

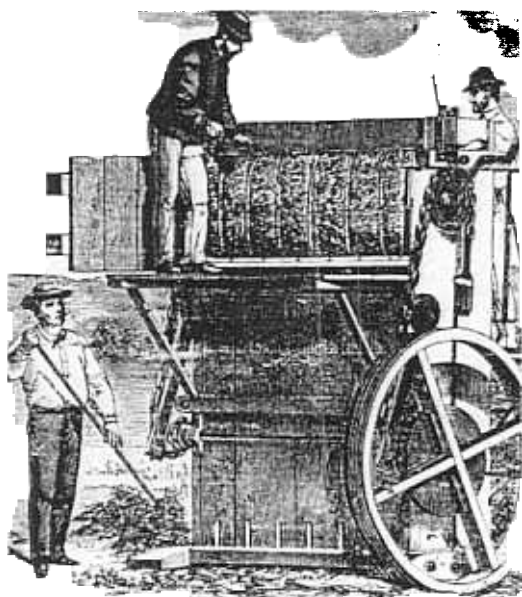


HISTORY, IMPORTANCE, AND PRODUCTION DYNAMICS OF ALFALFA IN CALIFORNIA

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ABSTRACT

Unlike most crops which have moved east-west, alfalfa gained its first important foothold in North America in the valleys and deserts of California in the 1850s after the Gold Rush. Alfalfa played a crucial role in the agriculture of California before the development of the high value fruit and vegetable crops which now are widely associated with the state's agriculture. Although alfalfa acreage has declined in recent decades due to water constraints, crop replacement, and urbanization, California is still the nations' leading producer of alfalfa, and alfalfa is the state's third most important crop in total revenue, behind grapes and cotton. Average California alfalfa yields have increased about ½ ton each decade since the 1920s, to over 7 tons/acre today. Production methods are primarily check-flood irrigation with 3-11 cuttings/year, depending upon location. Most production is in the San Joaquin Valley of California (50%), with an additional 26% from the Low Desert Regions. California is often an alfalfa-deficit state, with alfalfa imported from many neighboring states. Alfalfa will continue to be an important component of California agriculture, due to its indispensability in dairy rations and its interdependence with the \$3 billion/year California dairy industry.



The "Petaluma Hay Press" was commonly used in the San Joaquin Valley in the late 19th Century. Models were both hand-and-horse-powered.

Key Words: History, statistics, demography, varieties, yields, irrigation

HISTORY OF ALFALFA IN CALIFORNIA

Although the first recorded attempt to cultivate alfalfa as a crop in the US was in Georgia in 1736, this and other subsequent eastern colonial efforts were largely unsuccessful (Oakley and Westover, 1922; Barnes et al., 1988). Contrary to the pathway of many crops which were important in the East and then moved west, alfalfa gained its first important foothold in the US in California and other western states of the expanding nation in the 19th Century.

Alfalfa had been introduced to Spain by the

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Moorish invasions of the Eighth Century, and was closely tied with the horse culture of the Iberian peninsula, and thereby military power. Due to this linkage, alfalfa accompanied the Spanish colonial expeditions to South America and Mexico in the 16th Century, and is thought to have been introduced into present-day Southwestern US by early Spanish expeditions. However, the important introductions into California and the United States came during the Gold Rush around 1850 (Barnes et al., 1988)

Gold! The Gold Rush greatly altered the structure of California agriculture. In 1849, the non-native population was 26,000, and by the end of the year was 115,00 and by 1852 was 225,000. The price of cattle rose from under \$4/head to over \$500/head during the gold rush, leveling off at \$50-150/head in the 1850s. A series of droughts and floods hastened the transition from range cattle to hay/forage production in the decades after the Gold Rush. In 1861-62, floods reportedly created a runoff lake estimated to be 250-300 miles long and 20-60 miles wide in the Central Valley. A great drought in the 1860s killed many animals, and reduced herd size 5-fold. During this period, cattle ranchers were learning that irrigated forage production might lend some stability to this volatile enterprise.

California agriculture prior to the 1850s consisted of sleepy rancheros with the predominant economic products being cattle hides and tallow for shipment to eastern ports, Mexico, and South America. Boston, with its shoe industry, was a major recipient. Some Missions had by this time a long history of irrigation of row crops and vines on a small scale, but these were later replaced by the Mexican and American rancheros. Previously, the Native American people of California had represented about 1/3 of the Indian population of the continental US before Spanish contact. However, these peoples were largely non-agricultural, unlike their brethren from the East and Southwest. There is no reference to alfalfa being grown in California much before the 1850s.

