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California Field Crops: Location and Trends in Acreage, Yields, and Production, 1945-1991

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INTRODUCTION

California's agriculture is not only the largest of any state in the United States, but it is unique in that it contains broadbased, major commercial production of field crops, of fruit and nut crops, and of vegetables, in addition to significant dairy, livestock, poultry, apiary, and nursery and flower crop production. Its diversity in soils, climate, water and other resources, together with energetic and innovative management of production agriculture, marketing, processing and trade yields an agricultural product which is enviable across this nation and around the world.

Information about characteristics of California agriculture is often requested from a broad spectrum of people—among them, farmers, prospective farmers and other rural residents, investors, policy makers, input suppliers, bankers, students, and interested lay people. This report discusses changes observed since 1945 as a tool for better understanding of the current setting for field crop production in California.[1]

The report serves two purposes: It records longtime trends and short-run changes, and it aids in understanding future cropping possibilities. Because the figures on year-to-year changes cannot be considered precise, the discussion generally follows longer trends. However, certain year-to-year changes are quite pronounced and are clearly explainable by unusual weather, acreage controls, or widespread incidence of pests or disease.

This report summarizes changes in the production of California field crops through 1991, emphasizing those of the turbulent 1980s marked by external forces which had profound impacts on production agriculture—e.g., high interest and inflation rates and softening world markets at the start of the decade, the 1983 Payment-In-Kind (PIK) program, substantial financial stress in the mid-1980s, new farm programs in 1981, 1985 and 1990, increased regulation particularly of chemicals, and uncertain water supplies due to the drought, to name a few. The use of more sustainable agricultural practices, more careful management of limited water supplies, and prospective impacts from free trade and GATT policies are among the forces likely to exert major influences on field crop production in the remainder of this century.

This report on California field crops is the first of several on California crop and livestock production. Another, printed in 1994, is *California Vegetable Crops: Production and Marketing.* Two more are planned in the series—California fruit and nut production and California livestock and poultry. Of the three crop sectors—field crops, fruit and nut crops, and vegetable crops—two (fruit and nuts, vegetables) have expanded during the 1980s and one (field crops) has contracted both in terms of harvested acreage and its share of value product (Figure I). Field crops, which generally use land more extensively than tree or vegetable crops, still are the predominant cropping activity in California. However, the field crop share fell from 72.1 percent of cropped acreage in 1980 to 61.3 percent in 1990, while the relative share of total value of production fell even more significantly—from 42.3 percent in 1980 to 27.0 percent in 1990. Thus, while field crops still use more of California's agricultural land than do fruit and nuts or vegetables, field crop production no longer dominates in terms of value of production. In 1980, the value of field crop production was larger than the value of either tree fruit and nut or vegetable crops, while in 1990, it is smaller than either of the other two.

Part of the decline in the share of cropped acreage is the overall decline in total acreage cropped in California during the 1980s. Figure II shows slowly rising acreages of both tree fruits and nuts and vegetables over the decade, while total state acreage trended downward from 9.5 million acres in 1980 to 8.1 million in 1990. The decline came solely from reduced field crop acreage. Particularly noticeable is the sharp reduction in field crop acreage in 1983 in response to the PIK-program which provided growers incentives to remove cropland from production in that year.

California's Field Crop Production

In this report we bring together acreage, yield and production information for California's 13 major field crops. The 13 field crops (together with hay, other than alfalfa) accounted for 93.3 percent of field crop acreage and 95.6 percent of the total value of California field crop production for the 1990 crop year (Table I). Two crops, alfalfa hay and cotton, were harvested from more than a million acres; the value of one crop, cotton, exceeded 1 billion dollars.

The proportion of acres harvested of various field crops can be compared with their relative contributions to the total value of field crop pro-

[1] For a discussion of acreages, yields and production trends before 1945, see Johnston, W. E., and G. W. Dean, *California Crop Trends: Yields, Acreages, and Production Areas.* California Agricultural Experiment Station Circular 551, November 1969.

Figure I. Harvested Acreage and Value of Production, California Field Crops, Fruit and Nut Crops, and Vegetable Crops, 1980 and 1990

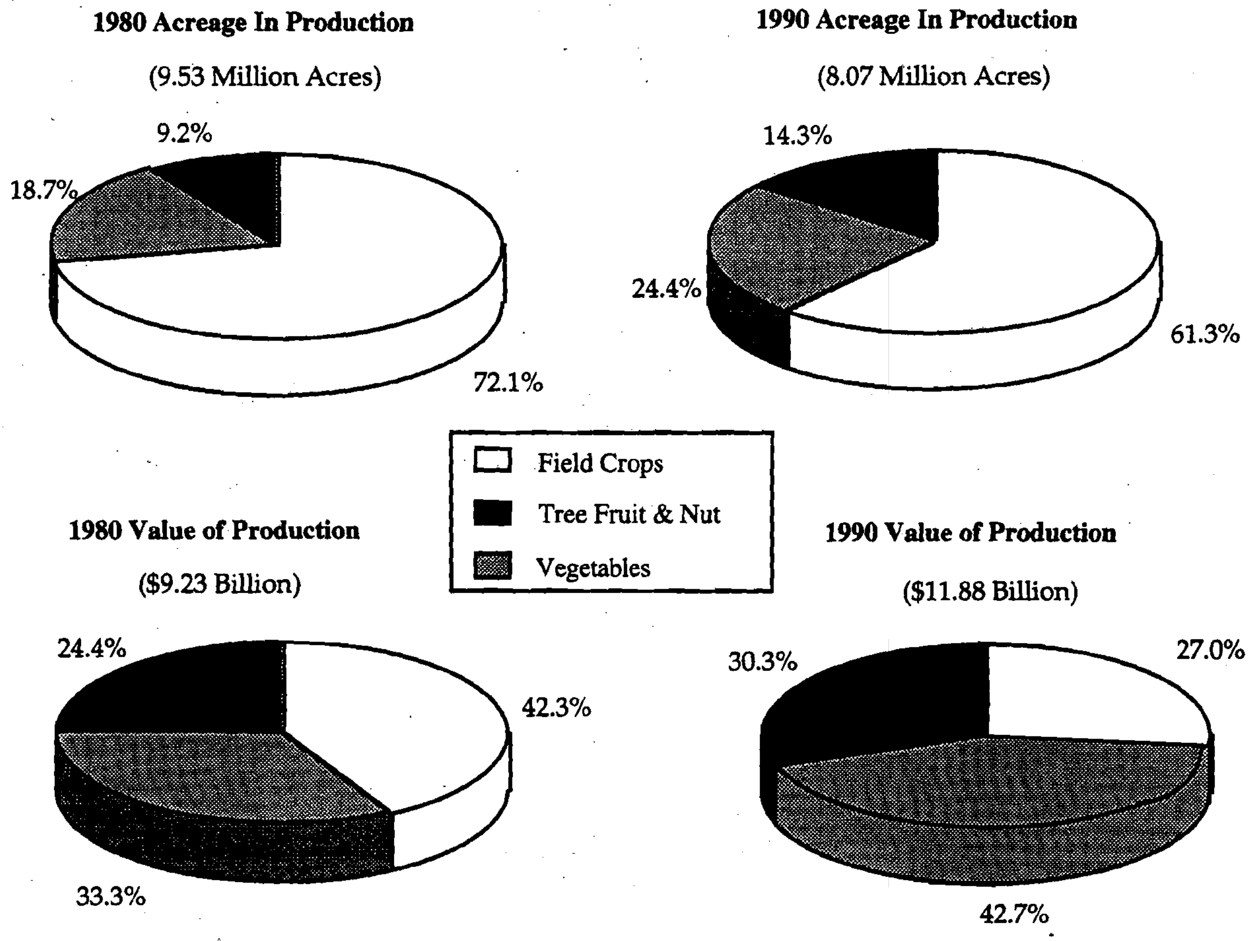
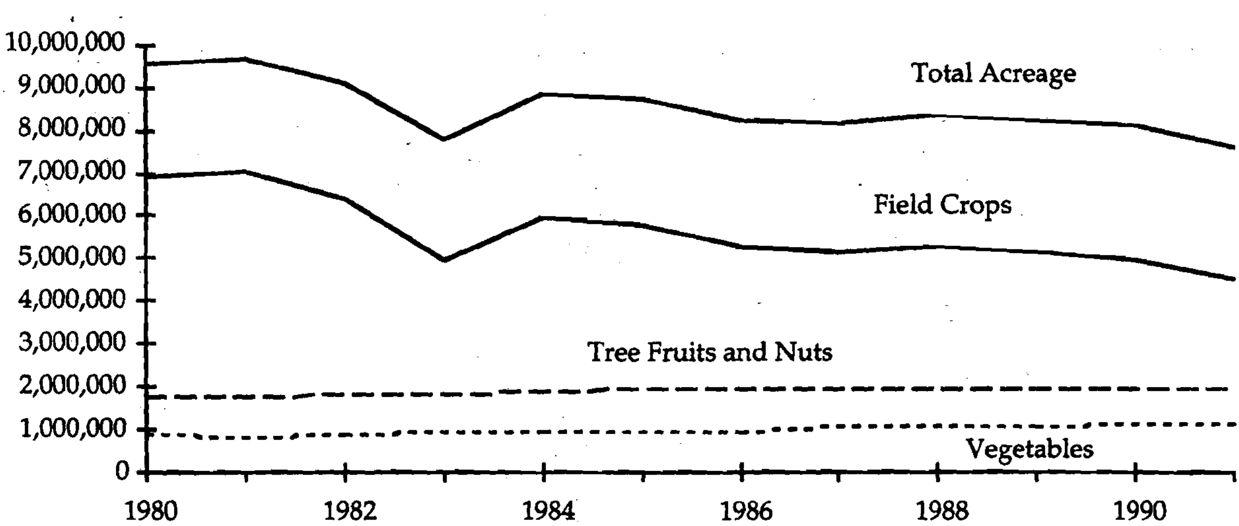


Figure II. Harvested Acreage of California Field Crops, Fruit and Nut Crops, and Vegetable Crops,1980-1990



duction, using data included in Table I, Cotton, the most valuable field crop, was grown on 22.6 percent of the field crop acreage, but its production represented a disproportionately greater (31.4 percent) of the total value of all field crops grown—and when the value of cottonseed is included, cotton production accounted for 36.3 percent of the value of all California field crops. Other crops, which have higher proportions for the value of production relative to harvested acreage, are sugar beets, potatoes and sweet potatoes.

Table I. California Field Crops, Acres Harvested and Value of Production, 1990

	1000 acres	1000$
Alfalfa and other hay	1,630.0	905,463
Alfalfa Seed	71.0	50,494
Barley	230.0	26,500
Dry beans	166.0	94,483
Corn for grain	160.0	78,080
Cotton	1,115.5	1,021,281
Cottonseed	—	161,276
Potatoes	50.0	183,580
Rice	395.0	190,190
Safflower	n/a	37,150
Sugar Beets	168.0	184,386
Sweet Potatoes	8.3	24,265
Wheat	619.0	157,618
Other field crops, including grain sorghum	n/a	142,458
TOTAL	4,612.8	3,257,224

Total field crop acreage since World War II has varied between 5 and 6 million acres, but the location of field crop acreage within the state has been affected by urbanization; by competition from higher valued fruit, nut, and vegetable crops; and by development of new extensively-farmed arable lands largely on the west side of the San Joaquin Valley, and to a lesser extent on the west side of the Sacramento Valley. There are only three exceptions to the bounds of total field crop acreage, all occurring in the past decade (Figure II). In 1981, for the first, and only time, field crop acreage exceeded 7 million acres (7.025 million acres). In 1983, acreage fell to a then all-time low of 4.971 million acres in response to PIK. Gradually declining field crop acreages throughout the remainder of the 1980s resulted in only 4.943 million acres being reported for 1990. A further reduction, to only 4.595 million acres has been reported for 1991, but the 1992 estimate has risen slightly to 4.693 million acres. Recent drought reduced acreage of field crops as some growers have had to allocate scarce water supplies to more conditions have undoubtedly contributed to the valuable fruit, nut and vegetable enterprises, but the trend in declining total field crop acreage is unmistakable in response to California agriculture's diminishing cropland base.

Acreage of specific crops within the field crop subsector of California's agricultural economy has varied, depending on the crop. Alfalfa hay, dry beans, cotton, potatoes and sugar beet acreages have been more stable (resistant to sharp declines over the decade of the 1980s) than have lesser valued, more-extensively grown cereal crops—e.g. barley, grain sorghum and wheat, and to a lesser extent, corn (Figure III). Thus, higher-valued products have better maintained their contributions to total field crop production than have others in the field crop subsector. This is borne out by annual statistics on acreage harvested and volume and value of production. While acreage harvested fell by nearly 30 percent over the period 1981-1990, the volume of production fell by a lesser amount, 18 percent, and value of production declined only 10 percent.

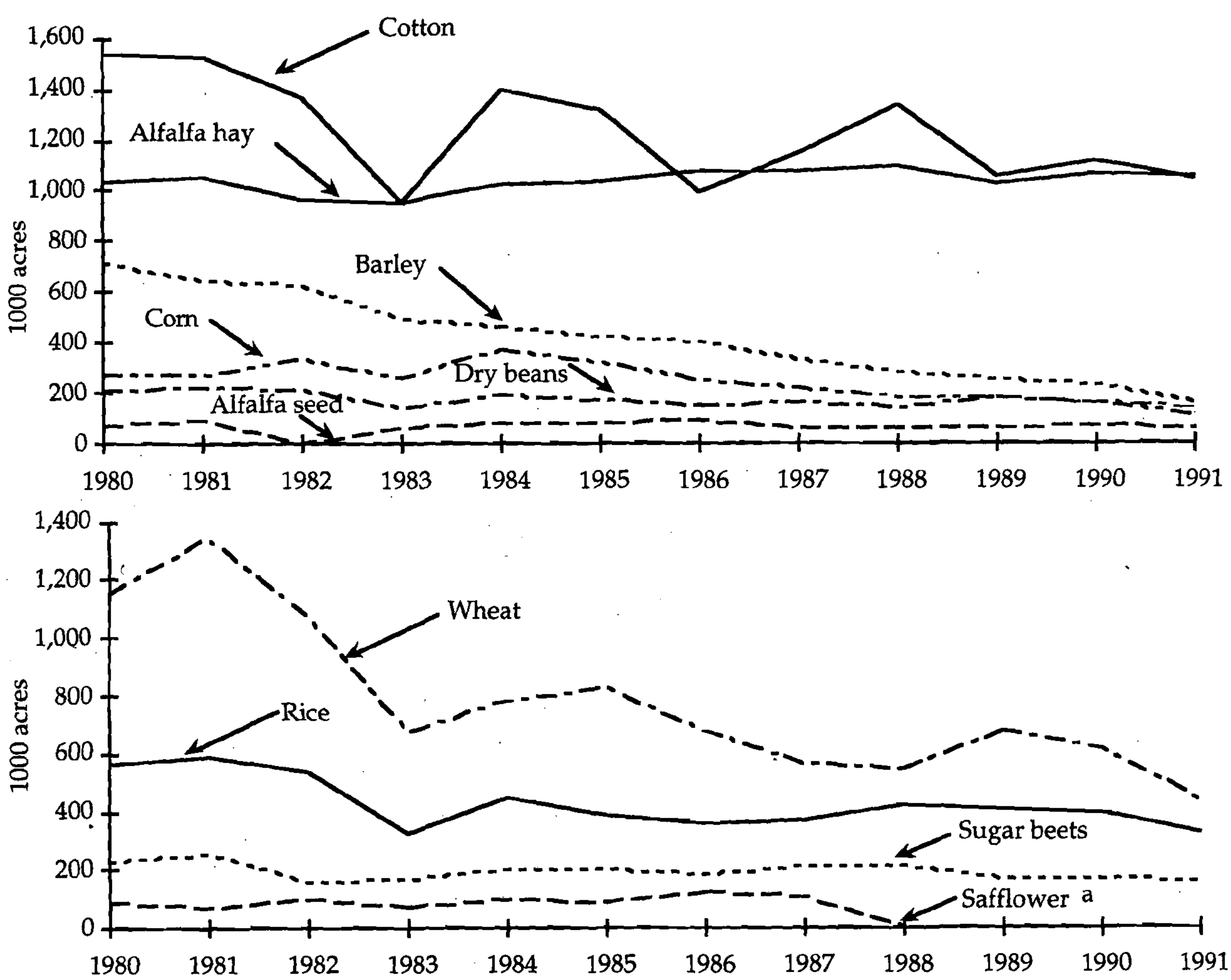
Organization and Acknowledgments

Trends in acreage, yields, and production for the major field crops are discussed crop by crop. Graphs show what the trends have been; the text tells why, and summarizes major factors behind the changes, including recent developments during the 1980s. The main crop production areas in the state are identified and background information is given for each crop.

Location of production is discussed with reference to the standard crop-reporting districts as defined by the California Department of Food and Agriculture. The eight principal production regions of the state are shown in Figure IV. The method of summarizing by county and by district, however, is not entirely satisfactory because the regions are drawn on county lines, rather than by economic or climatic boundaries. Also, the production of certain crops is sometimes extremely localized within a county. For example, rice in Placer County is only grown in the small section of the county that is really a part of the Sacramento Valley, not the mountain production region which encompasses all of Placer County. Over time, crops may shift location within a county or district, but our method of reporting will not reveal this change.

Data sources are not identified in the figures and tables presented in this report. The sources are mainly statistical summaries published by the California Department of Food and Agriculture, the California Agricultural Statistics Service, and the National Agricultural Statistics Service.

Figure III. Harvested Acreage of California Field Crops, 1980-1990

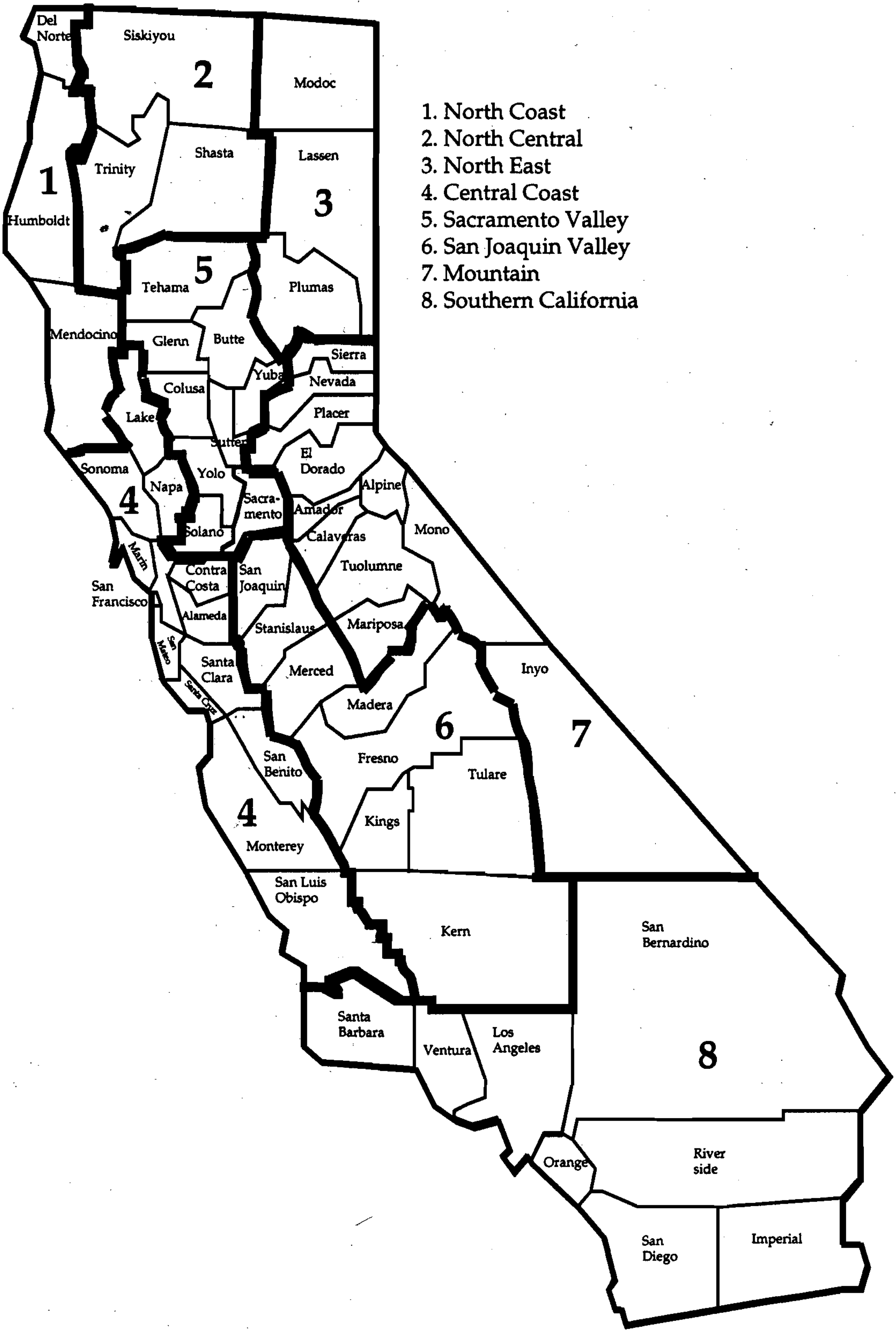


[a] Safflower data not available after 1987

These summaries can be obtained from the publishing agencies or reviewed in various agricultural libraries. Decennial censuses of agriculture were used to a lesser extent. A variety of other publications was consulted to provide background and further statistical data. Many of these publications are listed in the commodity reference sections at the end of this report. The appendix tables give the data behind the graphs in the report.

