce hay yields of 6 to 8 tons per acre. However, greater management skill is required to achieve profitable alfalfa production on marginal or undesirable sites. Remember, the better the site, the higher the potential yield.

SOIL FACTORS

The geologic history of intermountain California is complex. Consequently, within a single 40-acre field may be several different soil types. As the first step in determining the suitability of a site for alfalfa production, learn the soil types found there by consulting soil surveys. Published by the United States Department of Agriculture Natural Resources Conservation Service, these surveys contain soil maps to assist growers in identifying soil units, and include information on texture, water-holding capacity, depth, drainage, and infiltration rate. If the survey indicates that the site may have promise, have the soil and water analyzed. Do this before planting alfalfa on the site. Information on soil sampling methods is presented in chapter 5.

Physical Properties

Soil texture

The term *soil texture* refers to the relative proportion of sand, silt, and clay in soil. Soil texture affects the water-holding capacity and infiltration rate (the rate

Table 1.1. Characteristics of ideal, marginal, and undesirable sites for alfalfa production.

CHARACTERISTIC	UNIT OF MEASURE	IDEAL	MARGINAL	UNDESIRABLE[1]
Soil texture		Sandy loam–clay loam	Loamy sand, silty clay	Sand, clay
Soil depth	ft	>6	3–6	<3
Soil chemistry[2]				
pH		6.3–7.5	5.8–6.3 and 7.5–8.2	<5.8 or >8.2
EC_e	mmho/cm	0-2	2–5	>5
ESP	%	<7	7–15	>15
Boron	mg/L	0.5–2.0	2–6	>6
Frequency of waterlogging or high water table		Never	Only during dormant period	Sometimes during periods of active growth
Slope		Nearly level	Slightly sloping to 12% slope	>12% slope
Water supply	gpm/acre	>8	5.5–8	<5.5
Water quality				
EC_w	mmoh/cm	<1.3	1.3–3.0	>3.0
SAR		<6.0	6.0–9.0	>9.0
Boron	mg/L	<0.5	0.5–2.0	2.0–6.0

Note: These categories are approximate and should be modified when warranted by experience, local practices, special conditions, or irrigation method.
1. These sites are considered unsuitable for profitable alfalfa production unless reclaimed or specialized management is employed.
2. Values are based on saturated paste pH and saturated paste extract concentrations.

at which irrigation water will enter the soil profile). Clay holds the most water; sand allows the fastest water infiltration.

Alfalfa can be successfully produced on a wide range of soil textures, but sandy loam to clay-loam soils are preferred. These soil types provide the best combination of water holding and water infiltration for alfalfa. Sands and loamy sands have such low water-holding capacities that fields must be irrigated every few days, a task that is difficult with most irrigation systems (except center pivot or linear move systems). Alfalfa production on fine-textured clay soils can be equally difficult. In these soils, water infiltration and drainage are extremely slow. Aeration may be poor because the small pore spaces associated with fine soils limit the diffusion of oxygen to plant roots, impairing root growth.

Rocky soils are common in the Intermountain Region. Soils with numerous rocks near the surface are not well suited to cultivation and often damage harvest equipment. Avoid them whenever possible.

Depth and profile

The soil provides a rooting medium through which the alfalfa draws water and nutrients. The deeper the soil, the more water and nutrient storage capacity the site provides. To find soil profile problems, use a backhoe to dig several evaluation pits in a potential field (Figure 1.1). Each pit should be at least 4 feet deep.

> ***A site should provide a minimum of 3 feet of unrestricted rooting depth.***

An ideal site has deep, uniformly textured soil with no drainage or salt problems. Under ideal conditions, alfalfa roots will extend 6 to 12 feet deep or more. Unfortunately, because of the geology of the Intermountain Region, many soils are not that deep. To be suitable for alfalfa production, a site should provide a minimum of 3 feet of unrestricted rooting depth.

Like shallow soils, restrictive subsurface layers limit alfalfa production. The most common problems in the Intermountain Region are hardpans, claypans, sand and gravel lenses, and stratified or layered soils. These reduce alfalfa yields because they present a barrier to root penetration or inhibit water infiltration and drainage.


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Figure 1.1. Use a backhoe to dig several evaluation pits in a potential field to determine the soil depth and to detect soil profile problems.

Soil profile problems are not limited to compacted layers—abrupt changes in texture within the soil profile can have a similar effect. A clay layer within a sandy loam soil or a layer of sand within a loam or clay-loam soil can prevent root penetration and soil water movement. An abrupt change in soil texture impedes the downward movement of water even when water is moving from a clay soil into a sandy layer. Water movement into a different textural class does not occur to any appreciable degree until the layer above is saturated. Consequently, a zone of poor aeration often occurs at the interface between different layers and can even result in a temporarily perched water table. The greater the change in textural class and the more abrupt the change, the greater the effect.