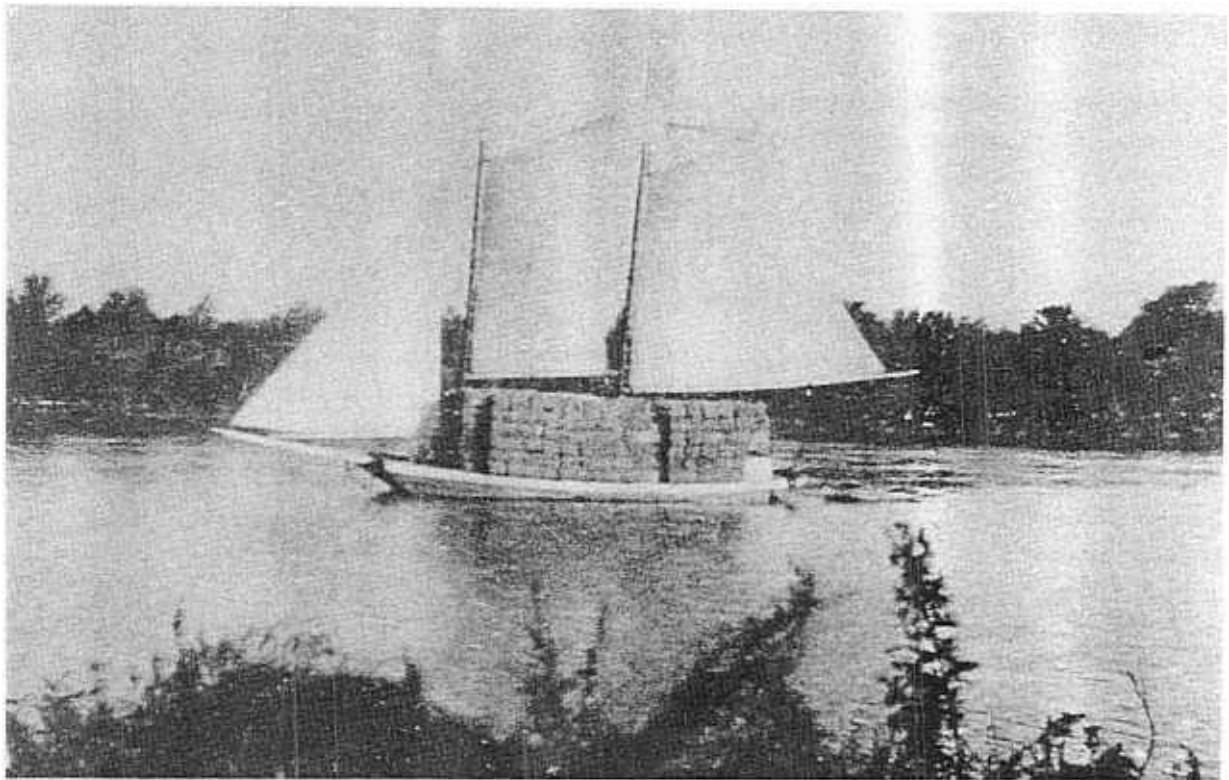
Plant Introductions. While exact dates are unknown, the first alfalfa seed probably entered California from South America between 1847 and 1850 (Hendry, 1926). The earliest references to alfalfa were in the *California Farmer* in 1855, where it was noted that alfalfa was grown on the lawn of home of a Captain Walsh in Benicia, a former capital of the State of California. It is not likely that seed came from eastern sources, since there is no reference to *lucerne* (its common name in the east) before this time. By the late 1850s, the Sacramento Union states that alfalfa was becoming popular among California stockmen (Nov. 26, 1858). In the same year, the US Minister to Chile reported that alfalfa had been cultivated in Chile for more than 20 years and promoted the crop to California stockmen (Clark and Kennedy, 1926).

"In the 1870s, alfalfa was the major irrigated crop in the county. Where farmers formerly cut one crop of alfalfa a year, now they cut five to seven. In 1879 farmland sold for \$25-\$100 an acre; in 1900... irrigated land sold for \$175 to \$300 an acre" - From a history of Yolo Co., California (Larkey and Walters, 1987).