The author acknowledges the valuable contributions, including review comments, by the following crop production specialists: Larry R. Teuber (alfalfa hay and seed), Lee Jackson and Y. Paul Puri (barley and wheat), Steven R. Temple (dry beans and sugar beets), Thomas E. Kearney (corn, safflower, and grain sorghum), Thomas A. Kerby (cotton), Herman Timm and Ronald E. Voss (potatoes and sweet potatoes), James E. Hill (rice), Steven Kaffka (sugar beets). All are University of California faculty or Cooperative Extension specialists and it is they who provided much of the agronomic and technical information contained in this report. Robert B. Drynan of the California Wheat Commission and Jerry Munson of the California Bean Advisory Board also provided information and comment. Student assistants Erica Meng, Kim Craft, Brian Hauss, Frank Han, and Kimberly Lanier ably collected data and prepared the tables and figures for this bulletin. Carole Nuckton assisted in the final stages of manuscript preparation. The cooperation of all is greatly appreciated.

Figure IV. Production Regions of California



1. North Coast
2. North Central
3. North East
4. Central Coast
5. Sacramento Valley
6. San Joaquin Valley
7. Mountain
8. Southern California

1. ALFALFA HAY

Background

California ranks second in the total quantity of alfalfa hay produced in the United States despite the fact that eight states have more acreage in alfalfa than California. In 1990, California produced nearly seven million tons of alfalfa hay on slightly more than a million acres; Wisconsin's slightly larger production of 8.4 million tons required nearly three times the acreage. States with larger acreages of alfalfa hay than California's are Wisconsin, South Dakota, Iowa, Minnesota, and Nebraska (as shown in Table 1.1), and North Dakota, Montana, and Michigan.

The California yield of 6.60 tons per acre was twice the U.S. average of 3.29 tons per acre. California's greater yields can generally be attributed to non-dormant cultivars that can take advantage of a longer growing season and to the irrigated production of alfalfa hay in the state. Major production areas in the San Joaquin Valley and Imperial Valleys not only have long growing seasons, they also have climates with rare rainfall in summer months to interfere with cutting and baling operations.

California's Alfalfa Hay Production

Hay is the third most valuable agricultural commodity grown in California with a 1990 value of $905 million, ranked behind grapes and cotton. Hay is grown in nearly every county in the state, on generally more acreage than any other crop and alfalfa hay represents about two-thirds of the total hay acreage. California alfalfa hay acreage has generally exceeded 1 million acres since the 1950s with peaks as high as 200,000 acres above that mark— in 1956, 1961, and 1971 (Figure 1.2a). Acreage declined somewhat through the 1970s and early 1980s as Central Valley farmers shifted some acreage to more profitable annuals, e.g., grains (in the 1970s), cotton, and processing tomatoes. In the San Joaquin Valley, alfalfa acreage responds to price and allotment/contract situations for cotton and processing tomatoes and, in the northern part of the valley, some traditional alfalfa land has been planted in trees and vines. Alfalfa hay production in the Imperial Valley is influenced by changes in cotton production conditions.

Table 1.1. U.S. Alfalfa Hay Production, 1990

Leading States	Area 1000 acres	Yield tons/acre	Production 1000 tons
Wisconsin	3,000	2.80	8,400
South Dakota	2,100	1.80	3,780
Iowa	1,700	3.75	6,375
Minnesota	1,600	3.20	5,120
Nebraska	1,450	3.30	4,785
California	1,060	6.60	6,996
United States	25,401	3.29	83,555

Note: California represents 4.2% of U.S. acreage, 201% of U.S. yields, and 8.4% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage; California ranks 9th in the nation.

Location of Production

There are seven major alfalfa climatic zones in the state: (1) low desert valleys of southern California, (2) high desert valleys of southern California, (3) coastal valleys of central and southern California, (4) the San Joaquin Valley, (5) the Sacramento Valley, (6) north coastal valleys, and (7) the northeastern intermountain region. As one moves from zone to zone up the length of the state, the number of alfalfa cuttings per year decreases as the climate cools. The climatic effect on production is varied in southern California, with four to six cuttings in the high desert region and as many as eight to ten in the low desert area. In the San Joaquin Valley there may be six to eight cuttings a year; in the Sacramento Valley, five to six, and in the cool northern northeastern intermountain region, farmers harvest only two to four cuttings a year.

The leading county in alfalfa hay production is Imperial with about one-fifth of the state's harvested acreage and a higher proportion of total value of production (nearly one-fourth) in 1990. Kern and Tulare counties each harvested slightly over 100,000 acres, followed by Fresno, Merced, Siskiyou, and San Joaquin counties.

The major production regions are identified in Table 1.2. Together, the San Joaquin Valley and Southern California (mainly the Imperial Valley) regions accounted for three-quarters of the harvested acreage in 1990—nearly 50 percent and 25 percent, respectively.

Acreages in the two regions have been relatively stable over the 1980s with increases noted for 1990 (Figure 1.1).

In contrast, acreage has increased by about 30 percent in the 1980s for the next most important production region—the Sacramento Valley. Acreage increases during the 1980s in the Sacramento Valley have made that region the third most important in harvested acreage, behind the San Joaquin and Southern California, and ahead of the North region.

Decreases in the North Central region are primarily due to reductions in Shasta County (Siskiyou County acreage has been relatively stable in that region), while the northeastern intermountain production region has shown a 10 percent increase.

Table 1.2. Regional Location of Alfalfa Hay Acreage, 1980 and 1990

Region	1980	1990
	acres	
North Coast	407	290
North Central	96,537	87,647
North East	59,300	64,900
Central Coast	28,473	15,962
Sacramento Valley	79,185	102,889
San Joaquin Valley	463,660	539,858
Mountain	14,456	12,196
Southern California	316,213	268,762
State	1,058,231	1,092,504

Varieties

Since alfalfa is grown in such a wide diversity of climates and on so many different soil types, it is essential that a variety be selected for a particular area that will produce a high yield with good stand persistence throughout its three-to-four year production cycle and proper quality for its intended market. Careful variety and brand selection is essential to success. The number of proprietary varieties has increased significantly during the past decade. The University of California Agricultural Experiment Station and Cooperative Extension have experimental plots throughout the state to test the adaption of various types to differing environments. Findings about stand persistence, resistance to disease and insects, nematode resistance, competition with weeds, and growth characteristics are catalogued annually by variety and brand.

Utilization and Distribution of Supply

Demand for alfalfa is determined to a large part by the size of the state's dairy herd which consumes, by far, the largest share of production—about 70 percent. Least-cost dairy feed formulations tend to keep alfalfa at minimum levels subject to fiber and palatability requirements. Further, the substitution of palatable ensilages has reduced this minimum alfalfa requirement. Although dairy feed strategies have tended to reduce the amount of alfalfa consumed per cow, the increase in the number of cows has more than made up for reductions in usage on a per animal basis.

Fed beef cattle are not significant users of alfalfa, but beef cattle do use enough to affect hay prices as animal inventory expands or contracts. Alfalfa is also fed to range cattle and calves, sheep, and lambs, but generally other types of forage and lower quality hay may be substituted when economically advisable.

California's large horse population is a factor too often ignored in analyses of demand for alfalfa. At one time, oat hay was the most important horse feed, for alfalfa was considered too high in protein and lacking in carbohydrates. Today the principal horse feeds include baled alfalfa hay, alfalfa pellets, or alfalfa cubes. Figuring conservatively, it

Figure 1.1. Regional Location of Alfalfa Hay Acreage, 1980-1990

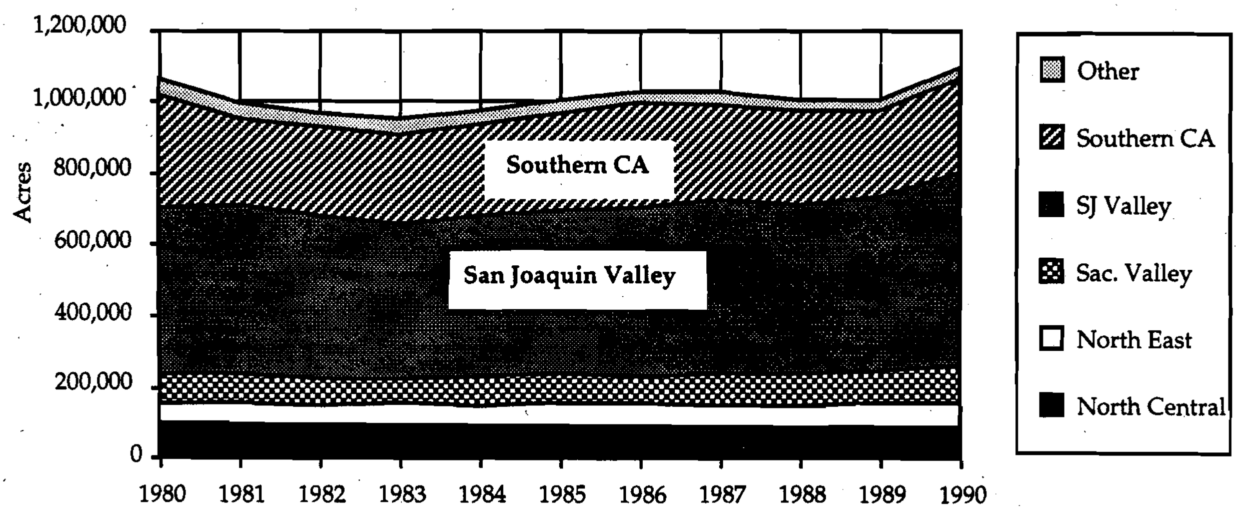
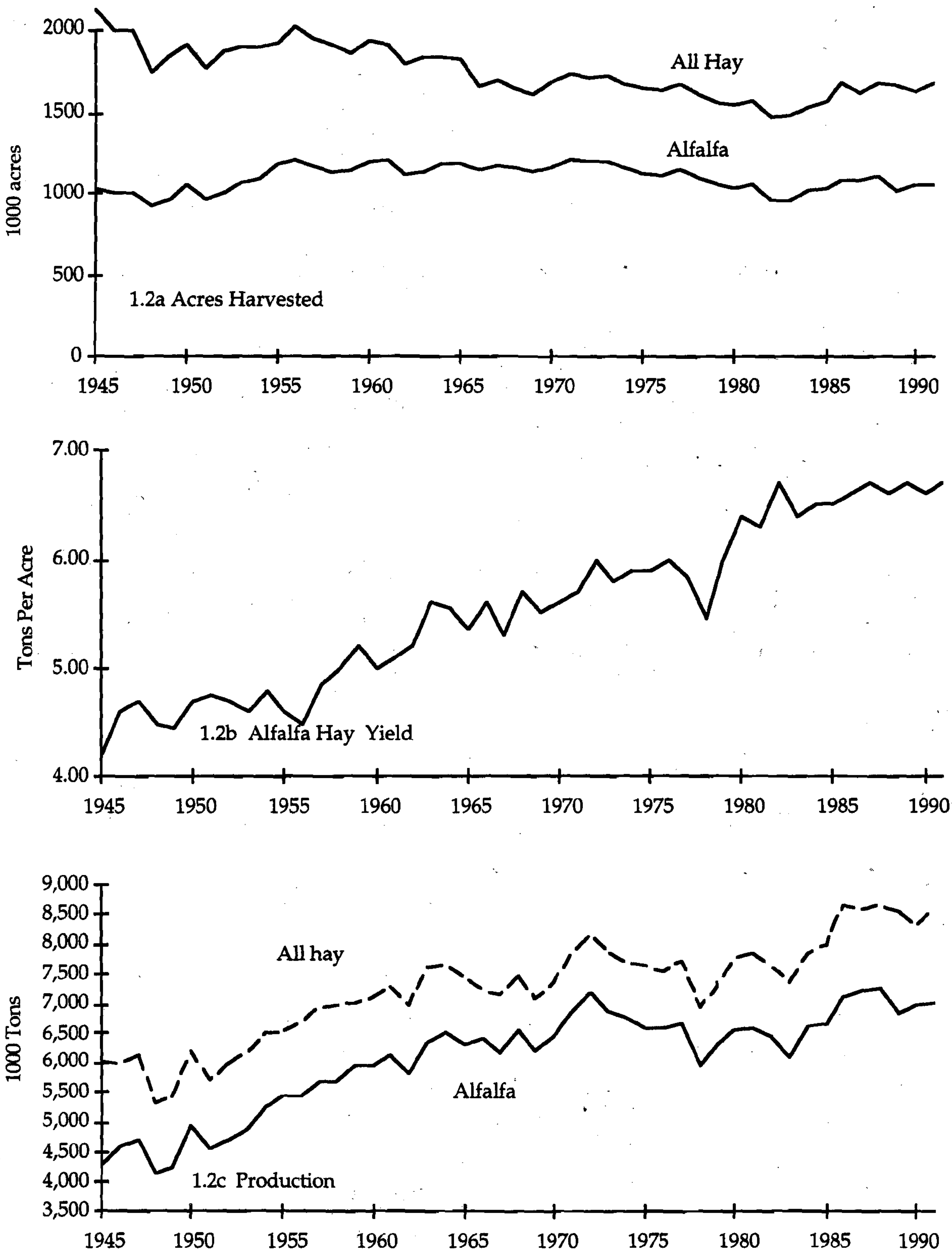


Figure 1.2. California Alfalfa Hay: Harvested Acreage (a), Yield (b), Production (c), 1945-1991



has been estimated that equines consume 17 to 22 percent of the state's production of alfalfa hay.

Trends in Acreage, Yields and Production

Alfalfa hay acreage was relatively constant, in excess of 1.1 million acres, over the period 1955 to 1977. It then fell by nearly 200,000 acres through 1983, but has since risen to range between 1.0 and 1.1 million acres (Figure 1.2a).

Dramatically increased yields (Figure 1.2b) are substantially due to the development of pest- and disease- resistant varieties. In the mid-1950s, for example, the spotted alfalfa aphid was devastating to alfalfa hay production. New, resistant varieties were developed that entirely replaced types formerly planted, and average yields increased into the early 1960s. In the late 1960s and early 1970s, yields continued to increase as further-improved varieties were adopted and better management practices, including proper irrigation techniques, became more widely adopted by producers. Current research focuses on water conservation technologies and management and the development of new varieties to make better use of winter growing periods.

Yield fluctuations about the general upward trend are primarily due to weather conditions. For example, untimely rain can cost a cutting; unseasonable coolness can retard growth; but favorable fall weather can permit an extra cutting. Pests, too, can affect yields significantly. Fair resistance to the pea aphid has been achieved, and varieties resistant to the blue alfalfa aphid have been developed.

The pronounced dip in yields in 1977 and 1978 reflected the severe two-year drought. The post-drought recovery and the increasing yields of the 1980s represent the adoption of multipest-resistant varieties and the increased ability of the state's farmers to manage resources optimally, including limited water supplies during the recent period of drought.

It is primarily better yields that account for the large increase in total production (Figure 1.2c). The 6.8 million tons produced in 1989 were on approximately the same acreage base (but perhaps in different areas) that produced only 4.3 million tons in 1945. Because of irrigated production, alfalfa yields (6.7 tons per acre) are nearly three times higher than those for other hay; as a result, alfalfa constitutes over 80 percent of the state's total hay production on only about two-thirds of the total hay acreage.

Alfalfa is an intermediate product the economic success of which hinges on the conditions in the markets it serves (primarily dairy). The Los Angeles and San Joaquin Valley milksheds are major markets for alfalfa hay. The minority of California's alfalfa hay production is used on farms where it is produced. Alfalfa prices will be affected if changes in national or international agricultural policies result in reductions in California's dairy herd. On the other hand, because of its beneficial effect on the soil, alfalfa remains an important rotation crop on many field crop farms, a fact that moderates the supply response to price decreases. Alfalfa as a perennial crop is planted with a three-to-four-year planning horizon in mind, which further reduces the responsiveness to short-period temporal changes in the economic environment.

Alfalfa is a highly water-intensive crop using 3 to 6 acre-feet of water per season, depending on soil, temperature, length of growing season, natural rainfall, and other factors. Production costs for alfalfa will be directly affected by higher water prices and pumping costs, reducing the long-term profitability of the crop in the state's crop mix, although its importance in crop rotation patterns will most likely remain.

2. ALFALFA SEED

Background

California is the major producer of alfalfa seed in the United States, producing upwards to one-half of the nation's alfalfa seed crop on less than one-fourth of the total U.S. acreage harvested for seed. California and other western states grow alfalfa seed as one would a crop of corn—that is, for the seed alone—while production elsewhere is less specialized on alfalfa seed.

Cultural practices differ substantially from those involved in growing hay. For example, most alfalfa seed crops are now thinned for better yields; whereas thick hay-type stands produce much less seed per acre. In contrast, midwestern seed production is more likely to be a secondary rather than a primary activity. That is, seed may be harvested after two or more cuttings of hay and annual proportions of hay, seed, and forage use of alfalfa acreage also vary with the weather. Yields in the West reflect these cultural differences. California yields per acre for primary alfalfa seed production are five to six times those of midwestern states with production of seed on alfalfa stands for hay and forage uses.

Certified Seed

In the United States, each state has an official seed certifying agency supported by farmers who grow various kinds of certified seed and who pay the agency to perform certification services. In California, the agency is the California Crop Improvement Association, located on the Davis campus of the University of California; the agency cooperates with the University and the California Department of Food and Agriculture. To grow certified alfalfa seed, a farmer must pay a fee to the agency to support research and inspection services which certify compliance with the stringent requirements that guarantee the purity of the final product. In California, from one-half to three-fourths of the total alfalfa seed crop has been certified since the early 1950s. The historical proportion of the crop that was certified is graphed along with total production in Figure 2.2c.

California's Alfalfa Seed Production

Location of Production

The location of alfalfa seed acreage by production region is given in Table 2.1 for 1980 and 1990. The state's alfalfa seed production is concentrated in the San Joaquin and Imperial Valleys. According to agricultural commissioners' reports, two counties in the San Joaquin Valley production region (Fresno and Kings) accounted for nearly 80 percent of harvested acreage, and about 90 percent of total

Table 2.1. Regional Location of Alfalfa Seed Acreage, 1980 and 1990

Region	1980	1990
	acres	
North East	405	607
Sacramento Valley	157	612
San Joaquin Valley	72,610	63,616
Southern California	13,631	15,795
Other	—	619
State	86,803	81,249

production in 1990. Fresno county contained nearly half of statewide acreage (40,000 acres of the statewide total of 81 thousand) while Kings County had nearly 24 thousand acres in 1990. The Imperial Valley is the remaining major production area with about 16 thousand acres and there is minor acreage in Glenn County in the Sacramento Valley. Less than a thousand acres are grown elsewhere in the state, outside of the four counties named above. Most of California's alfalfa seed is grown under some sort of contractual agreement with a processing, marketing firm.

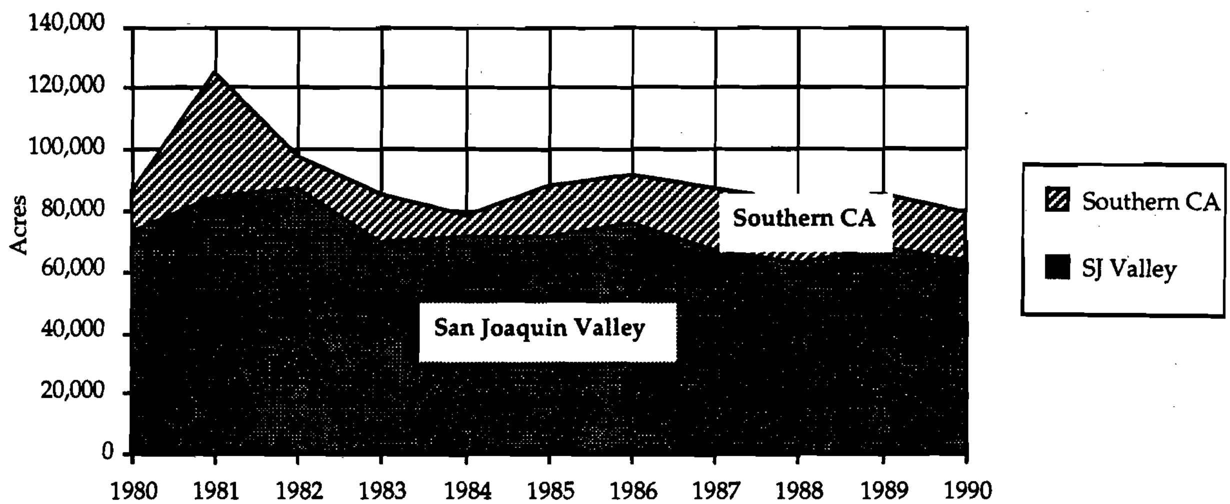
The location of alfalfa seed production is centered in the San Joaquin Valley. This region's production has been relatively more stable than harvested acreage in the Imperial Valley during the 1980s (Figure 2.1). Imperial Valley acreage increased dramatically from nearly 14,000 acres in 1980 to 40,000 in 1981; in the remainder of the 1980s it has largely been in the range of 15,000 to 20,000 acres.

Trends in Acreage Yield, and Production

In the 1930s and early 1940s, alfalfa seed production in California varied between 2.5 and 5 million pounds annually. Sharp increases in both acreage and yield beginning in the late 1940s resulted in achievement of production levels averaging more than 80 million pounds in 1955-57 (Figures 2.2a and 2.2b). The rapid development of the industry in the late 1940s and early 1950s was due to the recognition that seed could be produced in California and exported for planting in other areas and climates.

Imported foundation seed provided the basis for expanded commercial seed production, and California producers proved that they could provide reliable high-quality seed for buyers in other areas. The north central states are the

Figure 2.1. Regional Location of Alfalfa Seed Acreage, 1980-1990



dominant hay producing states in the United States with 60 percent of total alfalfa hay acreage and are thus the chief market for California-produced alfalfa seed. California-grown alfalfa seed is also exported in significant quantities. Early seed production was primarily that of certified public varieties, but over the years, demand has increased for both certified and noncertified private varieties. In the late 1950s and early 1960s, proprietary brands represented from 4 to 6 percent of total production. Rapid expansion of proprietary varieties constituted 47 percent of the 1970 crop. Private varieties now constitute about 60 percent of total production of alfalfa seed in California.