Deep tillage can help reduce, but usually can not eliminate problems associated with hardpans, claypans, and layered soils. Deep ripping is effective to resolve hardpan problems, since a fractured hardpan will not re-cement itself. However, ripping alone is not enough to solve a claypan or layered-soil problem. These problems are only solved by mixing soils to a depth below the restrictive layer. This is usually accomplished with a moldboard or slip plow. Major physical modification of soils is expensive (often in excess of $200 per acre), and alfalfa production seldom justifies the cost. When possible select an alternative site, free of restrictive subsurface layers.

Waterlogging and Fluctuating Water Tables

Some areas of the Intermountain Region are former swamps or lakes and are subject to fluctuating water tables and intermittent flooding. During years of above-average precipitation, the water table level may be well within the root zone of alfalfa. Alfalfa does not tolerate wet soil conditions during periods of active growth: perched or fluctuating water tables in the root zone can severely reduce yields and stand life. Oxygen depletion in the root zone and diseases of the root and crown (such as Phytophthora root rot) often occur under excessively wet conditions.

An intermittent, or fluctuating, high water table is usually more damaging than a stable high water table. With a stable high water table, the alfalfa roots are restricted to the well-aerated soil above the high water table. However, with a fluctuating water table, roots may grow below the high water table level when conditions are favorable, only to become damaged when the water table rises. The damage that occurs from waterlogging depends on the time of year when waterlogging occurs and its duration. Waterlogging is far more serious when it occurs during the growing season than when alfalfa is dormant. Furthermore, the longer waterlogging persists and the warmer the temperature, the greater the injury to the crop.

Deep tillage can improve internal drainage in some soils. Precise field leveling and drainage tile may also help correct waterlogging problems, but the resulting increase in alfalfa production may be insufficient to recover the costs. Avoid sites with waterlogging or a fluctuating high water table.

Alfalfa does not tolerate wet soil conditions during periods of active growth.

Chemical Properties

Fertility

The parent material of a soil largely determines its mineral content and fertility. Most areas of the Intermountain Region are naturally deficient in sulfur and phosphorus. Potassium, boron, and molybdenum are also deficient in some sites. These nutrient deficiencies are easily corrected through proper diagnosis and fertilizer application (see chapter 5); they do not limit site selection.

pH

Soil pH affects nutrient availability and can indicate problems with soil structure. Maximum nutrient availability for most crops occurs when pH values are between 6.0 and 7.0. However, higher pH values (6.3 to 7.5) are recommended for alfalfa production because they favor activity of nitrogen-fixing *Rhizobium* bacteria. Soils with pH values below 6.0 are unsuitable; lime them before planting, particularly if pH decreases with increasing soil depth. On the other hand, soil pH values above 8.2 indicate excess sodium. High-pH sites are relatively unproductive unless reclaimed (Figure 1.2).

Salinity and Sodicity

Problems with excess soil salt (saline soils) and sodium (sodic soils) occasionally occur in the Intermountain Region. Soils formed in enclosed basins under low-rainfall or desert conditions are often saline. Also conducive to high salt concentrations are high water tables in which salts rise because of the upward (capillary) movement of water. Similarly, irrigation water high in soluble salts contributes to soil salinity.

Alfalfa is moderately sensitive to salt. High salt may be toxic and reduce water availability. Visual indicators of excess salt include slick spots, white or black crusts on the soil surface; marginal leaf burn; and the presence of salt-tolerant weeds. Laboratory analysis of soils is required to confirm visual symptoms and to determine the type and degree of salinity. Carefully sample fields at different depths throughout the root zone when salinity is suspected.

Soil salinity is measured by determining the electrical conductivity of the soil extract (EC_e). Salts conduct electricity; therefore, the higher the electrical conductivity of the soil extract, the greater the salinity of the soil. EC_e values above 2.0 millimhos per centimeter (mmho/cm) can suppress alfalfa yields, depending upon the specific ions in the soil-water

Figure 1.2. Soil reclamation requirements.

Before it is possible to reclaim any saline or sodic soil, a grower must have

1. **an ample supply of quality water**
   Reclamation requires a supply of irrigation water sufficient to leach excess salts below the root zone. Until the soil is reclaimed, apply more water than is necessary to satisfy the needs of alfalfa. The extra water carries harmful salts below the root zone, where they are less likely to injure the crop.
2. **good drainage**
   Both surface and internal drainage must be adequate. Water must pass into and through the soil to carry away salts present in the soil or released during reclamation. Salts are not washed *off* the soil surface, but *through* the soil below the root zone. Therefore, soil reclamation cannot occur without adequate drainage to at least the depth of the root zone. Deep ripping or installation of drainage tiles may be required to provide acceptable internal drainage in some sites.
3. **a source of calcium**
   Reclamation of sodic (not saline) soils requires that calcium replace the sodium that is leached off soil particles. If calcium carbonate is present in the soil, sulfur-containing soil amendments can be used to free up the calcium. To soils low in calcium apply a calcium source, such as gypsum.
4. **adequate financing to complete the job**
   Reclamation requires a considerable investment. Unless you have adequate finances to complete the job, reclaiming salt-affected soils may not be a profitable venture.
5. **patience**
   Complete reclamation may take many years. Initially, growers must be content with improved land rather than an actual cash return from crop production.