Irrigation. Alfalfa was one of the first crops to be grown under irrigation in California. It was a natural fit with the livestock and the growing dairy industry. It was a faster source of income than grapes, and the income was spread over the season. While non-irrigated wheat was dependent upon far away markets, questionable brokers, huge price swings, and the vagaries of the weather, there was always

a steady, more local demand for alfalfa hay. In Yolo County, near Davis (then called Davisville), alfalfa was the major irrigated crop in the 1870s (Larkey and Walters, 1987), after large scale irrigation was introduced in the 1850s. The first dams and water systems were temporary and typically had to be rebuilt after each winter rain. Later, more permanent systems made alfalfa, vine, and tree fruit production possible. The first system in Yolo County, "James Moore's ditch", for example, was built in 1854, widened and lengthened in 1864 until it irrigated nearly 15,000 acres of alfalfa and about 300 acres of grapevines, the major irrigated crops in the county (Larkey and Walters, 1987).

Hay production in California increased from about 2,000 tons in 1850 to 550,000 tons in 1870 (Jelinek, 1979). This was accompanied by a rapid rise of population (560,247 by 1870), a switch from range to improved beef cattle, and a rise in dairying, primarily around San Francisco Bay,

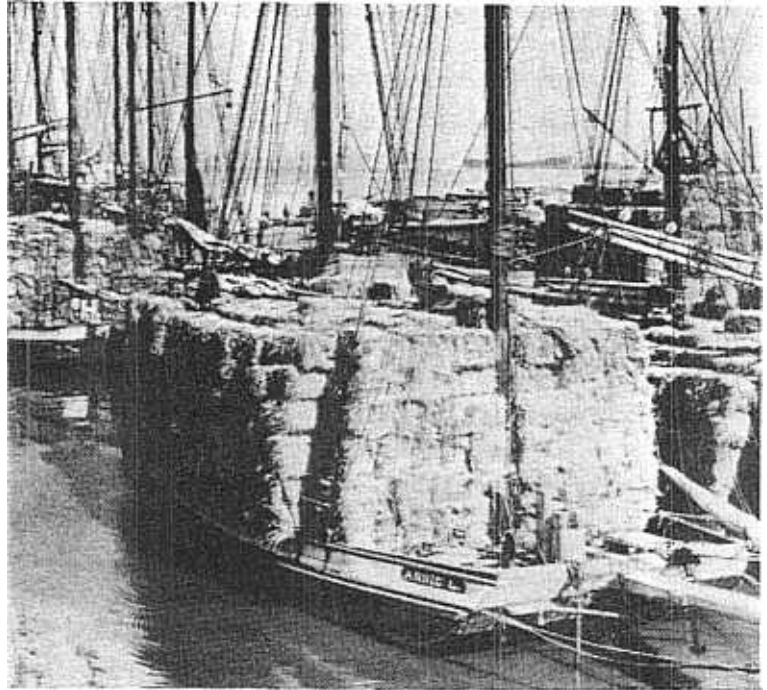


Hay schooners were a common sight on the Sacramento and San Joaquin Rivers during the early years of hay production in the Central Valley of California. Hay was shipped to the San Francisco bay area, Petaluma, and even via larger ships to the East Coast.

Humboldt County, Petaluma in northern California, and Los Angeles in Southern California. The Bonanza Wheat Era (1873-1902), which saw California wheat production rise to second place nationwide (behind only Minnesota), did not diminish the role of alfalfa, which slowly rose in importance during this period with the development of irrigation.

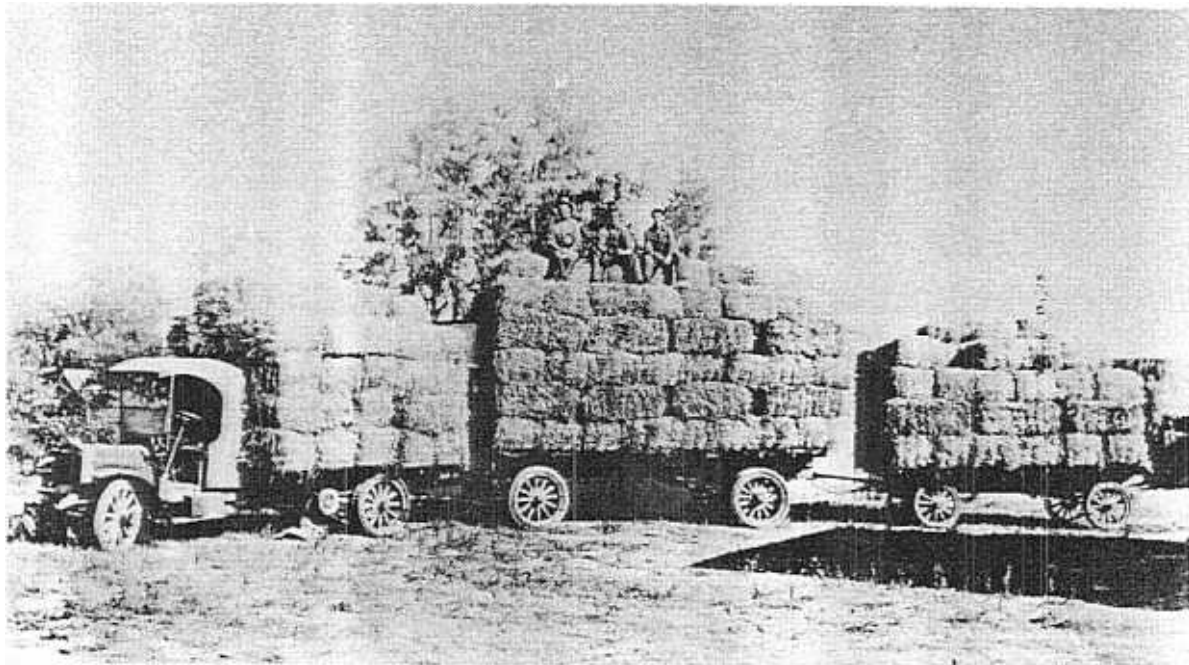
Alfalfa- A traded Crop. The availability of river transportation and the new rail lines greatly enhanced the viability of alfalfa as a cash crop in California, and alfalfa was a traded commodity