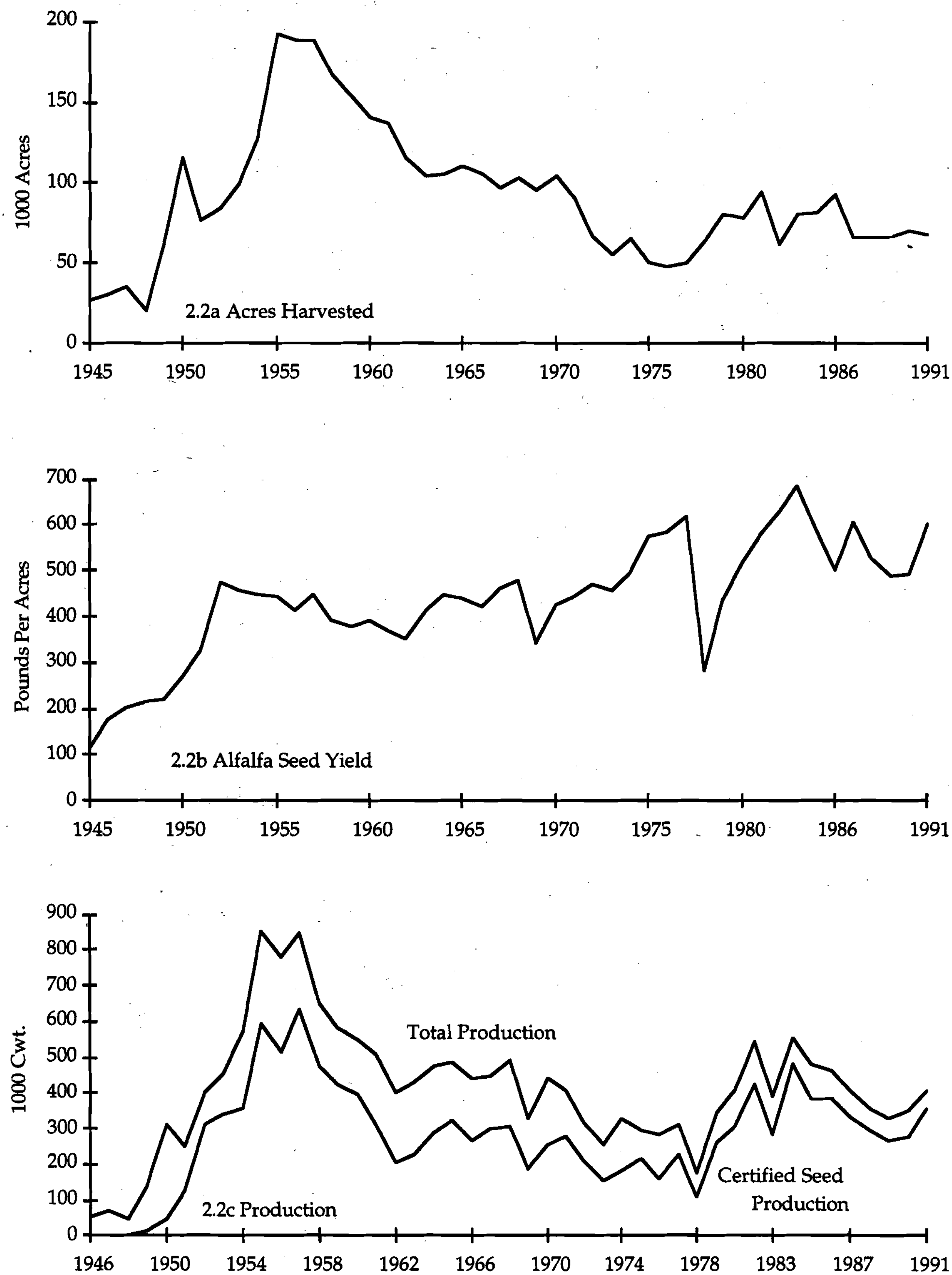
Part of the decline in acreage after the mid-1950s (Figure 2.2a) may have been because of the development of the seed industry in the Pacific Northwest where effective pollinators (wild bees) were more prevalent. Another part was due to general overproduction and also the decline in planted acres of alfalfa hay as continual-rotation corn was adopted in the north central states. Acreage in the 1980s was affected by weather (flooding of the Tulare Lake Basin in 1982) and recent weak market conditions (the current supply of seed in storage is larger than annual demands).

Sharp yield increases in the early 1950s resulted in the attainment of yields in excess of 400 pounds per acre (Figure 2.2b). The dramatic increase was partly due to the change from casual seed production on old alfalfa fields characteristic of the earlier period, to the more specialized commercial seed production setting of the industry in the 1950s. A greater awareness of pests, careful pollination considerations, and generally improved cultural programs, including irrigation practices, underlay the higher yield levels.

After 1952, yields were relatively stable for two decades with dips attributable to unfavorable weather conditions. Then, from one of these troughs—1969—yields climbed once again reaching an all-time high of 620 pounds per acre in 1977, and another record of 685 pounds per acre in 1984 following the industry's recovery from low yields in 1978 (only 280 pounds per acre) caused by early fall rains. A state marketing order for alfalfa seed research, authorized and implemented in 1973, may account in part for the improved yield trend of the 1970s.

Yields subsequent to 1984, have been affected by drought years (difficult water supply situations), Prop. 65 restrictions (removal of chemicals to control lygus bugs), and weak market conditions (limiting seed production to more advantageous production areas). Lack of replacement materials to control lygus bugs and market conditions provide considerable uncertainty to California alfalfa seed producers.

Figure 2.2. California Alfalfa Seed Harvested Acreage (a), Yield (b), Production (c), 1945-1991



3. BARLEY

Background

Barley grows in more countries than any other grain, and it ranks fourth after wheat, rice, and corn in total world grain acreage. Its ecological versatility has meant that frequently it is the crop chosen for inferior soils. Today, production is concentrated in the northern latitudes. The largest producer in terms of total harvested acreage and total production is the former Soviet Union. In 1991, the United States ranked 4th in harvested acreage and 3rd in volume of production (Table 3.1).

Table 3.1. World Barley Production, 1991

Leading Countries	Area 1000 ha	Yield kg./ha	Production 1000 MT
Former USSR	28,761	1,460	42,000
Canada	4,480	2,782	12,463
Spain	4,372	2,091	9,141
United States	3,405	2,970	10,113
Turkey	3,400	2,294	7,800
World	76,174	2,224	169,385

Note: The United States represented 4.5% of the world's barley area, 134% of the yield, and 6% of production in 1991.

Barley is grown in many states, but production is concentrated in cooler, drier areas of the country: North Dakota, Montana, Minnesota, Idaho, South Dakota and Washington. California ranked seventh in harvested acreage in 1990 (Table 3.2). Statistics for 1990 show that the California yield was less than that for the United States; that is not usually so.

Barley's main competitor is wheat in the northern areas of the United States. It is generally a less valuable crop than wheat so whenever planting restrictions and set-asides on wheat are relaxed barley acreage tends to decline.

Table 3.2. U.S. Barley Production, 1990

Leading States	Area 1000 acres	Yield bu/acre	Production 1000 tons
North Dakota	2,450	53	129,850
Montana	1,380	41	56,580
Minnesota	800	63	50,400
Idaho	780	72	56,160
South Dakota	500	49	24,500
California	230	50	10,000
United States	7,259	56	418,856

Note: California represents 3.1% of U.S. acreage, 89% of U.S. yields, and 2.5% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage; California ranks 7th in the nation.

The development of barley production in the United States has taken two distinct paths—the one, to grow a grain for malt to use in brewing; the other, for feed. Although the nation's acreage in barley has decreased since the 1950s, acreage devoted to malting barley nationwide has increased in response to increased demand for beer. Annual disappearance for malting and food uses has risen steadily from 150 million bushels in the mid-1970s to about 180 million bushels in 1988-1990. In California, however, the final disposition of locally grown barley in malting usage has almost disappeared with the acquisition of once-local breweries by national or Canadian firms and expansion of national breweries into California.

The portion of the total U.S. crop that goes for livestock and poultry feed remains the largest share. In 1990, 43 percent of total disappearance was used for feed; 38 percent went to the alcoholic beverage and food industries, and the remainder was exported. U.S. barley exports have exhibited extreme variability due to several factors including the availability of other feed grains, relative prices, and crop conditions in other countries. Major export markets have been Japan and Mexico.

California's Barley Production

In contrast to most of the rest of the country, California grows barley almost exclusively for feed. However, about 70 percent of the acreage grown in California's northern production regions (North East and North Central) is of malting varieties. These regions accounted for one-fifth of harvested acreage in 1990.

Location of Production

Barley is grown throughout the state with the bulk being produced on the valley floor and foothill land in the San Joaquin Valley production region. The location of barley acreage by production region in 1960, 1970, 1980, and 1990 is given in Table 3.3.

Most notable is the 50 percent decline in total state acreage from 1,586,000 acres in 1960 to 712,000 in 1980, followed by even more severe acreage losses to only 230,000 acres in 1990. There were much larger than proportional reductions in the Sacramento Valley and Southern California regions over the period 1960-1980, and in the Central Coast, San Joaquin Valley, and Southern California regions in the most recent decade, 1980-1990.

Table 3.3. Regional Location of Barley Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
North Coast	1,100	1,000	900	—
North Central	43,700	33,000	35,800	29,600
North East	32,700	21,500	23,200	14,800
Central Coast	214,000	170,000	155,200	51,300
Sacramento Valley	341,000	177,000	78,800	34,300
San Joaquin Valley	744,000	624,000	372,100	90,200
Mountain	1,500	2,500	1,200	—
Southern California	208,000	159,000	44,800	9,500
Other	—	—	—	300
State	1,586,000	1,188,000	712,000	230,000

Figure 3.1. Regional Location of Barley Acreage, 1980-1990

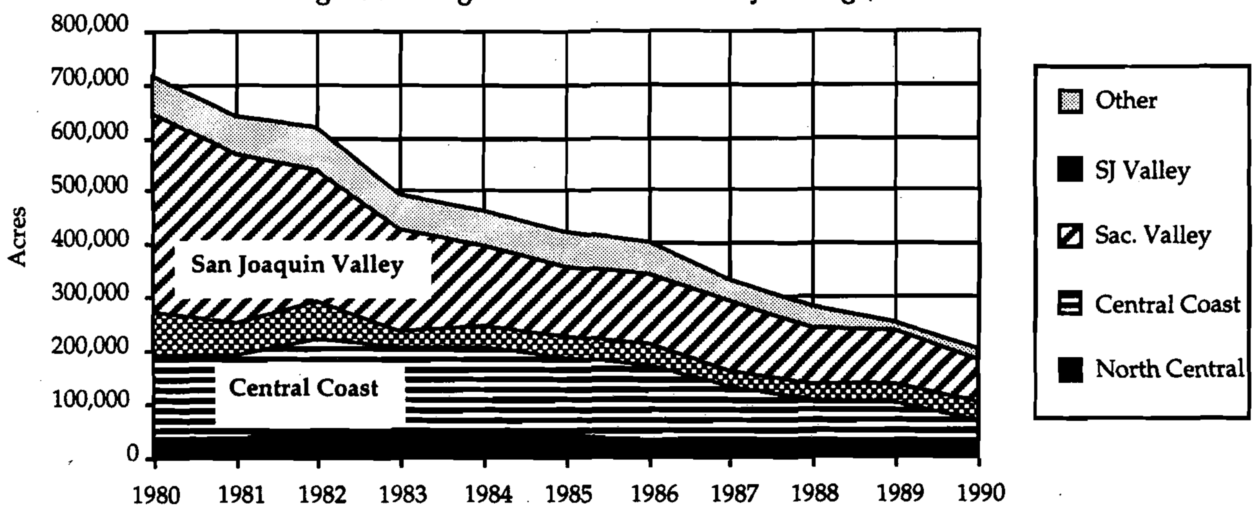


Figure 3.1 shows the changing regional composition of California barley production. The ten major production counties, in 1990, were in rank order: Kings, San Luis Obispo, Siskiyou, Tulare, Kern, Solano, Modoc, Fresno, Monterey, and San Benito counties. The severity of acreage reductions in the 1980s is clearly evident in the differential impact visible in Central Coast and San Joaquin Valley regions.

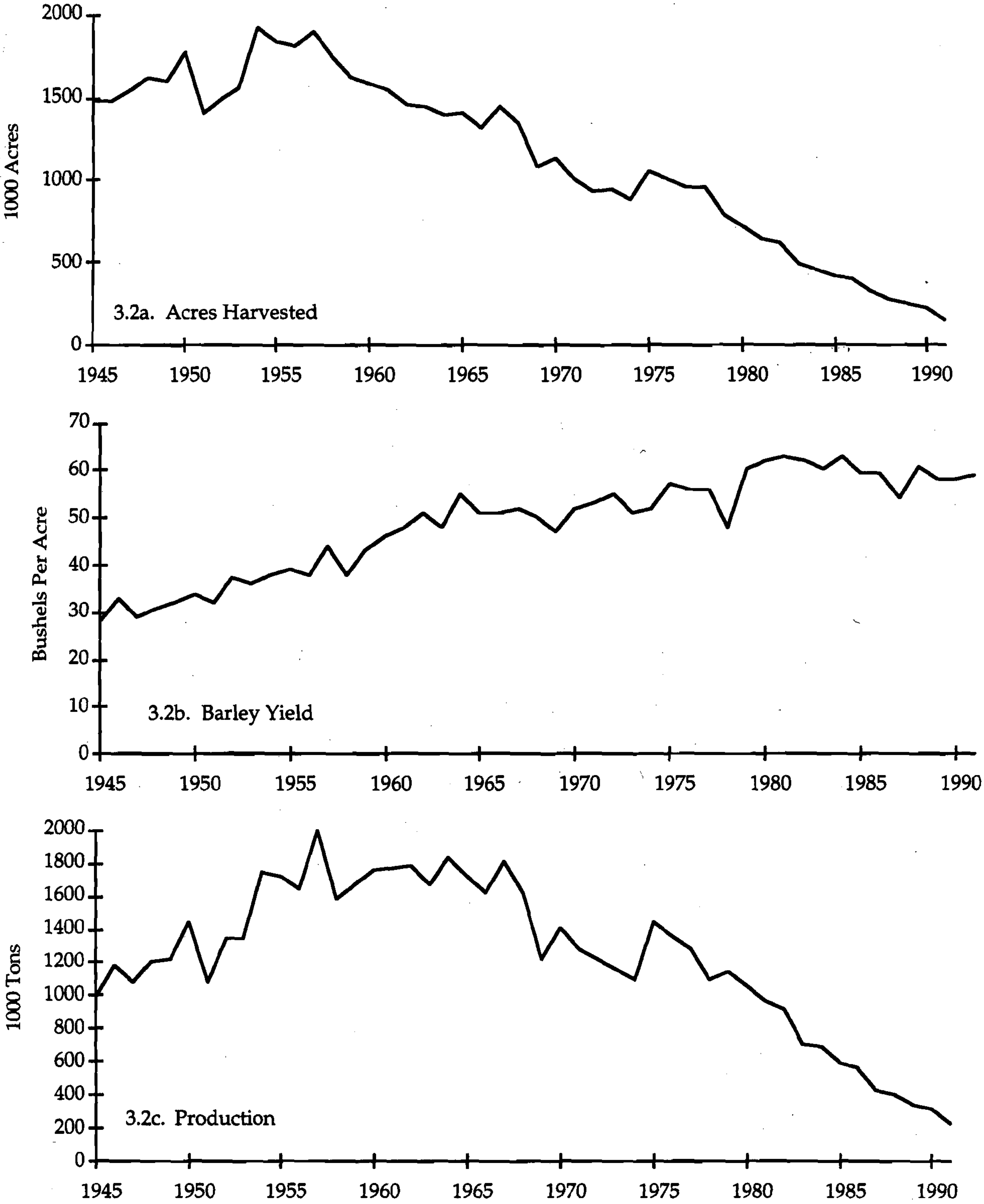
Trends in Acreage, Yields and Production

Before World War I, California barley earned a high premium because of its exceptional malting qualities. Then, expansion of irrigation in the Central Valley and prohibition brought a shift from barley to higher-income crops. Acreage and production rose during the 1930s and later, as Prohibition ended and as farmers recognized that barley was a useful rotation crop for breaking disease and pest cycles. Farmers also turned to barley, and continue to do so, when water is insufficient to raise other crops, or when soils are marginal, i.e., high saline. Gradually, as the emphasis shifted from malt barley to feed barley, the San Joaquin Valley became the dominant production area in the state.

Barley acreage in California has responded when acreage of other high-income crops has been restricted. The peak acreage in the mid-1950s coincides with the imposition of cotton allotments in 1954 (Figure 3.2a). Since 1957, the general trend in the state's barley acreage has been a declining one as farmers have shifted to more profitable crops, including high-yielding semi-dwarf wheat varieties.

The shift of acreage from dryland or rainfed to irrigated land contributed to the increasing barley yields depicted in Figure 3.2b. Barley yields increased through the 1970s. The low yield observed for 1978 was influenced by drought and poor crop conditions. Stable yields during the 1980s occurred despite significant variety improvements because a greater proportion of the acreage was on generally poorer soils. The reduced yield in 1986 the first year of the major drought, reflects crop

Figure 3.2. California Barley:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



failures on dryland acreages.

Barley production increased with increases in acreage through 1957. Fluctuations in production have been closely associated with changes in acreage. Despite steadily increasing yields, barley production has fallen markedly since the mid-1960s because of reduced acreage (Figure 3.2c).

New barley varieties can yield 1.5 to 2.0 tons per acre dryland and 3.0 to 3.5 tons when irrigated. The development of varieties with better lodging-resistance, having the capability of sustaining high yields under irrigation has added importantly to the general upward trend in yields. Better response to fertilization and improved cultural practices have also been important. Genetic yield potential of barley today is nearly as high as for wheat, but the fact that so much barley is grown on inferior soils keeps the state average lower than its potential.

Barley continues as an important crop on reclaimed (salty) land. Because barley can be grown with relatively low levels of fertilization and water, it is an attractive alternative in low-input sustainable agriculture systems, and it may replace some wheat in San Joaquin Valley cotton rotations because of its lesser demand for irrigation water. The availability of numerous feed varieties and several malting varieties allows the farmer to choose the barley best suited to farming circumstances.

4. DRY BEANS

Background

In terms of quantity of dry edible legumes (pulses) produced, the United States ranked fifth in 1990, following India, Brazil, Mexico, and China (Table 4.1). India's area is nearly as much as the next four producers and the five countries together account for about two-thirds of total world production. U. S. production in 1991 amounted to 8.5 percent of world production, but its yield was nearly three times the worldwide average.

Table 4.1. World Dry Bean Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
India	9,487	427	4,052
Brazil	5,508	500	2,751
Mexico	2,041	710	1,448
China	1,417	1,422	2,015
United States	754	1,983	1,495
World	26,316	666	17,525

Note: The United States represented 2.9% of the world's dry bean area, 298% of the yield, and 8.5% of the production in 1990.

In much of the United States, pulse production is limited to the common dry bean. In California, the generic name "dry bean" covers four general types of beans produced in the state, including garbanzos (a chickpea), blackeyes (a cowpea), and large and small limas in addition to common dry beans.

In acreage of pulse production, California ranked sixth behind North Dakota, Michigan, Nebraska, Colorado, and Idaho in 1990 (Table 4.2). Rankings of annual production frequently varies the placement of the top six producing states depending on seasonal conditions and price prospects for the types of beans produced in the various states. (For example, California's production ranked second in 1988 due to poor crop seasons in other rainfed production areas.) New production areas are developing in other upper plains and corn belt states that may ultimately compete with some of the types of dry beans grown in California.

Table 4.2. U.S. Dry Bean Production, 1990

Leading States	Area 1000 acres	Yield lbs./acre	Production 1000 cwt
North Dakota	550	910	5,005
Michigan	330	1,650	5,445
Nebraska	254	1,970	5,004
Colorado	225	1,900	4,275
Idaho	178	2,000	3,560
California	168	1,850	3,108
United States	2,086	1,554	32,429

Note: California represents 8.0% of U.S. dry bean acreage, 119% of U.S. yields, and 9.6% of U.S. production. The states above are ranked 1st through 6th, respectively, in terms of acreage.

While navy beans and pinto beans account for over half of all pulses produced nationwide, navys are not produced in California and only minor amounts of pintos are grown. There are, however, four varieties of beans which have been nearly exclusively grown in California—large limas, baby limas, blackeyes, and garbanzos. Until recently, these types were only produced in California, but Texas is now producing blackeyes; and Idaho, baby limas. The two types of limas and blackeyes alone constituted nearly two-thirds of all dry beans produced in California in 1990.

California's Dry Bean Production

Beans have been important crops in California for over 100 years. Besides their economic value in California (annual production averaging over $100 million for the 1988-1991 period), beans are important in crop rotation patterns in several areas because of their atmospheric nitrogen-fixing capacity. They fit into rotation plans by enhancing productivity of succeeding crops because of their beneficial effects on the soil. Bean straw is beneficial to succeeding crops when incorporated into the soil, and roots are rich in nitrogen. They fit well into low-input, sustainable rotations requiring limited pesticide application. They are best suited to deep loamy soils and require careful water management to prevent root rots and wilts, and scalding when grown in hot weather.