Adapted from Mueller. 1992. Site Selection. In: *Central San Joaquin Valley Alfalfa Establishment and Production.*

A water supply of at least 7 to 8 gallons per minute is needed for each acre of alfalfa.

solution. Alfalfa suffers a 10 percent yield reduction when soil salinity levels reach approximately 3.4 mmho/cm. In general, soils with EC_e values above 5.0 should be avoided or reclaimed prior to planting alfalfa. If drainage is adequate, saline soils can be reclaimed by deep leaching. Water in excess of crop needs must be applied for deep leaching to occur. This is most easily accomplished by reclaiming the soil prior to planting alfalfa or by applying water during the dormant season, when alfalfa is not actively growing.

Excess sodium can be a significant yield-limiting factor. High sodium levels cause clay particles to disperse. This degrades soil structure; the soil surface seals and water infiltration slows. Soils with an exchangeable sodium percentage above 15 are considered sodic. This means that more than 15 percent of the exchange sites (negatively charged positions on soil particles that hold onto positively charged elements and compounds) are occupied with sodium rather than beneficial elements such as calcium, magnesium, and potassium. When this condition occurs, a laboratory analysis can determine the gypsum requirement of the soil. *Gypsum requirement* refers to the amount of calcium required to displace sodium on the exchange sites. Sulfur can be used instead of gypsum to reclaim soils that are high in calcium carbonate. After an amendment has been applied and sodium replaced with calcium, the displaced sodium must be leached below the alfalfa root zone.

Avoid sites that are adversely affected with excess salts or sodium. The reclamation process usually requires several years and, in the case of sodic soils, a substantial investment in soil amendments. Subsurface drainage systems may also be required to effectively reclaim a site for sustainable economical alfalfa production.

Boron

Some sites present growers with boron problems. In the Intermountain Region boron deficiency is much more common than boron toxicity. Fertilizers can correct boron deficiency (see chapter 5). Because alfalfa is highly tolerant of boron, boron toxicity is rarely a problem in alfalfa fields in the Intermountain Region. When it occurs, however, it can be difficult to resolve. Boron is far more difficult to leach than sodium or other salts. Boron toxicity is usually associated with high concentrations of boron in the irrigation water. Changing the water supply may help correct the problem. High boron levels in soil are difficult to lower; doing so takes large quantities of water and many years. Fortunately, boron toxicity problems are not observed in alfalfa until soil boron levels exceed 6 milligrams per liter in saturated paste extract.

TOPOGRAPHY

Level or nearly level land facilitates irrigation and water penetration. Water accumulation in low spots can "drown out" alfalfa. Uneven or undulating fields may require extensive land leveling. This results in major cut and fill areas, which often create additional problems. Areas where major cuts have been made are usually less productive because much of the topsoil has been removed and the soil may be shallower than in surrounding areas. The productivity of cut areas may not match that of the rest of the field until they have been farmed for several years. Also, significant settling may occur in fill areas, making additional leveling necessary. To alleviate some of these problems, as well as the salinity problems that commonly occur in new fields, produce an annual crop such as small grains before planting alfalfa.

Both topography and soil texture should determine the type of irrigation used. Use sprinkler irrigation on coarse-textured soils or moderately sloping land. Even with sprinkler irrigation systems, the amount of slope that can be tolerated is limited, depending on the soil-water infiltration rate. In most cases, avoid slopes in excess of 12 to 15 percent.

IRRIGATION WATER

When selecting a potential site for alfalfa production, be sure that there is an adequate supply of quality water available for season-long irrigation. Both quantity and quality of irrigation water can limit alfalfa yields.

Quantity

Insufficient irrigation water is perhaps the most common site limitation in the Intermountain Region. Many fields have been planted with inadequate irrigation systems, pump capacity, or water supply. Peak water use of alfalfa, approximately 0.30 inches per day, occurs during July (see chapter 4). To meet peak water needs and compensate for inefficiencies in the irrigation system, a water supply of at least 7 to 8 gallons per minute is needed for each acre of alfalfa. The precise amount depends on the climate of the area and the uniformity of water application. Failure to meet peak water needs results in reduced seasonal yields and profits.

Quality

Poor water quality is occasionally a problem in the Intermountain Region. Water from underground wells may contain excess salt. Excess boron is a problem in some geothermal wells in the region. Some surface water sources contain excess colloidal clays, salts, or weed seeds that can present management and stand-life problems. See Table 1.1 for guidelines about water quality. Toxicities due to foliar absorption of sodium and chlorides can occur with sprinkler irrigation. This is most common during periods of very low humidity and high winds.

Little can be done to improve irrigation water quality. In fact, soil reclamation efforts are unproductive if irrigation water quality is poor. The only cost-effective method of dealing with poor irrigation water is to find an alternative water source or blend the existing water with higher-quality water.

ADDITIONAL READING

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