from the earliest periods. After all, the transportation system was largely hay-powered, along with steam, water and rail. The San Joaquin and Sacramento Rivers provided a water highway from the agricultural areas of the Central Valley to the growing population centers of San Francisco and other coastal regions, where dairy farming developed. In southern California, alfalfa hay was raised in the deserts around Los Angeles, as well as the San Diego region, and was the key first crop in the newly irrigated areas of the Imperial Valley.



Hay schooners in the delta region of northern California

It may surprise some that by the turn of the century, alfalfa acreage east of the Mississippi River accounted for only 1% of the total US production (Oakley and Westover, 1922), with about 90% west of the Missouri River (Clark and Kennedy, 1926). In the 1920s, the leading alfalfa states were Kansas, Nebraska, Colorado,



Hay transportation on Crenshaw Ave., Los Angeles County, circa 1920s, currently part of South Central Los Angeles.

California, and Idaho, and the average yield for the US was about 2.2 tons/acre (Oakley and Westover, 1922). Introduction and spread of ‘Grimm’ and other winter hardy cultivars hastened the development of alfalfa for northern and eastern states in subsequent years.

California production of alfalfa rose from 484,000 acres in 1909 to almost 795,000 in 1929, by which time the pattern of California alfalfa production and acreage was set. The counties in California with greatest production were Tulare, Fresno, Merced, and Stanislaus in the San Joaquin Valley, which today remains the major production zone in the State. Imperial Valley developed alfalfa as the first major irrigated crop in the area, but lack of proximity of markets was limiting factor. However, the development of good highways, rail links and expanded irrigation increased Imperial’s importance in alfalfa production. In 1919, Imperial produced only 4.0% of the total California tonnage, while in 1929, it produced 11.5% (Braun, 1931), and today produces well over 25% of the state’s production. A process of conversion of alfalfa acreage to higher-value specialty crops (e.g. grapes), has always been a factor in California alfalfa production. This, in addition to high water costs and urban sprawl has limited the acreage since the 1970s. Acreage peaked at about 1.2 million acres in the 1970s, and today is between 900,000 and 950,000 acres.

Twentieth Century Progress. Since the early 1920s, alfalfa yields per acre have increased about two-fold in California (Figure 1). This amounts to an average increase of approximately ½ ton each decade. Unlike many crops which have increased yields in the Twentieth Century, we do not