Location of Production

Dry bean production in now concentrated in the Central Valley, with about two-thirds of the acreage in the San Joaquin Valley, the remainder in the Sacramento Valley (Figure 4.1). The two most important counties, in terms of acreage devoted to bean production, are Stanislaus and San Joaquin (about 30,000 acres, each), followed by Sutter (15 to 20,000 acres, annually) and Colusa, Solano, Fresno, Tulare, and Kern (each with acreages of 10,000 to 15,000 annually). Changes in acreages in the production areas over the decade of

Figure 4.1. Regional Location of Dry Bean Acreage, 1980-1990

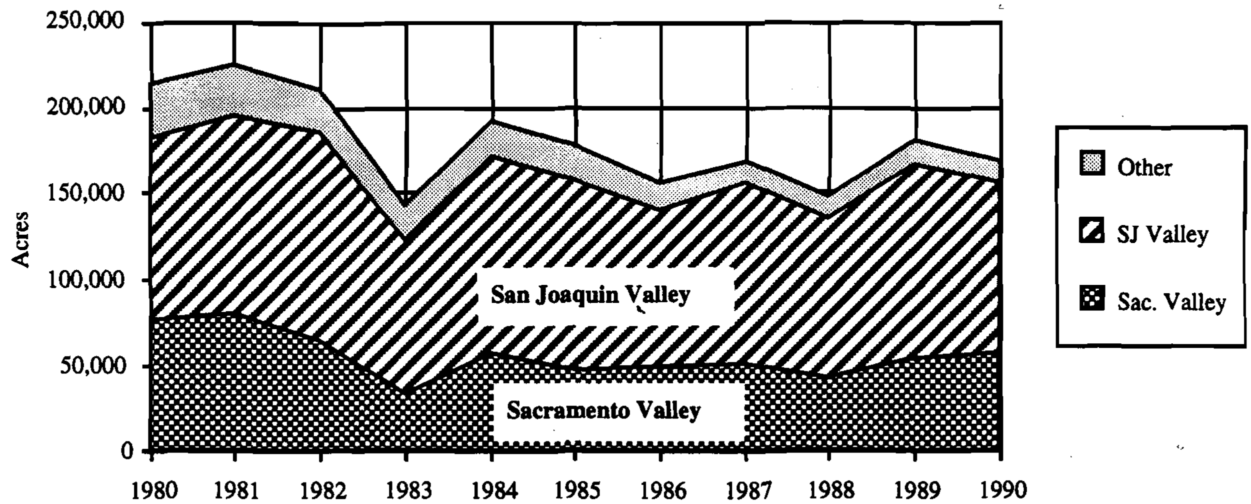


Table 4.3. Statewide Dry Bean Production, 1979, 1990

Variety	1979	1990
	cwt. (clean)	
Large Limas	520,000	460,000
Baby Limas	650,000	570,000
Pinks	240,000	214,000
Small Whites	85,000	—
Blackeyes	850,000	906,000
Light Red Kidneys	530,000	502,000
Dark Red Kidneys	255,000	252,000
Miscellaneous	390,000	154,000
Total	3,520,000	3,058,000

the 1980s are largely price-determined. Acreage outside the Central Valley ("other" in Figure 4.1) is in cooler coastal areas—mainly Monterey and Santa Barbara. Acreages continue to decrease there because of competition of other higher valued crops, urbanization, and disease problems.

Bean varieties and California's Production

An overview of California's bean production is given in Table 4.3, which identifies the major types of beans produced in 1980 and 1990 production years. Market classes, based largely on size, color, and shape, are discussed individually. Acreages of each of the major market classes are shown in Figure 4.2. Acreage changes for bean classes are largely due to changing price prospects and expectations.

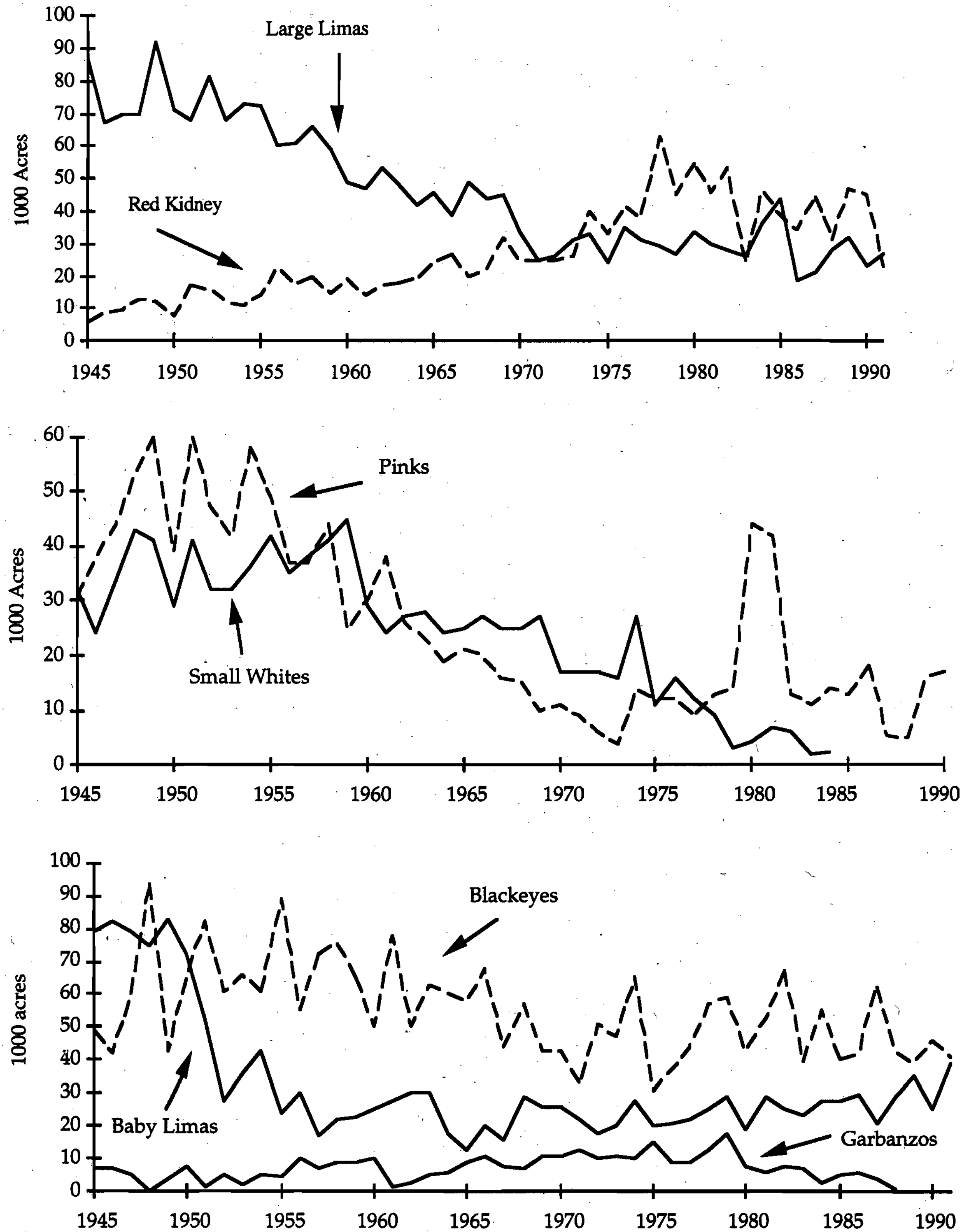
Large Limas. Large limas or standards are of Peruvian origin and were grown in California as a garden vegetable beginning in the mid-1800s. Commercially, they were originally raised for seed, but exceptional yields led to their introduction to market as a dry edible bean. Production was once confined to a long coastal strip stretching between Santa Barbara and San Diego. Today, most of large limas are grown in the Central Valley with a major production area on the west side of the northern part of the San Joaquin Valley centered around Patterson. However, the south coastal regions still produce some of the finest canning quality limas.

Baby Limas. Baby limas were grown by Native Americans long before Europeans came to this continent. Like large limas, early commercial seed production proceeded their development as a dry edible bean market class. It is one of the more flexible beans that finds its way into rotations throughout the Central Valley. Production is concentrated in the northern San Joaquin Valley—Stanislaus and San Joaquin counties—and in Sutter County in the Sacramento Valley.

Both large and baby limas are sold mainly in the dry form, but they may also be canned. About one-third to one-half of the baby lima crop is exported, mainly to Japan, though exports vary considerably from year to year.

Blackeyes. Blackeye beans are a variety of cowpea produced and harvested in California as a dry bean. Blackeyes originated in central Africa and were brought to the United States in colonial times. Southerners still use the cowpea (including blackeyes) for green beans, as a cover crop, and for hay. Production as an edible dry bean was confined to California from the 1960s through much of the 1980s, but commercial production is now being reestablished in Texas, which had produced blackeyes through the 1960s. Blackeyes, however, remain a favorite food in the southern United States, so most of California's production is shipped to the South in either dry or canned product form. Exports, amounting to about 10 to 15

Figure 4.2. Acreage of Major Market Classes of Dry Beans, California, 1945-1991



percent of the California crop are shipped throughout the world. Blackeye bean production occurs throughout the Central Valley with concentration in Tulare and Kern counties.

Red Kidneys. California accounts for about 40 percent of total U.S. red kidney bean production with significant production also found in New York, Michigan, and Idaho. Two types are grown: dark red and light red, with the latter being the predominant variety in California, representing about two-thirds of total production. Light reds are sold domestically in both dry and canned forms and a small portion is exported to Latin American and Caribbean markets. Dark reds are used solely for canning; some are exported to Europe for canning. The light red kidney is New York's most important bean, and one segment of California production is to grow disease-free seed for use in New York. Production is concentrated on river-bottom lands of the Sacramento and San Joaquin rivers, with the most important counties being Sutter and San Joaquin counties, respectively.

Small Whites. California once produced nearly all of the small white beans produced in the nation. They were the preferred variety for use in canned baked beans, but reduced quantities available from Salinas Valley and high prices shifted baked bean processors to pea beans. Acreage is no longer reported and production is minor.

Pinks. California has grown an important share of the U.S. total of pinks. It is sold domestically in dry form and canned with meat products. Some pinks are also exported to Mexico, Puerto Rico, and Brazil. The major producing areas in the United States include Colorado, Nebraska, and Idaho. California production centers in the Sacramento Valley—primarily in Sutter County. Large contracts between the United States and Mexico for pinto and pink beans caused a temporary surge in California's pink bean acreage in 1980 and 1981.

Garbanzos. Garbanzo beans, a variety of chickpea, were brought to California during the mission period. They are not grown extensively elsewhere in the United States. Production was once limited to the cool coastal areas of southern California. That region's dominance declined, beginning in the early 1980s, because of disease problems, and by the end of the decade it was essentially out of production. Two significant University of California varieties now signal a change in the industry. While a disease-resistant variety has been developed for the coastal production area, a second variety introduces the garbanzo as a winter crop in the San Joaquin Valley. New growers in the San Joaquin Valley produced a crop of about 150,000 cwt. in early 1992 which is comparable in size to the largest crops produced in the traditional production area in the 1970s. The next few years will better define the location of production and size of the California crop. Currently, garbanzo beans are not produced in sufficient quantities to satisfy domestic demand and so they are also imported, mostly from Mexico.

Other Varieties. Cranberry beans, once grown more extensively in the Sacramento Valley, were found to be prone to root rot, and consequently, only minor quantities are produced today. Pinto beans, favored in the Mexican diet, were grown in the northern San Joaquin and Sacramento Valleys in the 1950s and minor quantities are still produced. Production of small reds (a popular chili bean) has shifted mainly to Idaho.

Several other varieties of beans are grown in California only for seed. Since these types are generally not well suited to California, yields are low, but their production in a disease-free environment merits a premium from contractors in other states and nations. In total, the acreage of seed bean production was over 27,000 acres in 1990 (about one-eighth the acreage of dry beans). Major seed producing areas were in rank order: Solano, Monterey, Santa Barbara, San Joaquin, Colusa and Glenn counties.

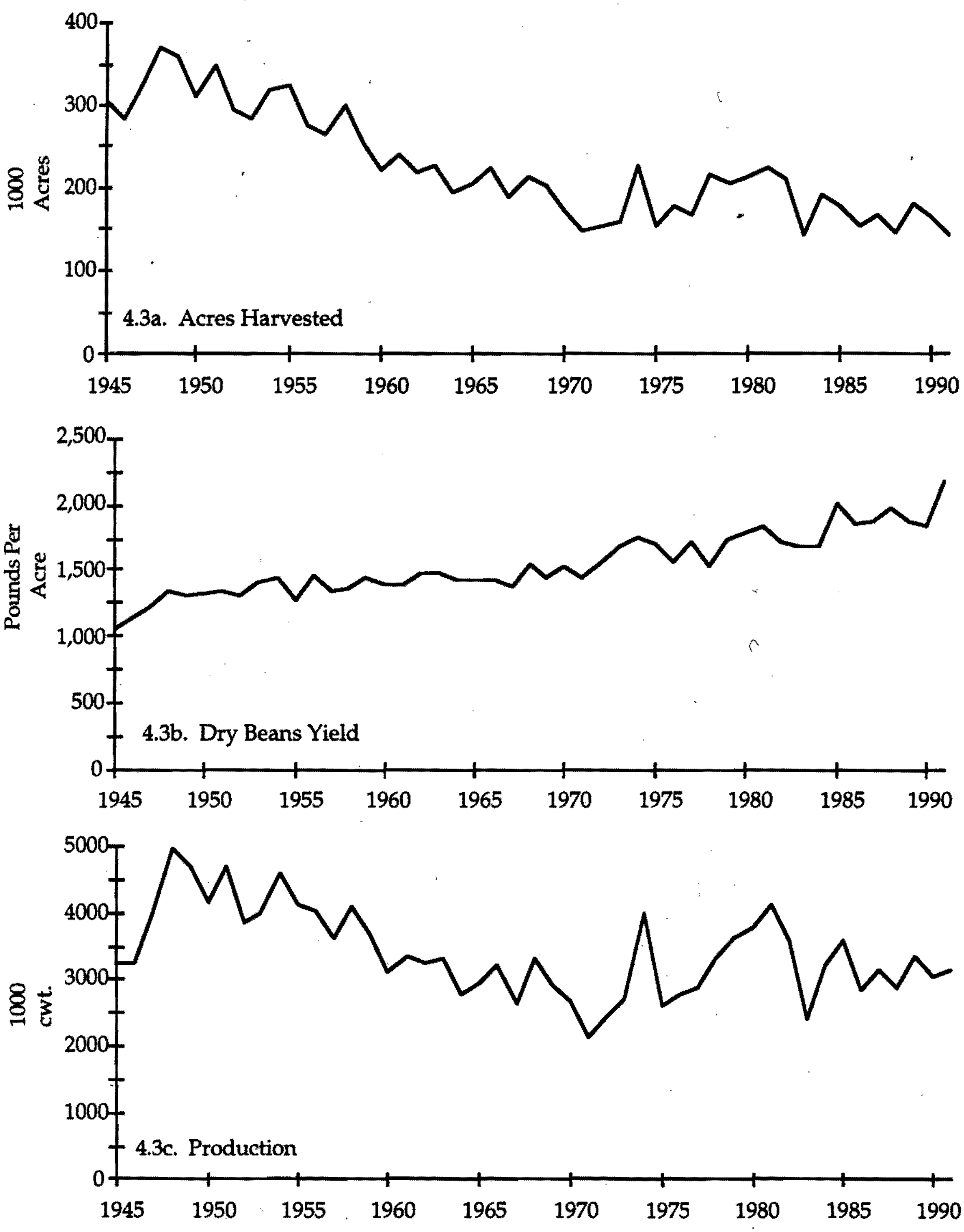
Trends in Acreage, Yields and Production

The statewide trend in acres planted was generally downward over the post-World War II period for most varieties through the early 1970s. Acreage devoted to aggregate dry bean production has, for the past two decades, been rather constant to slightly downward, with considerable annual variation (Figure 4.3a).

However, historical aggregate acreages mask changes in acreages devoted to specific varieties as revealed in Figure 4.2. Blackeyes in particular, show large and regular annual swings in acreage. Baby lima acreage appears to be on a slight upward trend, while garbanzo acreage, decimated by disease in the 1980s, is poised for a strong rebound in its new San Joaquin Valley production region. Pink bean production, except for the strong export demand in 1980 and 1981, has been relatively stable, while small white acreage has virtually disappeared. Large lima acreage and red kidney acreages show no distinct recent trends, though red kidneys are more variable.

Dry bean yields are influenced by varieties produced. In general, gradually rising statewide yields (Figure 4.3b) have partially offset acreage declines so that total production appears to have fallen less markedly during the post-World War II through early 1970s. Production, since 1971, is more upward through the present due to stable statewide acreage and rising yields (Figure 4.3c). As noted above, aggregate statistics mask important differences among types making analysis difficult because of changes in the mix of beans produced in California and differential yield levels among types.

Figure 4.3. California Dry Beans: Harvested Acreage (a), Yield (b), Production (c), 1945-1990



5. CORN

Background

The United States is the largest producer of field corn in the world, both in terms of harvested acreage and total production (Table 5.1). The U.S. acreage is 20 percent of worldwide acreage, and more of the nation's acreage is devoted to growing corn (for grain) than any other crop. In recent years, corn grown for silage amounts to about an additional 10 percent of corn acreage.

Table 5.1. World Corn Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
United States	27,859	6,815	189,867
China	20,490	4,556	93,350
Brazil	11,892	1,901	22,604
Mexico	7,051	1,918	13,527
India	5,700	1,439	8,200
World	129,150	3,707	478,775

Note: The United States represented 21.6% of the world's corn area in 1991, 184% of the yield, and 40% of the production.

In recent years, corn and wheat acreages have vied for first and second rankings in acreage among U.S. crops. California is not a major producer of field corn, ranking only 23rd in production and 27th in acreage in the nation in 1990. Concentration of U.S. production is in the Corn Belt—Iowa, Illinois, Nebraska, Minnesota, Indiana, and Ohio (Table 5.2). Higher yields in California (under normal weather conditions, about one-third above the U.S. average; one-fourth above the Corn Belt), give California a higher share of U.S. production than its acreage share.

Table 5.2. U.S. Corn Production, 1990

Leading States	Area 1000 acres	Yield bu./acre	Production 1000 bu.
Iowa	12,400	126	1,562,400
Illinois	10,400	127	1,320,800
Nebraska	7,300	128	934,400
Minnesota	6,150	124	762,600
Indiana	5,450	129	703,050
California	160	160	25,600
United States	66,952	119	7,933,068

Note: California represented 0.2% of U.S. corn acreage in 1990, 135% of U.S. yield, and 0.3% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage; California ranked 27th in the nation.

In 1989, over 55 percent of the U.S. disappearance of corn was for domestic feed uses, about 16 percent was in food, alcohol, or seed uses, and nearly 30 percent was exported. The proportion of the U.S. corn supply used in food form has increased over time with increased domestic consumption of corn products such as syrups, starches, meal, flour, oil, margarine, and snack foods. Domestic consumption of corn syrups increased from 560 million gallons in 1975 to 1.8 billion gallons in 1989, an increase of about 330 percent in the 15-year period. A large proportion of the value of corn syrup is represented by use of high-fructose corn syrup (HFCS) in the food and beverage processing industry. It is of equal or greater sweetness than other sweeteners and is generally less expensive.

California's Corn Supply

Because over one-half the corn needed in California must be shipped in from other states, the state's supply-utilization pattern differs from the national one just discussed. Rather than one-half, over three-fourths of the state's corn supply is used to feed livestock and poultry. Corn has increased in importance as a proportion of all grains fed (including barley, grain sorghum, oats, and wheat). Within limits, these grains are substitutable on the basis of net energy content and shifts do occur as prices and other factors change.

In spite of shipping in so much of its corn, California has participated in the growth of the liquid corn sweetener industry. Transporting corn to be processed for use in the state is easier than shipping HFCS to California since HFCS must be kept at a controlled temperature.

California's Corn Production

About 375,000 California acres were seeded in corn in 1990, 160,000 of which were harvested for grain; most of the rest was for silage. While most grain corn is feed corn, there has been continual growth in the production of specialty corns, specifically flour corn and popcorn. Flour corn serves the growing demand for Hispanic food products (e.g., tortillas). Major producers, located in the San Joaquin Valley, contract for the product that is priced higher than feed corn, but has lower yields. Most of the production is in the San Joaquin Valley (centered in Madera County), but it occasionally will move further north to meet market needs. Solano and Yolo counties are locations of production for popcorn varieties. While the same varieties are grown in

Table 5.3. Regional Location of Corn Acreage for Grain, by decades, 1960-1990

	1960	1970	1980	1990
	acres			
North Coast	—	200	—	—
North Central	100	—	—	—
North East	—	50	400	—
Central Coast	4,500	9,700	5,200	5,000
Sacramento Valley	52,700	68,400	137,800	74,500
San Joaquin Valley	69,800	137,000	126,200	79,000
Mountain	200	—	100	600
Southern California	2,700	650	300	300
Other Counties	—	—	—	600
State	130,000	216,000	270,000	160,000

other areas of the United States, California's production yields a high percentage of large kernels, desirable for popcorn fixed in microwave ovens.