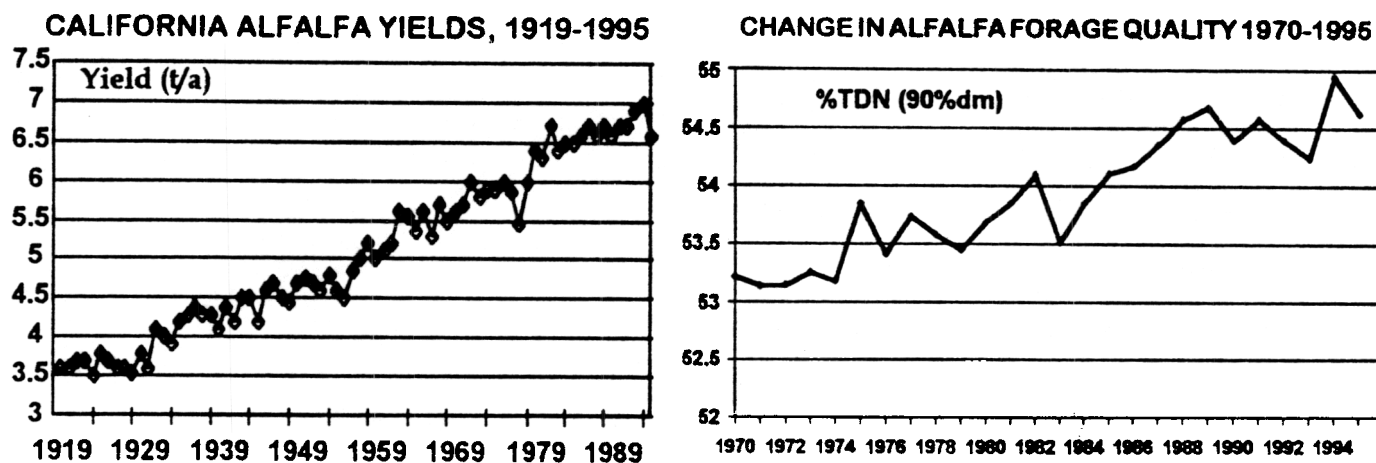


Figure 1. Changes in alfalfa yield and quality in California. Yield data is from the California Department of Food and Agriculture. Forage quality data is expressed as Total Digestible Nutrients (TDN), which is calculated either from MCF or ADF. Data from Petaluma Hay Analysis, average of all cuttings, mostly Intermountain and Sacramento Valley hays.

see evidence of a “yield plateau” in California alfalfa yields; yields appear to be continuing to increase (Fig.1). This progress is due to a number of factors, including improved varieties, better land preparation, better water distribution systems, improved fertility, superior harvesting methods, and overall improved management. It should also be pointed out that shifts of production from lower-yielding areas to the Imperial Valley, which averages over 8 tons/acre has

also been a factor.

In the past twenty five years, evaluation of forage quality has been a significant factor. Petaluma Hay Analysis in Petaluma, CA, just north of San Francisco has shown a gradual increase in quality of the samples they receive from about 53% TDN to about 54.5% TDN (90% dm, Fig. 1). Growers have modified their cutting schedules and production practices to try to meet the demands of dairy producers for higher energy, higher protein hay. It should also be pointed out that the behavior of growers in only trying to test those hays which are likely to give good values may also be a factor in the apparent increase in forage quality over the past 25 years.

Improved varieties played a vital role improving yield. In the 1920s, there were only five groups known to researchers mostly by their country of origin, in addition to the “commons” (California

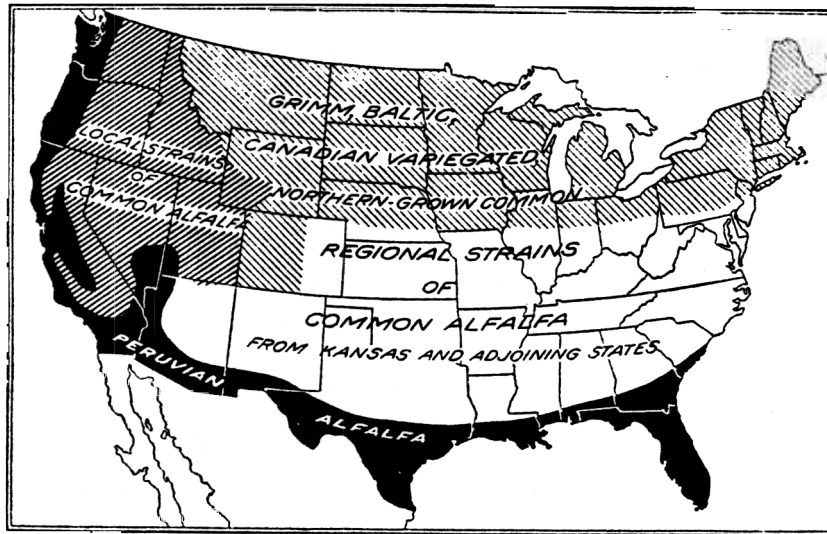


Figure 2. Availability of alfalfa varieties in the United States, circa 1920s (Oakley and Westover, 1921). By contrast, in 1996 the Certified Alfalfa Seed Council listed 256 certified cultivars; 60-70 new varieties are released each year.