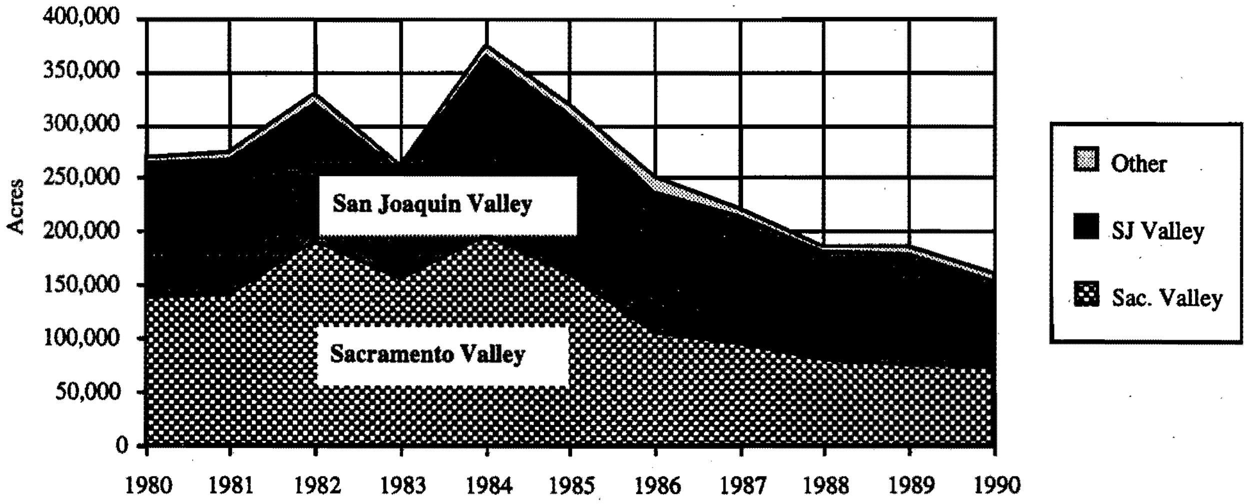
Location of production

The 1990 acreage harvested for grain is significantly below the 1980 acreage (270,000 acres) — and the decade's high acreage (375,000 acres in 1984)—due to low prices, reduced water availability, and higher energy costs for pumping. Production is concentrated in the Central Valley, with the Sacramento Valley and the San Joaquin Valley accounting for about 45 percent and 50 percent, respectively, of the state's corn-grain total tonnage in 1990 (Table 5.3).

Acreage in both production regions grew substantially over the period 1960 through the early 1980s (1984), with initial acreage expansion in the San Joaquin Valley, followed by increases in the Sacramento Valley. Four adjacent counties—San Joaquin, Sacramento, Yolo, and Solano counties—are the dominant production areas accounting for nearly two-thirds of California acreage in 1990. Parts of these counties together are known as the Delta area of the Sacramento and San Joaquin valleys. This area is the state's traditional corn-growing region because relatively low water costs, low fertilization requirements of peat soils, and advantageous climate prove conducive to high yields and profitable production.

Figure 5.1 shows changes in total corn grain acreage and its location for the decade of the 1980s. Acreage has been relatively more stable in the San Joaquin Valley. Acreage in both valleys rose sharply in 1982 and again in 1984 following 1983 Payment-in-Kind (PIK) program acreage reductions. Sacramento Valley acreage since 1986 has declined downward more gradually.

Figure 5.1. Regional Location of Corn Acreage, 1980-1990



Trends in Acreage, Yields and Production

The sharp expansion of corn acreage from 1953 to 1957 (Figure 5.2a) extended the location of production from the Delta to the better mineral soils further south in the San Joaquin Valley by moving corn onto former cotton land made available because of acreage restrictions. This expansion coincided with favorable corn prices and such major technical developments as the development of double-cross hybrids suitable to the new growing areas; improved cultural programs, including better fertilization, irrigation, and agricultural chemical practices; and machinery innovations, such as the corn combine.

After the peak production year, 1957, acreage declined sharply to about former levels with production retreating back to the Delta due to lower corn prices. The increase in sugar beet acreage in the San Joaquin Valley was closely related to the drop-off in corn acreage. Melons and several other crops also more profitable in the face of declining corn prices.

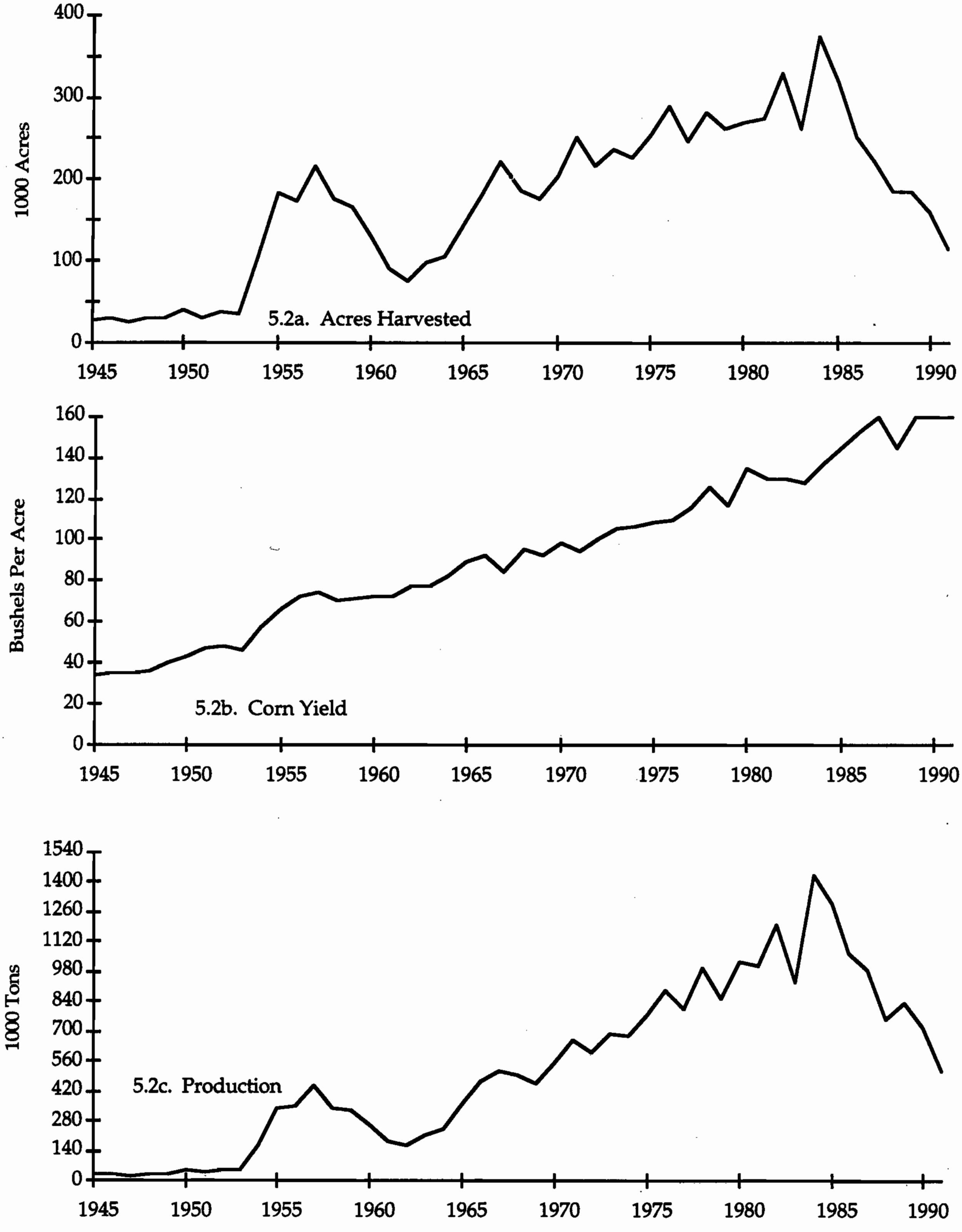
An improvement in price and additional technological developments brought about a second expansion in acreage beginning in 1963. New single-cross hybrid corn varieties with higher yield capability were successfully introduced. In addition, an increased demand for corn for food uses spurred acreage increases. Total acreage trended generally upward in the state for the two-decade period, 1963-1984, with the differential regional growth patterns noted above. Sharp acreage reductions since 1984 are related to generally low prices (1988 was the exception due to drought in the major U.S. production region, the Corn Belt) and to water availabilities and cost. Acreage fell to 160,000 acres in 1990 and only 115,000 acres in 1991 (the state's lowest acreage since 1964), but rebounded slightly to 160,000 acres in 1992.

Although California is a relatively minor producer, the state's corn yield is usually the highest in the nation, due in part to the benefits of controlled irrigation, as opposed to rainfed production in much of the Corn Belt. California's yield in 1990 was 4.5 tons per acre, compared to the U.S. average of only 3.3 tons per acre.

The introduction of hybrid corn varieties in the late 1940s with the inflow of technology and increased grower interest (triggered, in part, by favorable prices) resulted in doubling the statewide yield from 34 bushels in 1945 to 66 in 1955 and 74 bushels by 1957 (Figure 5.2b). After a period of stable yields in the late 1950s, better screening of the many midwestern hybrid varieties available was carried on to select those best suited for California. The nearly steady increase in yields since 1961 can be attributed to these improved hybrid varieties; to better fertilization, weed and insect control; and other cultural practices. The sharply reduced yield in 1988 was due to the effects of high summer temperatures during critical periods of growth. High yields of 160 bushels per acre attained in 1990 and 1991 are nearly five times their immediate postwar level.

With only a slight variation around the yield trend line over the 37-year period, changes in total production are mainly explained by changes in total acreage (Figure 5.2c). Production has fallen sharply (by half) from its peak of 1.4 million tons in 1984. Nonetheless, the 1990 production level of 716 thousand tons is still 25 times the amount produced immediately following World War II.

Figure 5.2. California Corn:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



6. COTTON

Background

Worldwide, the production of cotton has more than tripled since the mid-1950s (from 30 million bales in 1955 to 95 million in 1991). During the same time period, the U.S. share has been reduced from about one-half to less than one-fifth of the world's total production (Table 6.1). For much of the post-World War II period, the United States was the world's dominant cotton producer; however, China has moved to top place by installing government economic incentives to greatly increase domestic cotton production in an effort to reduce its dependency on imports from the United States and elsewhere. Despite this, the United States continues to be the world's leading exporter of cotton, shipping 30 percent of all the cotton entering international trade channels in the early 1990s.

Table 6.1. World Cotton Production, 1991

Leading Countries	1000 MT
China	5,663
United States	3,819
Former USSR	2,420
India	1,700
Pakistan	2,112
World	20,641

Note: The United States represented 18.5% of the world's cotton production in 1991.

The nation's cotton is currently produced in 17 states from Virginia to California with major production concentrations in the Delta areas of Mississippi, Arkansas, and Louisiana; the Texas High Plains and Rolling Plains; central Arizona; and the San Joaquin Valley of California. These and other minor production areas are in "cotton belt" areas, lying below the transcontinental "line" delineating areas that have 200 frost-free days a year with a minimum summer average temperature of 77° Fahrenheit and cooler areas to the north.

Upland cotton. American upland cotton is the predominate type of cotton grown in the United States and in most of major cotton producing countries. It typically constitutes about 98 percent of the total U.S. cotton crop. Over the century, upland cotton production shifted dramatically within this great belt from east to west, reaching its zenith in the 1979-1981 period. By 1980, production in the West (California, Arizona and Nevada) amounted to 40 percent of total U.S. production, while only 25 percent was produced in the Southeast and Delta regions.

The shift in production away from the Southeast, where most of the nation's textile mills are located, also left excess ginning capacity in the traditional producing areas. Reasons for the shift were related to boll weevil infestations, problems of disease in the humid Southeast, production affected by both too much and too little rainfall, and other weather factors such as hurricanes and hail, plus the fact that southwestern and western production, occurring on relatively flat acreages, was best able to adopt the postwar mechanical and irrigation technologies. Among American upland cottons, western cotton has the reputation among both domestic and foreign buyers as being the premium medium staple cotton of consistently high fiber strength useful in many apparel fabric applications. Average prices received for California cotton during the 1980s were about 10 percent higher than U.S. average prices.

More recently, however, there has been a resurgence of upland cotton production in the Southeast and Delta at the expense of western production so that the shares have been reversed—40 percent of U.S. production in the Southeast and Delta and 25 percent in the West. Some of this shift may be related to recent drought conditions limiting water availabilities in the southern San Joaquin Valley, to increased water costs in both Arizona and Southern California production areas, and increased pest populations of pink bollworm and sweet potato whitefly.

Extra-long staple cotton. A second type of cotton is commonly referred to as American-Pima, or extra-long staple (ELS) cotton. Production of ELS cotton is small relative to that of upland cotton because its production costs per pound are higher and its markets are chiefly high-value products such as sewing thread and expensive apparel items.

ELS cotton has been grown chiefly in west Texas, New Mexico, and Arizona, but it is also a crop of growing interest to California cotton producers. With less than a thousand acres reported in production in the 1987 crop year, over 25 thousand acres were harvested in 1990, giving California producers about 15 percent of national production on 11 percent of harvested acreage.

Unlike Arizona's production of ELS cotton, California producers have no base acreage under government programs. Despite the lack of target price guarantees, acreage expanded to 64,000 acres

Table 6.2. U.S. Cotton Production, 1990

Leading States	Area 1000 acres	Yield lbs./acre	Production 1000 bales
Texas	5,000	480	5,000
Mississippi	1,215	731	1,850
California	1,060	1,245	2,750
Louisiana	790	717	1,180
Arkansas	750	704	1,100
United States	11,480	638	15,254

Note: California represented 9.2% of U.S. cotton acreage in 1990, 195% of U.S. yield, and 18% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage.

in 1991 and 110,000 acres in 1991. California produced 36.7 percent of the U.S. ELS crop and will be the leading state in 1992, accounting for 40 to 50 percent of total U.S. production depending on final harvest yield outcomes. California yields, 20 percent higher than Arizona's, and low cost production systems give growers much optimism about the commercial future of American-Pima production in the San Joaquin Valley.

All cotton. California's production of cotton has declined from its 1979-1981 level of about 3.3 million bales on 1.5 million acres to 2.75 million bales on one million acres in 1990 (Table 6.2). It now ranks third in acreage (behind Texas and Mississippi), second in production (behind Texas). California's yields are nearly double the U.S. average, so that its 1990 share of national acreage—9 percent—translates into 18 percent of total U.S. production.

Cotton was the single most important fiber used by the U.S. textile industry until the 1960s, when manmade fibers surpassed it in use. Cotton's share in U.S. fiber consumption declined dramatically—from 85 percent of all fibers in 1930 to only 25 percent in 1980—and various synthetic fibers dominated the market. Although synthetics became increasingly important, cotton retained considerable market acceptance because of its characteristics when blended with other fibers. In the late 1960s, western cotton was in high demand because of particular characteristics making it very desirable for blending. However, as blending expertise increased, shorter stapled cotton grown closer to eastern textile mills could also be used in blends. At that point, far western cotton production became increasingly export-market oriented.

California's exports constitute nearly one-third of total U.S. exports and cotton lint is the state's leading agricultural export. In 1965, exports represented less than 15 percent of the value of California's cotton crop; by the mid-1970s over half was exported; and 80 percent of the crop was exported in 1990. The increased export market for California's cotton also reflects the development of a textile industry in low labor cost areas of the world and the resulting increase in U.S. imports of textile products.

Over the past decade, there has been a marked consumer shift away from synthetic fibers in apparel and home fabrics back to cotton. By 1991, cotton's share had increased to nearly half (49 percent) of the staple fiber market.

Cottonseed

Cottonseed is a very valuable byproduct of cotton production. In 1990, $161 million was added to the value of the state's agricultural product by seed (compared with $1,021 million for lint). For every bale produced, about 800 pounds of seed is sold. Only about 5 to 10 percent of the total seed produced is saved for next year's crop. Because the cottonseed oil market has been depressed due to soybean prices the past several years, over one-half of California's cottonseed is being fed directly to dairy cattle.

Processed cottonseed yields four main products: oil, meal, hulls, and linters. Cottonseed oil and cottonseed meal are the major products. Cottonseed oil is made into cooking oil, margarine, shortening, mayonnaise, and many other food products. Most of the high protein cottonseed meal is degossypolized and fed—three-fourths to livestock, one-fourth to poultry. The tough hulls are treated and also fed to livestock, providing roughage. "Linters," the fuzz remaining on the seed after separating most of the lint from the seed prior to oil extraction, are used in a wide variety of products, such as gauze, upholstery stuffing, twine, plastics, rayon, gunpowder, and tire cord.

California's Cotton Production

Although cotton was first grown in California in the late 1700s, attempts to establish commercial production were sporadic until its introduction into the Imperial Valley in the 1900s. Production was later expanded into the San Joaquin Valley in the 1910s and that area has evolved to be the center of the state's cotton industry. In 1990, almost all (97 percent) of the state's total cotton crop was produced in the San Joaquin Valley (Table 6.3), with Fresno, Kings, and Kern Counties together accounting for over three-quarters of the state's acreage.

The increase in San Joaquin Valley acreage reflects the addition of west side lands being served by the State Water Project beginning in the late 1960s. Southern California production areas (Imperial and Riverside Counties) even though

Table 6.3. Regional Location of Cotton Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
Central Coast	180	—	—	—
San Joaquin Valley	860,900	612,900	1,421,000	1,084,500
Southern California	84,920	49,500	116,500	30,400
Other	—	—	2,500	600
State	946,000	662,400	1,540,000	1,115,500

they had long enjoyed higher yields than the San Joaquin Valley because of the longer growing season, were also historically more troubled with insect infestation than the area to the north. In fact, during the 1930s and 1940s, southern California cotton production was almost nonexistent, resuming again in the 1950s with the development of better pesticides. However, Imperial Valley acreage, and minor amounts in other desert valleys of the Southern California region, have again been sharply reduced because of increasing pink bollworm resistance to pesticides. The recent sweet potato whitefly invasion in the Imperial Valley may be a further threat to cotton production there because cotton culture may be at odds with the need for a long host free period necessary to protect valuable winter vegetable crop production. The dominance of the San Joaquin Valley and the gradual reduction of Southern California (Imperial Valley) acreages over the 1980s are shown in Figure 6.1.

Acreage Trends

California acreage patterns for American upland cotton reflect farmers' responses to government programs, prices, and exogenous forces. After a period of acreage expansion in the 1930s in response to favorable prices, grower compliance with the cotton program reduced acreage by about a half to about 300,000 acres in 1938. Acreage was restricted to near that level throughout World War II by price ceilings, shortages of harvest labor, and the relatively high priority of other crops.

Acreage increased sharply immediately after the war as shown in Figure 6.2a. Curtailment of foreign production and high domestic support prices led to major development of irrigated cotton land in California between 1945 and 1949 with acreage increasing nearly threefold—to 925,000 acres—during that period. Rapid postwar expansion in acreage partly reflected increased profitability resulting from early innovation of machine harvesting and improved cultural practices. In 1950, acreage was restricted by allotment and again in 1954 as domestic inventories and production excess of demands.

By the mid-1950s many postwar innovations had clearly changed the way in which cotton was produced. Mechanical harvesting, together with the introduction of organic insecticides, fungicides for seedling disease, herbicides, and acid-delinted seed which made it possible to plant to a stand, thereby largely eliminating thinning and hand weeding, all served to give the West a competitive advantage over smaller-farm based production in traditional cotton areas.