Common, Kansas Common, etc.- Fig. 2). So few difficulties were seen with alfalfa prior to the 1920s, that very little research effort was expended on alfalfa (Tufts et al., 1946), but that soon changed as breeders discovered that they could select for improved performance and disease resistance, beginning with Bacterial Wilt. By the 1950s, a greater number of strains were available in California, mostly USDA and Experiment Station selections from the common types and plant introductions. In 1953, the Certified Alfalfa Seed Council, distinguished sponsors of this Symposium, launched educational programs to promote the use of alfalfa and the communicate importance of improved certified alfalfa seed. In 1954, Caliverde, a Bacterial Wilt resistant selection from California Common was released by Dr. Ernie Stanford at UC, and in the same year Lahontan was released by both California and Nevada, a variety developed by Dr. Oliver Smith at Reno. Lahontan proved to be resistant to Bacterial Wilt and Stem Nematode, but not Root Knot Nematode, and later was found to be resistant to Spotted Alfalfa Aphid and Phytophthora root Rot.

Pest Crises. In 1954, the Spotted Alfalfa Aphid [*Therioaphis maculata* (Buckton)] hit with a vengeance, beginning near Albuquerque, NM, and by 1956 was all over California, causing over \$40 million in damages (V. Marble, pers. comm.). 'Moapa' was selected in this year out of African lines, subsequently released in 1957, and, together with Lahantan, quickly became an important means to address this pest problem. In the late 1950s, private plant breeders became active in the improvement of alfalfa, and by the mid 1960s had made significant contributions in developing Pea Aphid (*Acyrtosiphon pisum*)-resistant varieties. Dr. Bill Lehman, working at the UC Research Station at El Centro, release UC Salton and UC Cargo with Pea Aphid resistance, which were quite popular due to their greater resistance to Phytophthora Root Rot and "scald" compared with other varieties.

By the late 1960s, the need for multiple-pest resistance was apparent, and private breeders were much more active. Moapa 69 was reselected from Moapa in 1969 to provide a new source of seed with Spotted Alfalfa Aphid resistance. In 1974 and 1975 there was a horrible attack from a new supposed "Pea Aphid", which was renamed by Dr. Vern Marble as the "Blue Alfalfa Aphid" and later identified as *Acyrtosiphon kondoi* Shinji. It quickly spread throughout the Southwestern USA, and a team of researchers from the Southwest was formed to address this new pest. About 100 plants were selected by Bill Lehman in 1975, tested by the USDA in Tuscon, and released as CUF101, which had 51%-55% resistance to the Blue Alfalfa Aphid plus resistance to the Spotted Alfalfa and Pea Aphids, and some scald and Phytophthora resistance (Lehman et al., 1978), one of the first truly 'multiple pest resistant' varieties released (V. Marble, pers. comm.). The name CUF is an acronym for California (University of California), USDA, and farmer, representing the cooperating entities which produced CUF. CUF101 was the better of two lots (101 and 102) originally tested. CUF101 was later introduced into Argentina, South Africa, Australia, and the Middle East, where it has had a great, almost revolutionary impact, due partly to its greater non-dormancy than local varieties. CUF101, probably more than any other US cultivar, has had a tremendous impact on the alfalfa production of quite a few foreign nations, as well as in California. Today, however, there are a number of cultivars which surpass CUF101 in yield potential.

CURRENT IMPORTANCE OF ALFALFA

Alfalfa is the second most important revenue-producing field crop in California, behind cotton, and the third-most important crop overall (behind grapes and cotton), and the seventh-ranked agricultural enterprise in California (Table 1). Alfalfa is the major feedstock for the state's nearly \$3 billion/year dairy industry, and an important part of the \$1.4 billion/year cattle industry. When taken as an interdependent whole, the forage-cattle-dairy industry is unquestionable the most important agricultural sector in California, and alfalfa is the primary forage, especially for dairy. As detailed above, alfalfa has always been linked with the cattle industry, and grew in importance along with the California dairy industry (Table 1).

The Importance of Dairy. California is currently the nations leading state in the production of milk and cream (Table 2). Dairy production in California has increased 51% from 1985 to 1995 while national production has increased about 9% over the same period (CDFA, 1995). California dairying grew to its present-day status due to a number of factors. One was the

Table 1. Top Ten Farm Products in California, and their value in 1994 (California Agricultural Statistics, California Dept. of Food and Agric., USDA. Sept. 1995).

Product	Value
Milk and Cream	\$2,946,464
Grapes	1,675,361
Cattle and Calves	1,429,294
Nursery Products	1,302,472
Cotton Lint	1,135,527
Almonds	894,250
Hay	868,040¹
Flowers and Foliage	683,978
Processing Tomatoes	655,638
Strawberries	634,126
Total California Farm Value (1994)	\$20.1 Billion

1. About \$712 million of this is alfalfa hay, with the remainder coming primarily from sudangrass, small grain, and other miscellaneous grass hays.