Figure 6.1. Regional Location of Cotton Acreage, 1980-1990

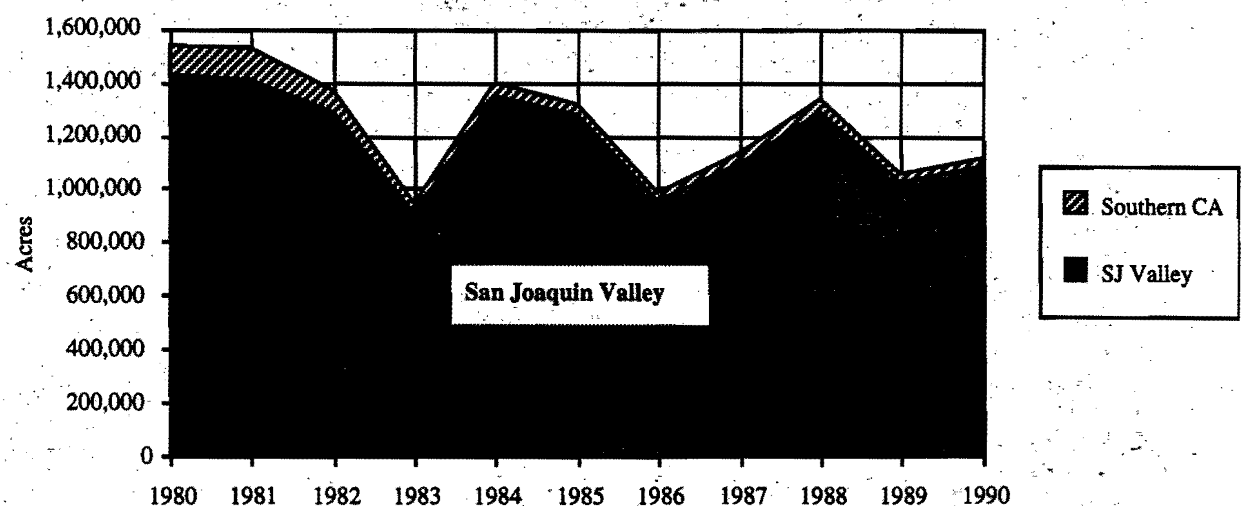
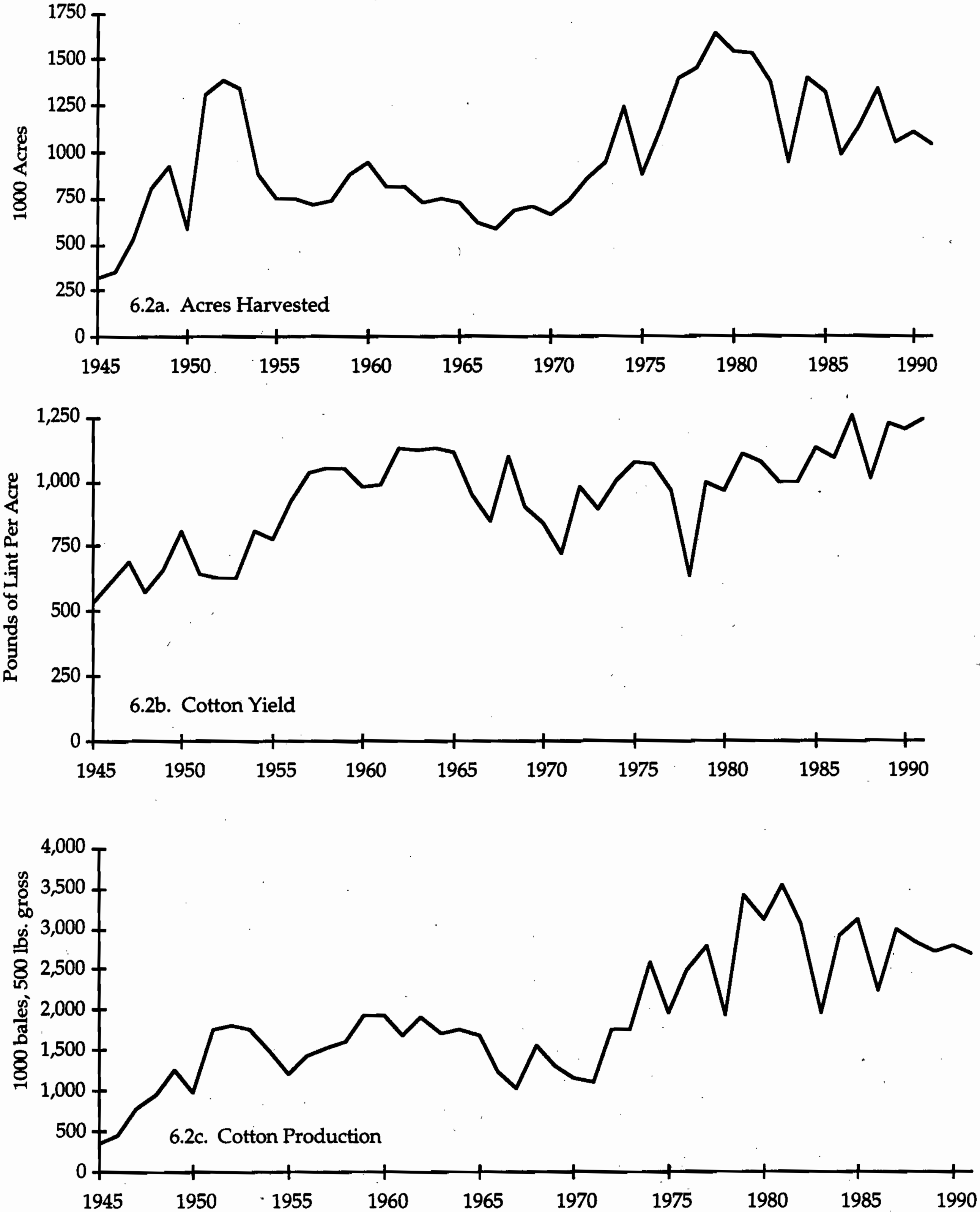


Figure 6.2. California Cotton:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



Allotments, marketing quotas, and other governmental programs for cotton have been in effect most of the time since the mid-1950s through the early 1970s, and acreage remained relatively steady. Marketing quotas were eliminated in 1974 and attractive market prices led to a sharp increase in California acreage from 942,000 to over 1.2 million acres. Then, under the less restrictive environment, prices softened and acreage dropped nearly 30 percent to only 875,000 acres in 1975. Acreage has since exceeded 1 million acres annually with a high acreage of over 1.6 million acres in 1979 and a low of 950,000 acres in 1983 when over 4 million cotton acres nationwide were diverted to conservation uses under the Payment-In-Kind (PIK) program. The recent decrease in acreages noted since 1989 is likely influenced by water scarcity and cost. Competition by vegetable crops for good soils on the west side and both more limited and more costly water supplies have led to reduced cotton acreage.

Since the low in 1975, California acreage has fluctuated as farmers responded to government programs and to export markets and world prices. More than any other production region, the West has significantly lower upland cotton program participation rates, averaging only 68 percent over the period 1982-88 as compared to 85 percent nationwide. This is due to the existence of relatively large growers in the West facing payment limitations under government programs and also to the existence of premiums for California cotton on world markets which have both led to production outside of program limits.

There is great potential for cotton production.. New varieties and production systems are under examination at the University's Shafter Field Station. New higher yielding varieties require more intensive management systems which utilize integrated pest management to monitor and control pests, plant growth regulators to shorten as much as two weeks the growing season, improvements in irrigation management, and development of nutritional guidelines, while working to assure the region's reputation for high fiber quality. The compressed growing period gained by the use of growth regulators reduces water usage. New varieties have a high level of verticillium wilt tolerance ,permitting more flexibility in selecting acreage. Higher yields and lower costs have also been gained by development of narrow row cultivation systems using new adapted varieties, increased use of module builders which permit a more orderly and efficient harvest, and a rapid increase in once-over harvest which decreases the cost of a second picking.

Yield and Production Trends

California cotton yields increased steadily from the late 1920s through the 1930s reaching a peak in 1940 of 749 pounds per acre under exceptionally favorable weather conditions. During World War II, yields were depressed by labor shortages and unfavorable weather. Yields later increased again, but with major annual fluctuations, rising to over 1,100 pounds per acre in the early 1960s (Figure 6.2b).

Although weather and pests can influence yields, so do changes in government programs. Whenever controls are less binding, acreage tends to expand to somewhat less productive soils, depressing average yields. As controls are more tightly enforced, land of marginal quality goes out of production and yields increase as production is concentrated on better soils.

Since 1957, yields in the state have generally been above 900 pounds per acre with highs above 1,000 pounds (over 2 bales) per acre in many years. Part of the increase in yield can be explained by a postwar shift within the San Joaquin Valley from older east side production areas where verticillium wilt was adversely affecting production, to virgin lands on the West Side. The slightly warmer climate on the West Side was also beneficial. Higher yields are also attributable to increased use of fertilizer, more effective disease and insect control, and other improved practices. Since the mid-1950s, the trend line was nearly level through the mid-1980s, with below-average yields generally due to adverse weather—for example, a cool growing season in 1966 and a late spring in 1967 (which delayed planting). In 1978, heavy winter rains and a cool spring meant that foothill vegetation provided a host for a major economic pest, the lygus bug, thought to have devoured cotton buds, reducing the average yield to only 640 pounds per acre. Throughout this period, genetic yield advances had been verified, yet the general trend was nearly level, implying that some factor in the production system had depressed yield potential.

In four of the five years, 1987-1991, average yields exceeded 1,200 pounds per acre reflecting improvements gained by new variety and system innovations. Yields were depressed to only 1,015 pounds per acre in 1988 because of a very cold spring and a hot summer and a high incidence of verticillium wilt disease following hot summer and cool August climatic conditions. Total production of cotton, upland and pima, closely follows acreage changes, over time, amplified by annual fluctuations in yield (Figure 6.2c).

7. POTATOES

Background

Many species of potato grow wild in South and Central America. Cultivation of potatoes dates back nearly 2,500 years, to the Incas in the Peruvian Andes. The potato had to cross the Atlantic twice before its introduction to the North American continent. It was first discovered in 1537 by Spanish explorers in Peru and was then introduced to Europe early in the 16th century and to Ireland by Sir Walter Raleigh about 1586. In less than 100 years it became a major crop in Ireland as well as in Northern Europe.

In Ireland, the agricultural and general economy became dependent on the potato as the staple food because the high-yielding potato made it possible to produce adequate food supplies on small plots of land. The Irish potato famine of 1845-46 was caused by late blight disease and led to widespread starvation of about a million persons and the emigration of another million, mostly to the United States. Because of its early food use and importance in Ireland, the potato plant is sometimes *erroneously* called the Irish potato.

The potato is a cool season crop, although it is being increasingly grown in warm climates. World production is concentrated in the northern hemisphere (Europe, the former Soviet Union, the United States, China and India). In 1990, the European continent accounted for 26 percent of the world's harvested area and 37 percent of total world production.

The former Soviet Union leads with one-third of the world's potato area in production and nearly a quarter of the world's production (Table 7.1). United States, the world's fifth most important area of production accounted for only 3.1 percent of world area, but 6.6 percent of world production. The U.S. yield was slightly more than twice the worldwide average.

Table 7.1. World Potato Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
Former USSR	6,000	10,750	64,500
China	3,002	11,838	35,533
Poland	1,733	16,759	29,038
India	942	16,195	15,254
United States	557	34,083	18,970
World	17,710	14,746	261,162

Note: The United States represented 3.2% of the world's potato area, 231% of the yield, and 7.3% of the production.

Potatoes were introduced in the United States in Virginia by the English in 1621, but its favor as a crop did not occur until a group of Scots-Irish immigrants brought it to New Hampshire in 1719. It is now grown commercially in every state and is produced throughout the year. Major production occurs in the fall in northern states. The fall crop is stored mostly for distribution through the following winter, spring, and summer. A winter crop is produced only in California and Florida. These same states, together with several southern states, produce a spring crop while the southern and some central states, and California produce during the summer season.

Ten states have consistently accounted for more than 80 percent of production; they are, in 1990 rank order of production: Idaho, Washington, Colorado, Wisconsin, Oregon, Maine, California, North Dakota, Minnesota, and Michigan.

There has been a remarkable shift in production from the eastern and central states to those in the West, particularly the northwest. In 1950, U.S. potato acreage was relatively evenly distributed among the four regions—west, 26 percent; central 30 percent; northeast, 23 percent; and south, 21 percent. The driving forces shifting the location of production westward were (1) development of irrigated land in northwest and mountain states, (2) growing consumer preference for processed over fresh potatoes, (3) development of the Russet Burbank variety with a uniformly high proportion of solids for processing uses, (4) capture of market share of fresh potato consumption from eastern-grown white potatoes, and (5) improved storage which extends the marketing season for western potatoes. As a consequence, the 1993 distribution of U.S. potato acreage has tilted markedly towards the West which now accounts for 55 percent of total acreage as compared to 28 percent for central states, 10 percent for northeastern states, and only 7 percent for southern states.

Idaho leads the nation by producing nearly 30 percent of the U.S. potato crop and leading the nation in shipments of both fresh potatoes and processed products, largely frozen (Table 7.2). Washington and Oregon production is mostly for processed potato products. North Dakota is the nation's largest producer of chipping potatoes and is a major source of certified potato seed grown on about 20 percent of its acreage. California, the 7th largest producer, ranks ninth in acreage devoted to potato production. California production is primarily for fresh markets.

Table 7.2. U.S. Potato Production, 1990

Leading States	Area 1000 acres	Production 1000 cwt.
Idaho	393	112,340
North Dakota	145	16,675
Washington	132	67,980
Maine	74	16,110
Colorado	72	24,032
California	50	17,783
United States	1,359	393,867

Note: California represented 3.7% of U.S. potato acreage in 1990 and 4.5% of U.S. production. The first five states in the table are ranked 1st through 5th, respectively, in acreage; California ranked 9th in the nation.

About 85 percent of the U.S. crop is used for human consumption. Of that, about one-third is consumed fresh and the remainder in processed form. The most significant change in potato consumption over the past 30 years has been the rise of frozen potato use, spurred by the popularity of fast food restaurants, and an associated decline in fresh use. Per capita consumption has risen, in total, by 30 percent to about 130 pounds at present. In 1960, fresh use totaled 81 pounds per person, but by 1990 fresh consumption was only 47.5 pounds per capita. The drop of more than 30 pounds per person in fresh potato use contrasts with about 60 pounds gain in consumption of processed potato products over the period. In 1959-1960, only 4 percent of the crop was processed; in 1990-1991, one third of all the potatoes grown in the United States was processed into *frozen* products, mainly french fries and mostly in the Pacific Northwest. Recent (1992) consumption estimates indicate a 3 pound increase in per capita consumption of fresh potatoes over 1990 levels, perhaps due to the increased popularity of fresh produce in general and the convenience of microwave ovens in many American households.

California's Potato Production

California is the only state with production during all four seasons; potatoes are harvested every day of the year in one or more of the geographically distinct growing areas. The major use is for fresh markets in the West and, to a lesser degree, for potato chips; none of the state's production is processed into frozen products. California potatoes are of unsurpassed fresh market quality in a state and region with an increasing population, which gives it competitive advantage in the marketing of a relatively bulky end-product. California production is especially important during the marketing months of June and July when shipments from California constitute about one-third of national shipments.

Location of Production

Table 7.3 identifies the location of potato production according to the usual crop production regions. However, crop production regions do not match well with the geographically-distinct potato production regions. For example, the San Joaquin Valley crop production region actually contains two distinct potato districts, and northern mountain valley potato production actually occurs in three crop production regions—north central, north east, and mountain.

Table 7.3. Regional Location of Irish Potato Acreage, by decades,1980-1990

Region	1980	1990
	acres	
North Coast	524	453
North Central	6,300	8,494
North East	4,900	6,836
Central Coast	1,825	1,000
San Joaquin Valley	23,159	25,807
Southern California	8,630	6,854
Other	—	1,487
State	45,338	50,931

The five major areas of potato production are: (1) Northern Mountain Valleys (Siskiyou, Modoc, Shasta, Lassen, Inyo and Mono counties); (2) Coastal (Humboldt and Del Norte County to San Diego County); (3) Delta (San Joaquin County); (4) Southern San Joaquin Valley (Kern and Tulare counties); and (5) Southern California (Riverside and Imperial counties). (See Table 7.4.)

Table 7.4. Traditional Potato Production Areas, 1980 and 1990

Production Areas	1980	1990
	acres	
Northern Mountain Valleys	11,200	15,330
Coastal	2,449	1,453
Delta	1,821	1,920
So. San Joaquin Valley	21,338	23,887
Southern California	7,060	6,854
Other	1,470	1,487
State	45,338	50,931

The southern San Joaquin Valley is the major potato production area of the state with major production on well-drained, sandy and loam soils, primarily in Kern County. Kern County's 23,887 acres in 1990 accounted for nearly 50 percent of the acreage reported for the state. Two crops are possible with the largest harvest occurring in May-June and a small crop during December-February periods; the latter harvest is from ground storage as markets dictate. Traditionally, Kern County production became available in the May-June period when northern U.S. stocks were depleted, but advances in storage technology now permit northern production areas to store potatoes year-round. Transportation costs to eastern markets have increased tremendously, also. Acreage and production have, therefore, declined from approximately 65,000 acres in the early 1950s with the loss of that particular marketing niche. High cost of production (land, water) precludes frozen and dehydration processing outlets although the chip processing industry, established 40 years ago, continues to hold steady; increased cost of transportation limits fresh marketings to western markets; and the lack of high quality russet-skinned varieties suited to production in California's hot interior valleys prevents a more competitive position relative to Russet Burbank (also known as the Idaho Russet variety).

The Northern Mountain valleys' production, the second most important potato area, is concentrated on well-drained, high-organic matter soils of the Tulelake basin in Siskiyou and Modoc counties, and lesser acreages in Shasta and Lassen counties. Tulelake potatoes are planted in May and harvested in September/October. Commercially grown potatoes, particularly Russet Burbank, are almost exclusively grown and sold to fresh market outlets from storage through June or July of the following year. Tulelake production is in direct competition with fresh marketings from other fall season producers across the northern United States. Storage advances now make Tulelake product competitive with Kern County's in the spring and early summer. Growth is limited to California and other western fresh markets by competition and Tulelake's size which is not large enough to attract processing interests. The Mountain Valley areas are also the major seed-potato producing areas in the state. Tulelake acreage has declined from about 18,000 acres in the late-1960s to slightly less than 14,000 acres in 1990.

Delta production (mainly San Joaquin County) consists of a summer seed crop harvested in late fall and early winter, and a commercial fresh market crop harvested from June through September. Production occurs on peat soils of the Delta formed by the San Joaquin and Sacramento rivers. San Joaquin County acreage in 1990 was about 2,000 acres, down substantially from 5,000 acres in the mid-1960s.

Southern California production is located primarily in the San Jacinto and Hemet areas of Riverside County. Like the Kern County area, two crops are possible with summer and winter harvest periods, the latter being harvested from ground storage as market opportunities arise. Acreages in Riverside County have declined from nearly 12,000 acres in the mid-1960s to about 7,000 acres in 1990. Some potatoes are also produced in the Coachella Valley area, planted in September and harvested very early for fresh markets in March and April.

Coastal area production consists of northern production concentrated in Humboldt County which is mainly chipping varieties for storage; it is noted for high quality (high solids) potatoes. Late-summer (August/September) fresh market production occurs in the Central Coast region around Santa Maria, and chipping potatoes are grown in the Salinas Valley. Losses of substantial acreage to higher valued vegetable production in Salinas and Santa Maria valleys have reduced the importance of this region from around 15,000 acres in the mid-1960s to only 1,000 acres in 1990 (Table 7.3)

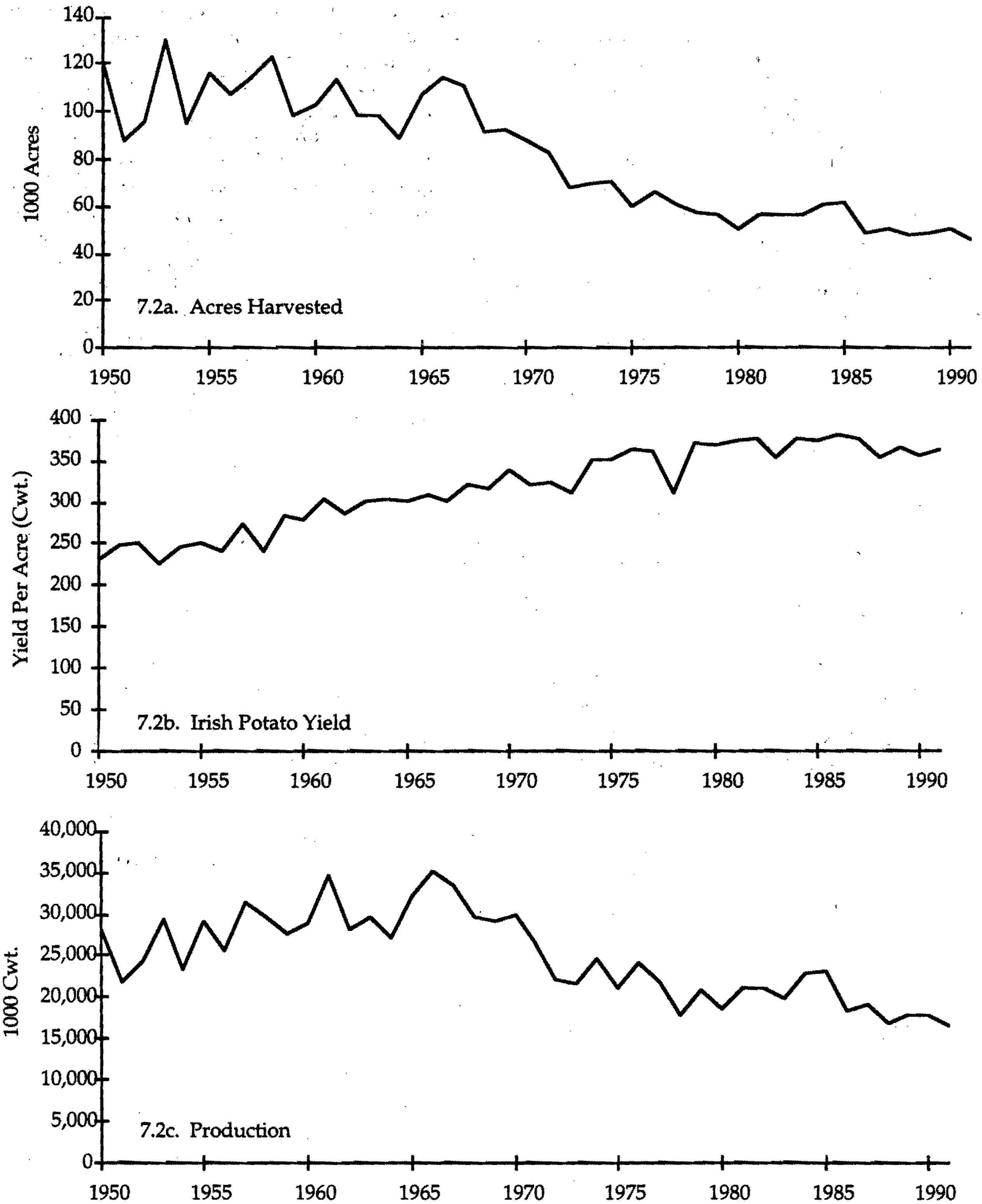
Figure 7.1 summarizes changes in acreage over the past decade. San Joaquin Valley acreage is the most variable over the time period reflecting the competitive pressures still applied to the state's largest production area, despite its significantly reduced size—from 65,000 in the 1950s to 23,000 acres in 1990.

Trends in Acreage, Yields and Production

Potato acreage was highly variable and ranged from 90,000 to 120,000 acres during the 1950s and 1960s (Figure 7.2a). It has since declined steadily with lesser variation to its current level of about 50,000 acres for the period 1986-1990. (A further decline to just over 40,000 has been reported for 1992). Advances in storage technologies in northern states, increases in costs of transportation for bulky product, and competition for high cost land and water resources were contributing causes to the gradual decline from the earlier levels. Annual acreage variability can be attributable to local production and national market outcomes. For example, record high U.S. potato stocks in 1985 and expected low prices for the following year were a contributing cause for the drop in acreage noted in 1986. Low average prices for California potatoes persisted through the 1988 crop.

The declining acreage will be influenced by the nature of California's production, e.g., mostly for fresh market and chipping outlets in California and the western United States, and competition with other western production regions. The combination of increasing western populations and rising fresh consumption (baked potatoes, positive nutritional publicity, and microwave influences) should maintain demand for California fresh produce.

Figure 7.2. California Irish Potatoes:
Harvested Acreage (a), Yield (b), Production (c), 1950-1991



California yields rose steadily from 1950 to 1980, and have leveled off since then (Figure 7.2b). Improved cultural practices, pest control, and new varieties have been developed, underpinning the rise in the state's average potato yield. California's fresh-market oriented production is less focused on high yield than is production for processing in other states. Instead, the aim is to achieve a high proportion of the harvest as grade #1 market potatoes. Variety improvement efforts at the University of California are in conjunction with cooperative research agreements with Idaho, Colorado and North Dakota researchers. Variety screening is done in California. Several new chipping and new long white varieties, and a Russet (Russet Norkotah), an early maturing variety with attractive eye-appeal and high percentage #1 grade product for Kern County conditions, are among the recent contributions to the industry. Recent losses of pesticides may dampen future yield increases until offsetting improvements in IPM and other sustainable cultural practices can be developed and implemented. Current examination of drip irrigation systems and crop rotation alternatives could lead to somewhat increased yields and quality. Production of California potatoes has been influenced by both annual acreage and yield outcomes (Figure 7.2c). Production increased during the 1950s and 1960s because of rising yields despite level, but fluctuating acreages. Production declined substantially from a peak of 35 million hundredweight in 1966 to current levels of about 18 million cwt. for 1986-1991. Several sharp weather-induced yield declines (in 1978, 1983, and 1988) have accentuated changes in production even though acreage was relatively stable over the decade of the 1980s.

8. RICE

Background

Most rice-producing countries consume all or most of the rice they grow; many import additional supplies. In 1988/89, the United States was the world's second largest exporter of rice, providing 19 percent of all the rice in international trade channels despite the fact that U.S. production constituted only 1.5 percent of the total world production. Prospects for short-term, or even longer, market development in Japan and Korea appear more promising in the face of short 1993 domestic supplies and broadly-based trade liberalization efforts.

Despite its continuing large export position, U.S. rice producers are less reliant today on international markets than a decade ago due to a doubling in domestic consumption. Annual U.S. rice consumption increased from 26.9 million cwt. in 1978-79 to an estimated 51.6 million in 1990-91. Major sources of increased domestic consumption lie in the rapid increase of our Asian and Latino populations and in processed value-added rice products.

The world's seven largest production areas are the Indian subcontinent (India, Bangladesh), China, Indonesia, Thailand, Vietnam, and Brazil. U.S. production in 1990 amounted to less than 1.5 percent of world production (Table 8.1). Although the United States is a relatively minor producer on the world scene, it is important to the world's rice economy because of its strong export position.

Table 8.1. World Rice Production, 1991

Leading Countries	Area 100 ha.	Yield kg./ha.	Production 1000 MT
India	42,200	2,629	110,945
China	33,100	5,663	187,450
Bangladesh	10,940	2,612	28,575
Indonesia	10,187	4,351	44,321
Thailand	10,000	2,004	20,040
United States	1,113	6,295	7,006
World	148,366	3,504	519,869

Note: The United States represented 0.75% of the world's rice area in 1991, 180% of the yield, and 1.4% of the production.

The main rice growing regions of the United States are: (l) the Grand Prairie of Arkansas and northeastern Arkansas, (2) the Mississippi River Delta, (3) southwestern Louisiana and the Gulf Coast of Texas, and (4) the Central Valley of California. Arkansas is the leading rice-producing state—1.2 million acres producing 60 million cwt. of rice, mainly long grain varieties (Table 8.2). California's production, primarily of medium grain varieties, is the second largest in the United States. California's 385 thousand acres represented about 14 percent of the nation's 1990 rice acreage, but because of high yields accounted for nearly one-fifth of the total U.S. production.

Table 8.2. U.S. Rice Production, 1990

Leading States	Area 1000 acres	Yield lbs./acre	Production 1000 cwt.
Arkansas	1,200	5,000	60,000
Louisiana	545	4,860	26,469
California	385	7,600	29,260
Texas	353	6,000	21,180
Mississippi	250	5,700	14,250
United States	2,813	5,507	154,919

Note: California represented 13.7% of U.S. rice acreage in 1990, 138% of U.S. yield, and 18.9% of U.S. production. The states above are ranked 1st through 5th, respectively, in terms of acreage.

California's Rice Production

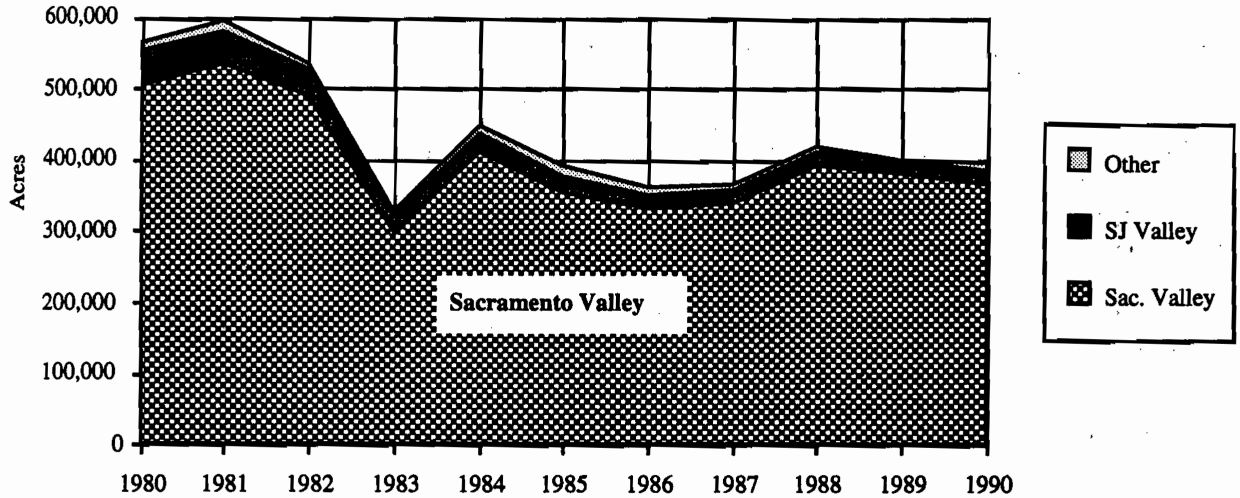
In California, rice is grown in basins (checks) surrounded by levees to control water levels. Generally, fields are flooded just before planting and remain covered with water during much of the growing season. Although commonly regarded as a water-intensive crop, rice requires about the same amount of water as several other summer crops when grown either (1) on heavy soils (that restrict percolation losses to underground basins) or (2) under good water management practices on precision-leveled basins (that reduce runoff to drainage and water ways).

As shown in Table 8.3 and Figure 8.1, over 90 percent of California's rice acreage is found in the Sacramento Valley. (Placer County rice production is also on adjacent valley lands though it is reported as being in the Mountain region). Clay soils require relatively less water for continuous flooding and naturally level land, improved by laser-leveling technology, thus allowing large rectangular checks to be efficiently cultivated and harvested with large machines. High quality irrigation water, good drainage, and hot summers also favor rice production in the Sacramento Valley. Rice production under management systems which focus on improved water use efficiencies to reduce percolation and runoff losses requires 36 to 46 inches of water during the long summer growing

Table 8.3. Regional Location of Rice Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
Central Coast	240,900	293,500	505,200	364,800
San Joaquin Valley	42,700	33,500	49,800	18,200
Southern California	4,400	4,000	10,000	11,500
Other	—	—	—	500
State	288,000	331,000	565,000	395,000

Figure 8.1. Regional Location of Rice Acreage, 1980-1990



season. In addition, the necessary storage, drying, and milling facilities, an important adjunct to rice production, have been located throughout the region.

The remainder of the state's rice acreage is in the San Joaquin Valley in the Escalon, Dos Palos, and Los Banos areas, where rice is sometimes grown in conjunction with the reclamation of problem soils or grown on heavy soils for which rotation crops are limited. Because of relatively high water costs, the San Joaquin Valley acreage has declined significantly in recent years.

Production Trends

Commercial rice production began in California in 1912 and increased rapidly during World War I. Between world wars I and II, California rice acreage was maintained at about 100,000 to 150,000 acres. Acreage controls were imposed in the 1930s and were continued until World War II. The nation's entire rice industry expanded during and after World War II as production was encouraged to provide wartime exports to allies and postwar relief shipments to distressed nations. By the 1950s, rice production abroad had largely recovered, the world price fell, and U.S. acreage allotments were reinstated in 1955.

For California, the postwar acreage pattern is shown in Figure 8.2a (on page 45). The peak acreages of 1953 and 1954 were partly stimulated by government programs to provide rice for South Korea and partly by growers' attempts to obtain acreage history before the government allotment program began in 1955. From a low of 226,000 acres in 1957, acreage gradually increased through the 1960s with plantings following government-allowed acreages.

In 1973, world grain supplies were short and the price of rice and other grains rose sharply. Acreage increased in response to higher prices as farmers planted rice beyond allotted acreages even though the additional acreage would not qualify for government price support and disaster relief programs. Acreage peaked in 1975 at 525,000 acres, but was reduced sharply downward to only 308,00 due to the two-year drought in 1976 and 1977. Acreage subsequently increased to 593,00 acres by 1981 because of high prices and strong exports to Asian markets (Korea, in particular). The low acreage in 1983 was the result of the PIK program, during which many growers took the opportunity to improve the productivity of their set-aside fields, by laser-leveling them. World-wide recession conditions in the early 1980s with weaker export markets, led to less rice acreage for the remainder of the decade as growers were curtailed by government acreage restrictions, price policies, and drought conditions.

Figure 8.1 shows the effects of market and climatic forces in California rice production areas over the past decade. The 1980 acreage was associated with strong market conditions while weaker markets and drought conditions characterized the latter part of the decade. Acreage reductions were relatively lower in the Sacramento Valley where water was both more abundant and lower priced. Sacramento Valley producers reduced acreage by nearly 40 percent in response to the 1983 PIK program. Current San Joaquin Valley acreage is about one-third of its 1980 level.

A recent study by the UC Agricultural Issues Center points to the potential of somewhat higher yields and increased production resulting from improved genetic capability of the rice plant and improved management. Limiting factors include environmental regulations and possible constraints on water supply. Water quality problems associated with herbicide use have been largely solved, but regulatory pressure will likely continue to further improve downstream water quality. The most immediate environmental constraint comes from newly-mandated air pollution controls that limit field burning following harvest. Less than 10 percent of rice irrigation is from wells where surface water is not available, or as a supplement to surface supplies. Therefore, increased competition for California's limited surface water supplies may constrain production because the high cost of pumping well water prevents its widespread use in rice production.

Yield and Production Trends

Both public and private research have been major and important stimuli to improvements for the California rice industry. Research in varietal development has been centered primarily at the 375 acre Rice Experiment Station at Biggs, while research in other aspects of rice production has been conducted by the University of California, Davis.

Per acre yields have increased from 2,700 pounds in 1945 to slightly less than 8,000 pounds per acre, rising rather constantly except for reduced yields in selected years (Figure 8.2b). Average yields in California are nearly half again as much as the national average (about 5,500 pounds per acre in 1990).

The sharp decrease in yields in 1953 and 1954 was due to a pronounced acreage expansion and unusually cold weather at flowering which adversely affected yields in 1954. In 1955, rice yield rose dramatically when the broadleaf weed problem was solved and less productive lands were removed from production. Yield increases through the mid-1970s resulted from higher levels of fertilizer application, better weed control with new chemicals, and better water management from precision land leveling.

The sharp increase in yields after 1978 can be largely attributed to the introduction of short-stature rice. These new short varieties with increased straw strength were lodging resistant and able to support heavier high-yielding panicles of grain. In 1979, an excellent production year climatically, when about 20 to 25 percent of the acreage was in short-statured varieties, yield rose to 6,520 pounds per acre. In 1980, when 60 to 70 percent of the acreage was in short-statured rice, yield dropped only slightly to 6,440 pounds even though growing conditions were considered poor. By 1981, 95 percent of the acreage was in short-statured rice which, together with very favorable climatic conditions, produced another sharp yield increase to 6,900 pounds.

Yield improvements in the 1980s result from varietal improvements and improved management. Substantial acreages laser-leveled in the late 1970s and early 80s (particularly on set-aside acreage during the 1983 PIK program), permitted improved water management in rice production. Variety improvements, more uniform heading, improved cold tolerance, shorter seasonality, etc. Short season varieties also contributed to improved yields because of earlier harvesting opportunities prior to possible wet fall weather.

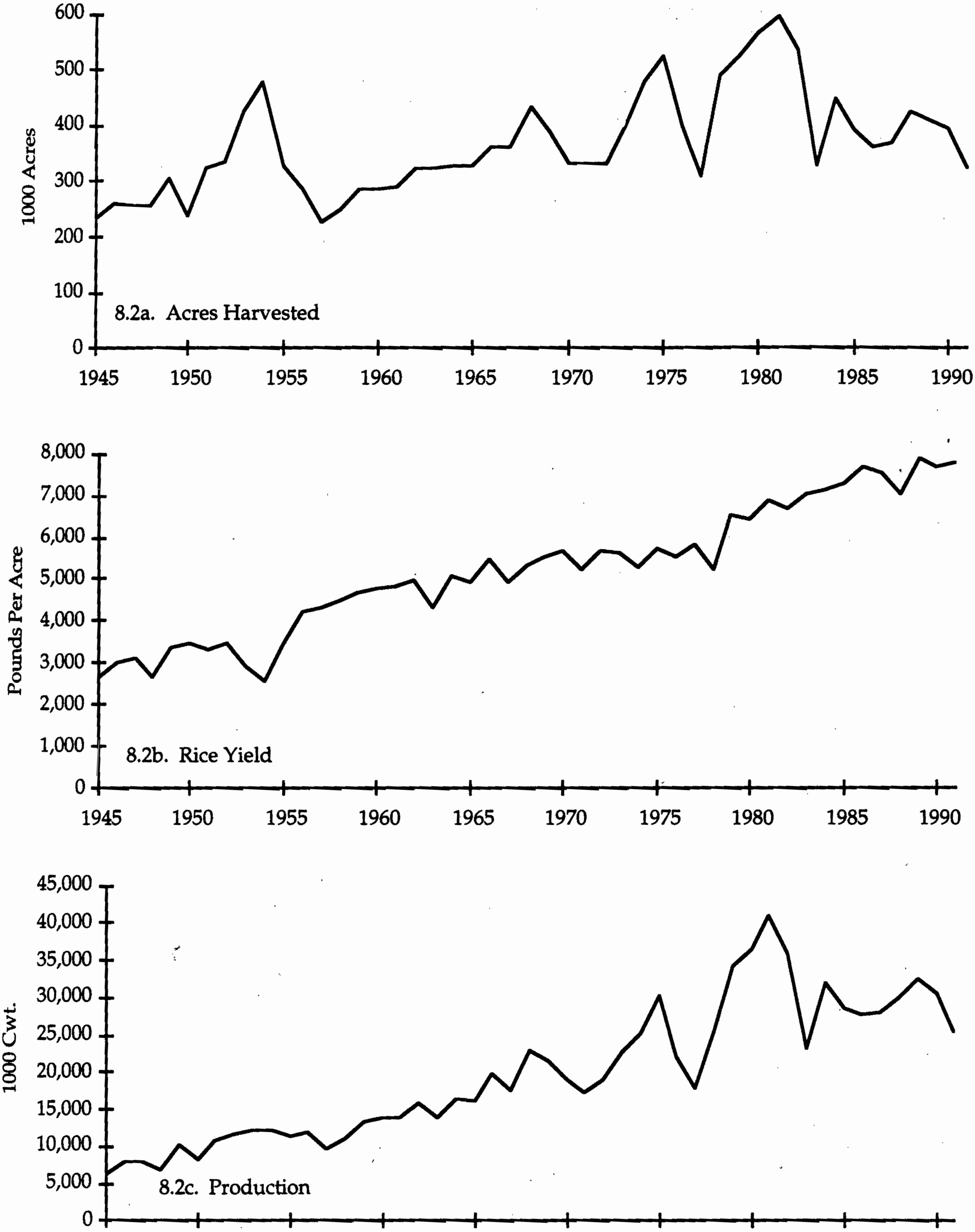
Rice production expanded from 6.3 million hundredweight in 1945 to 40.9 million cwt. in 1981, but since 1984 it has averaged about 30 million cwt. annually. Since yields have increased rather constantly, recent variations in production (Figure 8.2c) mirror harvested acreage (Figure 8.2a).

Varieties and Characteristics of California Rice

Before the 1970s, growers had only two or three varieties to choose among. In 1992, the University of California listed 12 recommended publicly-developed varieties of short, medium, long, premium quality, and specialty rice types. Varieties with maturities, which range from very early to late, can be chosen to fit the cropping schedule of a particular farm. Varieties also differ in temperature sensitivity and response to fertilizer and soil conditions. In short, it is now possible for farmers to choose a variety especially suited to their particular situations.

California's cool climate is better suited to production of the short- and long-grain japonica

Figure 8.2. California Rice:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



cultivars, originally from the temperate regions, than to the long-grain indica cultivars originating in the tropics. California grows nearly all (97 percent in 1990) of the nation's supply of short-grain rice. California produced 57 percent of all U.S. medium-grain type rice in 1990. In contrast, 83 percent of the rice grown in the rest of the United States is long grain.

Over the years, California rice production has gradually shifted from mostly short to mostly medium. In 1950, 98.7 percent of California's rice was short grain; in 1965, just over half. By 1970, more medium than short grain was grown. In 1980, nearly 80 percent was medium grain, while 88 percent of 1990 production was medium grain.

More recently, as a result of the rice breeding program, long-grain rice is adapted to and grown in California. It is preferred by many U.S. consumers for its dry, fluffy textures and usually commands a higher price than short- and medium-grain rice. California long-grain yields are higher than those in the rest of the nation, but growing conditions here result in a rice that is sticky when cooked. The sticky texture of California's medium- and short-grain rice is preferred by some East Asian populations both at home and abroad.

9. SAFFLOWER

Background

Safflower, an annual plant belonging to the thistle family, is one of the world's oldest crops. It has been grown for centuries in India, the Middle East, and North Africa where it is used as a dye and an edible oil. India still has the largest acreage in safflower, nearly two-thirds of the world's total, and Mexico is second (Table 9.1). U.S. acreage is third in the world, but because of yields nearly two and a half times greater than the worldwide average yield, the United States ranks second in production, accounting for one-sixth of the world's total production of safflower.

Table 9.1. World Safflower Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
India	842	578	487
Mexico	157	1,014	159
United States	98	1,735	170
Ethiopia	69	504	35
Argentina	50	700	35
World	1,265	725	917

Note: The United States represented 7.8% of the world's safflower area in 1991, 239% of the yield, and 18.5% of the production

The earliest reference in the United States to safflower was in an 1899 University of California research report. In the 1930s, safflower production was attempted in the Great Plains, but the seeds were low in oil content. With the development of improved varieties, the plant has been grown with some success in several western states since World War II. Varieties were developed with increased oil content, less hull, and a greater resistance to disease. California is now the major production region in the United States, with lesser production in Montana, Arizona, South Dakota, North Dakota, and Idaho.

Uses of Safflower

For centuries, the plant's dried flowers have served as a source of dye, producing a wide range of reds. Although synthetic dyes have mostly replaced it, safflower is still used to color cosmetics, food, artificial flowers, and liqueur. Until the 1960s, safflower's chief commercial use in the United States was as drying oil for paints and related products. It is particularly good in colorless varnishes and light-colored paint since it does not darken or yellow with age.

Safflower has long been used as a cooking oil in India and elsewhere, but it was not until 1957 that safflower oil was sold in the United States for edible purposes. Medical research revealed that vegetable oils high in linoleic acid tend to reduce the cholesterol content of the blood and are thought, therefore, to reduce the incidence of atherosclerosis. Subsequent promotion of the oil's high ratio of polyunsaturates to saturates led to its popularity as a salad and cooking oil and increased use in margarines. After the oil is extracted, the seed is ground into meal to serve as a protein supplement for cattle, sheep, and poultry.

Safflower's main competitors in the United States in vegetable oils are soybeans and sunflowers, and, recently, canola. Other competing vegetable oils include corn, cottonseed, and peanut oil, produced as byproducts.

California's Safflower Production

Most production of safflower is grown under processor contract. California has produced varieties yielding the traditional polyunsaturated oil, but a growing proportion of the acreage is devoted to another type which yields a monounsaturated (oleic) oil. This oil is chemically similar to olive oil but has a blander flavor. It makes an excellent film-free (commercial) cooking oil which does not impart flavor to the food.

There is also a growing market for pesticide-free safflower oil. Safflower is the only major vegetable oil that can be grown with little or no pesticides.

Besides its ability to be produced without pesticides, safflower has other characteristics that align it with low-input, sustainable agricultural (LISA) systems. Planted in late winter, water requirements are low and safflower roots penetrate the soil deeply, improving the infiltration rate of water for a subsequent crop. In the San Joaquin Valley, safflower is beneficial on heavy soils preceding cotton because it produces deep cracks in the soil into which salts on the soil surface are moved during preirrigation, out of reach of the cotton plant's root system. Because it is deep rooted, it is a good crop for disease control, drying out soils, for example, in tomato rotations, and it can be grown in the Sacramento Valley following rice. In the San Joaquin Valley, preirrigation is used; any subsequent irrigations must be applied with care and precision to avoid root rot.