Table 2. Number of cows, average production per cow, total production, and gross receipts from dairies in the five top US dairy states, 1995 (California Dairy Industry statistics, 1995, CA Dept. Of Food and Agriculture).

State	Number of Milk Cows ¹	Average Production/ Cow	Total Farm Production	Farm Cash Receipts ²
	(x 1,000)	(lbs/cow)	(million lbs.)	(x \$1,000)
California	1,254	20,197	25,327	3,078,480
Wisconsin	1,490	15,397	22,942	2,915,917
New York	703	16,562	11,643	1,493,710
Pennsylvania	642	16,511	10,600	1,456,359
Minnesota	599	15,763	9,442	1,185,504
Total US	9,461	16,451	155,644	19,923,557

1. Average number is during year, excluding heifers. 2. Milk and Cream only.

phenomenal increase in California's population to become the most populous US state, thereby creating ready local markets. Immigrant families, many Dutch, Italian, and Portuguese with skills in dairying settled here, mostly disembarking from western ports. But one of the major factors was the ready supply of inexpensive feeds, primarily byproducts from the diverse agriculture of the state, and, of course, a ready supply of high quality pure alfalfa hay. These byproducts (cottonseed, sugarbeet pulp, tomato pumice, almond hulls, etc.) were initially provided at little or no charge to the dairy producers. The past 25 years has seen these products grow into commodities of considerable value. Recently, the high commodity prices have caused many dairy producers to cut back on these purchased commodities, creating an even higher demand for alfalfa and other forages.

The phenomenal growth rate of California dairies amounting to about 5% per year has created a tremendous and continuing demand for high-quality alfalfa in the state. In recent years, demand for high digestible energy, high protein hay is seldom fully satisfied in California markets, and a significant portion comes in from neighboring states. In addition, the development of export markets to Japan and other far-eastern countries has been an important factor, making California not quite self-sufficient in alfalfa production. California is typically the state with the highest prices in the nation for alfalfa hay, and a "sink" for hay products from all over the West. Imports into California have exceeded exports in the past several years from 1% to 8% of the state's total production, indicating that the state did not produce sufficient supplies for our own consumption.

PRODUCTION DYNAMICS IN CALIFORNIA

Alfalfa is grown in most of the major agricultural regions in California, from near the Oregon border, to near the Mexican border (Figure 3). The Salinas Valley, on the coast near Monterey is the only major agricultural region without significant alfalfa acreage. There are four major production zones in California. The Intermountain Region in Northern California consists of a series of mountain valleys at elevations ranging from 2,500 to 5,000 feet. This region produces about 13% of the state's alfalfa (Figure 4). Alfalfa is the most important cash crop on many of these ranches, and is harvested 3-4 times/year, much of it shipped to the dairies in the coastal areas or the Central Valley. The Sacramento Valley produces about 10-11% of the state's alfalfa crop. In this region, it is rotated with tomatoes, wheat, and corn and harvested 6-7 times/year. The San Joaquin Valley is the largest production zone in the state, consisting of about 10 counties which produce nearly half of California's alfalfa. In the southern part of the San Joaquin, alfalfa is often rotated with cotton, which dominates the landscape, and alfalfa is rotated with grains and corn in the northern areas of the San Joaquin Valley. In this area, alfalfa is harvested 7-8 times/year. The desert region produces about a quarter of California's alfalfa, primarily the low desert of Imperial and Riverside counties. Major markets for the alfalfa from this region have been the dairies in the Los Angeles area, and exports. Desert production often occurs on heavy soils, and at very high temperatures. Alfalfa is harvested 8-11 times/year in this region. The San Joaquin Valley and the Desert Region lead the state in average yield potential. Average regional yields and statewide yields are given in Figure 4.

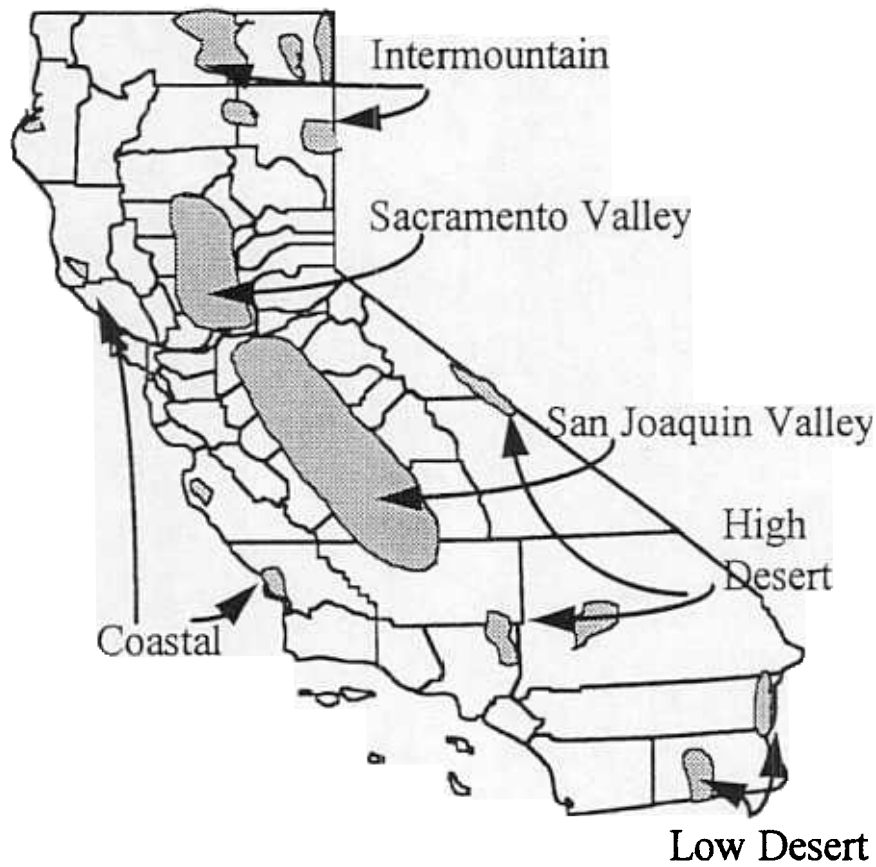


Figure 3. Alfalfa production regions in California.

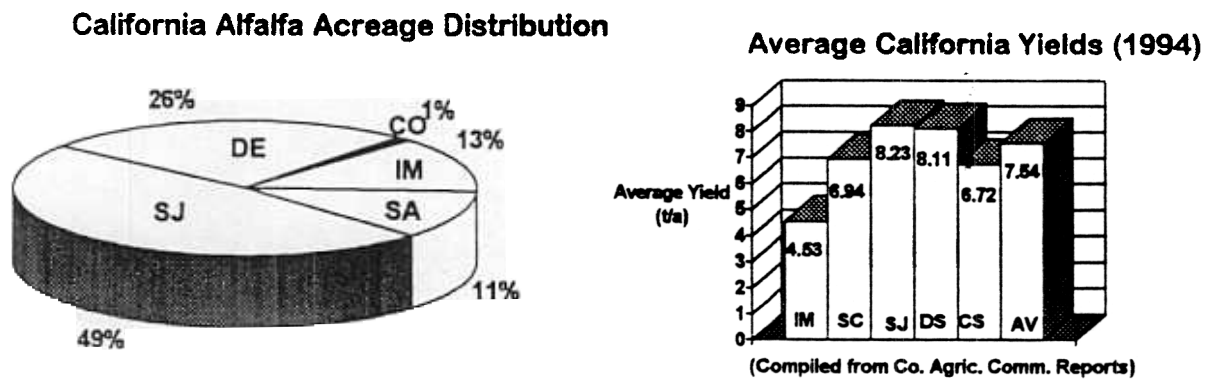


Figure 4. California Acreage distribution and yield of alfalfa, mid-1990s. Regions are the San Joaquin (SJ), Desert (DE), Coastal (CO), Intermountain (IM), and Sacramento (SA). AV is statewide average.

THE FUTURE

There is little doubt that the fortunes of the California alfalfa producers are closely linked with that of the state's \$3 billion dairy industry. The demand for high-quality legume forages by dairy producers is rarely fully satisfied by California producers, a trend which is likely to continue. It is unclear whether the rate of dairy expansion will continue the rate of growth of the past ten years of about 5% per year. Exports have also been of increased importance for California forages. Alfalfa acreage is circumscribed by water price and availability, competing crops, urbanization, as well as demand. It is unlikely that alfalfa acreage will increase in the future, and further gradual acreage erosion in the major areas is likely due to these constraints. However, the presence of such a large in-state demand for high quality forages, as well the important role of alfalfa in rotations (see Putnam & Kafka, 1995) will likely assure a vital role for alfalfa well into the future of California agriculture.

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