Table 9.2. Regional Location of Safflower Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
North East	—	—	217	—
Central Coast	2,013	—	4,661	1,400
Sacramento Valley	146,900	97,880	42,652	49,286
San Joaquin Valley	18,188	103,430	50,294	57,503
Southern California	—	—	110	—
Other	—	—	—	2,818
State	167,101	201,310	97,934	111,007

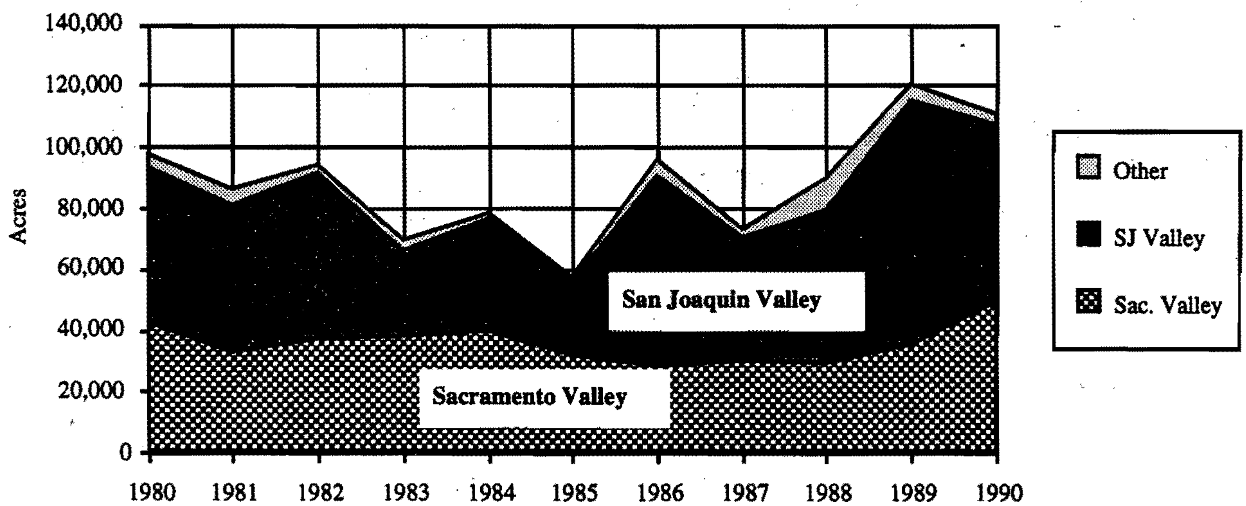
Safflower was one of several crops (barley, oat hay, sunflowers) drawn into rotations in water deficient drought areas, but expansion is contained by the availability of processor contracts and markets.

Location of Production
The early expansion of the safflower industry occurred in the Sacramento Valley, but since 1970 acreage has been slightly more in the San Joaquin Valley (Table 9.2). Currently, in 1990, the San Joaquin Valley accounts for about one-half of the state's acreage and the Sacramento Valley about 45 percent. According to county agricultural commissioners' reports, the leading counties in 1990 in safflower acreage were Kings with nearly 36 thousand acres (32 percent of the total) and Yolo with nearly 28 thousand acres (25 percent of the state's acreage). Other producing counties, in rank order, were San Joaquin (9,000 acres) and Sutter, Fresno, Solano, Kern, Sacramento, and Colusa, each with 4,000 to 7,000 harvested acres.

Figure 9.1 shows acreage in the major production regions over the past decade. Acreage in the Sacramento Valley is relatively more stable than that in the San Joaquin Valley due to safflower's role in the northern rice producing zone.

Trends in Acreage, Yields and Production
Safflower was first introduced as a promising crop in California in 1950, expanding from minor levels to about 300,000 acres in 1963 and an all-time high of 341,000 acres in 1966 (Figure 9.2a). The expansion of market demand in the late 1950s and early 1960s, with safflower's increasing popularity as an edible vegetable oil and associated highprice incentives, resulted in the surge in safflower acreage over that period. Foreign market demand also influenced production during the 1960s when Japan imported large quantities duty-free; however, the market was later displaced by the availability of sunflower oil in the 1970s from the former Soviet Union.

Figure 9.1. Regional Location of Safflower Acreage, 1980-1990

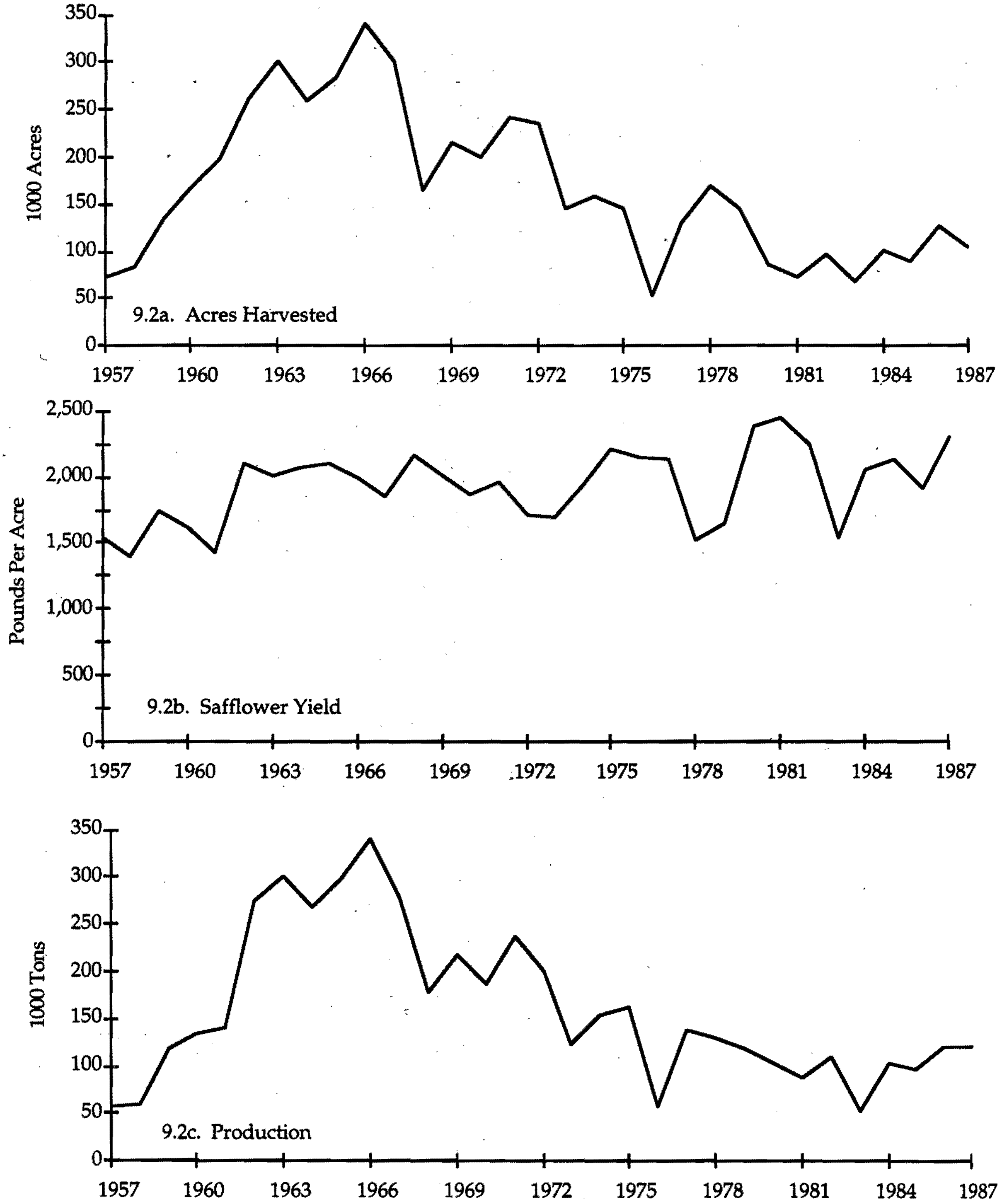


As has been explained, safflower is also a valuable rotation crop for drying out the soil in irrigated rotations. Its chief competitor is wheat so that favorable wheat returns during the late 1960s and the early 1970s and other profitable alternative crops reduced the state's safflower acreage to less than one-third of its peak in 1966. Acreage increased during the 1976-77 drought period and has had a slight upward trend during the 1980s. Acreage is expected to expand during the 1990s as processor demands increase.

The yield trend has been rather stable, but with wide variability over the past several decades (Figure 9.2b). The 1981 yield of 2,444 pounds per acre was a record yield. Higher yields reflect increased experience of farmers in growing safflower and their use of improved cultural practices on relatively good land. Wide fluctuations in yields persist, however, due principally to weather conditions. For example, along cool spring increases yields; hot weather too early adversely affects them. High rainfall during the stand establishment period in 1983 led to low yields of only about 1500 pounds per acre.

Expected prices for safflower and alternative crops influence farmers' decisions about whether to put safflower on their best land. Obviously, these decisions are reflected in fluctuations in annual yield statistics. Because yields have been flat (neither trending sharply up or down), production of safflower (Figure 9.2c) has been closely correlated with movements in statewide acreage.

Figure 9.2. California Safflower:
Harvested Acreage (a), Yield (b), Production (c), 1957-1987



10. GRAIN SORGHUM

Background

Sorghum is an ancient crop originating in eastern Africa about 6,000 years ago. Crop scientists still return to Africa to look for varietal characteristics to incorporate into new hybrid types. There are four general types of sorghums: (l) sweet sorghums with tall, juicy, sweet stalks; (2) grass sorghums with slender stems, abundant tillers, and small seeds; (3) broomcorns with long panicle branches; and (4) grain sorghum with relatively larger kernels than the other types.

Sweet sorghums are used for making a syrup once popular for its tangy flavor, dark color and viscosity. Today, blander sweeteners and lighter syrups are preferred in the United States. Some varieties of sweet sorghums are good as silage and forage. Grass sorghums, particularly sudangrass and sudangrass-sorghum hybrids are cultivated for pasture, green chop, and hay. Another grass sorghum, Johnson grass has been used as a forage crop but, because it does not winterkill, it is widely regarded as a weed pest and a carryover host for sorghum and corn diseases, including maize dwarf mosaic virus. Broomcorn sorghums are used in broom manufacture.

Grain Sorghum Production and Utilization

The most important kind of sorghum in terms of production value is that harvested for grain. In developed nations, sorghum is mostly used for feed; in developing nations, for food. Table 10.1 shows that while the United States is ranked third in acreage devoted to grain sorghum cultivation, it is the world's largest producer, producing about a quarter of total production on only 8 percent of the world's grain sorghum area. U.S. yields are nearly three times the world average.

Sorghum grain is about equal to corn in feed value, but will grow on poorer soils than corn.

Table 10.1. World Grain Sorghum Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
India	15,000	720	10,800
Nigeria	4,600	1,043	4,800
Sudan	4,694	626	2,941
United States	3,974	3,704	14,720
Mexico	1,380	3,164	4,367
World	44,702	1,292	57,763

Note: The United States represented 8.9% of the world's grain sorghum area in 1991, 287% of the yield, and 25% of the production.

Sorghums are more tolerant of both alkali and saline soils than most field crops and have substantial drought resistance. From two-thirds to three-fourths of the U.S. crop is used for feed; most of the rest is exported for use as feed in the importing countries. Japan is the major importer of U.S.-grown sorghum grain, accounting for a third of U.S. exports in 1989. Mexico accounts for a slightly smaller percentage (28 percent) and the remainder of the Americas about 13 percent.

Sorghum grain is a major cash crop in the southern Great Plains where production coincides with the region's feedlot industry. Together Kansas, Texas, Nebraska, Missouri, and Oklahoma accounted for 85 percent of the U.S. total in 1990 (Table 10.2). Arizona, Colorado, and South Dakota are also large producers. California's minor production in 1990 was not reported in federal statistics.

Table 10.2. U.S. Grain Sorghum Production, 1990

Leading States	Area 1000 acres	Yield bu./acre	Production 1000 tons
Kansas	2,800	66	5,174
Texas	2,600	52	385,220
Nebraska	1,400	77	3,018
Missouri	520	82	1,194
Oklahoma	350	44	431
United States	9,079	62.9	16,002

Note: In 1985, California represented 0.2% of U.S. grain sorghum acreage, 124% of U.S. yield, and 0.3% of U.S. production. The states above are ranked 1st through 5th, respectively, in 1990 acreage; California ranked 19th.

California's Grain Sorghum Production

Changes in California's production of sorghum grain over the past four decades are shown in Table 10.3. In California, the production of grain sorghum virtually disappeared during the 1980s. Because grain sorghum yield increases have lagged far behind competitor grains and because of generally low grain prices, California production fell from nearly 400,000 acres in 1970 to only 9,000 acres in 1989 (Table 10.3). Production had been concentrated in the Sacramento and San Joaquin Valley regions. In 1990, the collection of sorghum statistics was discontinued by the California Agricultural Statistical Services because of the crop's declining importance.

Table 10.3. Regional Location of Grain Sorghum Acreage, by decades, 1960-1989

Region	1960	1970	1980	1990
		acres		
North Coast	200	200	—	—
Central Coast	3,900	6,500	2,000	—
Sacramento Valley	105,800	125,000	75,000	4,400
San Joaquin Valley	104,700	173,500	58,600	4,000
Mountain	700	800	—	—
Southern California	17,700	90,000	11,900	500
Other	—	—	4,500	100
State	233,000	396,000	152,000	9,000

All the grain sorghum grown in California was used within the state. Because of its tropical origin, sorghum is able to withstand the summer heat of the Central Valley where nearly all of the acreage was located.

The development of the Ryer 15 variety in the early 1950s increased the double-crop potential of sorghum grains, greatly enhancing their position in the crop mix of the state.

Quick-maturing, short-season hybrids with favorable yields were often planted following winter cereal crops, with an advantage that the same equipment used for other grains may be used for sorghum. In the Sacramento Valley, the major production region, the timing of operations for rice and grain sorghum fit well together. Also, when late spring rains delayed the planting of certain crops, grain sorghum could be planted as a substitute. Its early attraction as a short-season double crop declined with the development of other short-season crop alternatives and recognition that high levels of carbonatious materials in grain sorghum stalks tied up nitrogen in the soil.

Trends in Acreages, Yields and Production

Grain sorghum acreage in California increased about threefold during the period 1953 to 1958 above acreage levels of the late 1940s (Figure 10.2a). Acreage allotments for cotton in 1954 and after, resulted in major increases in acreage of grain sorghum and other crops. In addition, the availability of new hybrid varieties in the mid-1950s significantly increased yield and income potential of grain sorghums. Prior to the introduction of hybrids, the year-to-year variability in grain sorghum acreage was noticeably more extreme. Hybrids not only have the advantage of increased yields but are resistant to lodging and are earlier and more uniform in maturity.

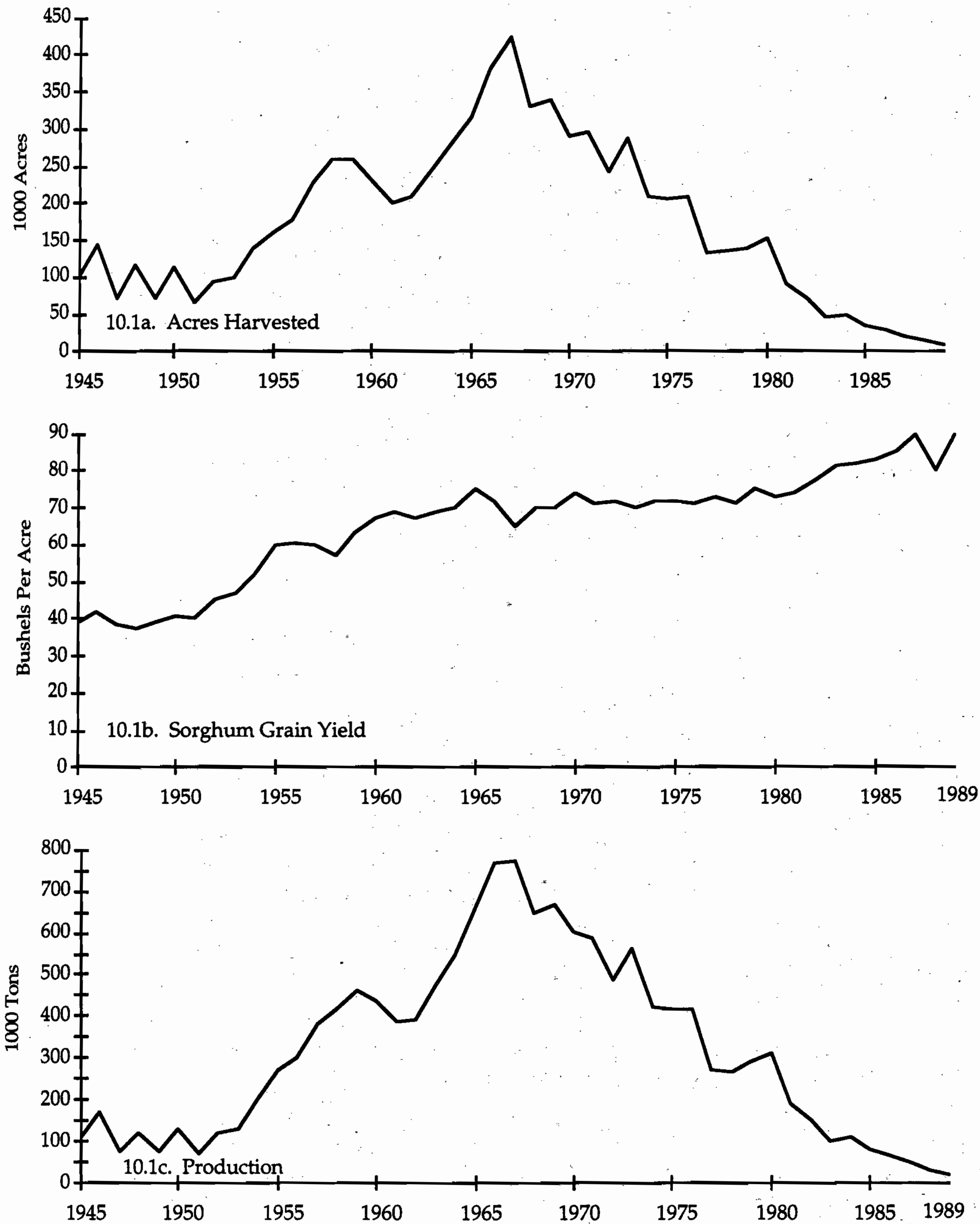
The decline in acreage from 1959 to 1961 was due largely to a poor price situation, whereas the sizable acreage increase from 1961 to 1967 was due both to more favorable prices and the introduction of additional commercial hybrid varieties with shorter seasonal maturities, increasing the double-cropping potential. As a consequence, grain sorghum acreage reached a peak of 424,000 acres in 1967.

The fact that many livestock operators prefer corn to sorghum (even though the latter is comparable in feed value) helps to explain the decline in the state's sorghum acreage since the mid-1960s. Even in double-crop situations, high-yielding hybrid corn is now more frequently chosen over sorghum. Also, new varieties of Mexican red (semi-dwarf) wheat began replacing sorghum acreage in the late 1960s. Sorghum continued to retain a position in the state's crop mix, however, since it was drought-tolerant, needing less irrigation than alternative crops, and used the same equipment needed for other grains. Poor prices relative to other cereals and only minor advances in yields continued the decline of grain sorghum in the state's crop mix, until its now near-demise from production in California.

Yields increased in the postwar period, peaking in the mid-1960s shortly before the peak acreage year, 1967 (Figure 10.2b). The yield increases of the 1950s and early 1960s were due to growers' gaining experience with higher-yielding single-cross hybrid varieties and their using better production practices, including more optimal water and fertilization programs. After a brief two-year decline, yields since 1968 have been generally steady, with a slight upward trend.

Production trends follow acreage trends but are accentuated during the period of increasing yields in the 1950s and early 1960s (Figure 10.2c). Production peaked at 771,700 tons in 1967. After the peak years in the mid-1960s, production and acreage have moved together during the long period characterized by rather constant yields. By the end of the 1980s (in 1989), California's production of grain sorghum amounted to only 22,000 tons.

Figure 10.1. California Grain Sorghum:
Harvested Acreage (a), Yield (b), Production (c), 1945-1989



Background

Sugar, probably the most universally consumed agricultural product in the world, is also widely produced over the globe. In tropical regions and in some temperate zones, sugar cane is grown; in colder areas, sugar beets are produced. The largest sugarcane producing nations are: India, Brazil, Cuba, China, Mexico, Australia, Indonesia, and Malaysia.

In many developing countries, noncentrifugal (brown) sugar, produced in small-scale, labor-intensive systems is a chief source of sucrose; brown sugar does not enter international trade channels. In contrast, centrifugal (white) sugar has historically been subject to complex national and international agreements, and U.S.-produced sugar is by no means an exception.

The major sugar beet producing nations in 1990, in rank order, were: the former Soviet Union, China, United States, France, and Poland (Table 11.1). While the United States produced 8.2 percent of the world's total sugar beet production in 1990, it produced a lesser proportion of total sugar production, only 5.6 percent.

Table 11.1. World Sugar Beet Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
Former USSR	3,160	25,000	79,000
China	700	23,196	16,237
United States	562	44,952	25,263
France	459	63,791	29,280
Poland	361	31,581	11,412
World	8,446	35,106	296,519

Note: The United States represented 6.7% of the world's sugar beet area in 1991, 128% of the yield, and 8.5% of the production.

Despite significant production of both sugar beet and cane sugar, imports still provide an important contribution in meeting the nation's sugar needs. In 1990, imports contributed about 30 percent of national sugar marketings (2,726 thousand tons of imports) with Brazil, Colombia, the Dominican Republic, the Philippines and Guatemala being the major sources of U.S. imports. Mexico, Argentina and Australia have also been major exporters in recent years.

Of the sugar produced domestically (the continental United States, Hawaii, and Puerto Rico) in 1990, 42 percent came from cane and 58 percent from beets. Major cane-producing states are Florida, Hawaii, and Louisiana with lesser production in Texas. Because of Hawaii's climate, yields there are the highest in the world—upwards 100 tons of fresh cane per acre. Most Hawaiian raw sugar is shipped to the C&H sugar refinery at Carquinez in the northern San Francisco Bay.

Sugar beets have been grown in as many as 20 states. In 1990, 15 states grew beets, with Minnesota leading in acreage, followed by North Dakota, Idaho, California, and Michigan (Table 11.2).

Table 11.2. U.S. Sugar Beet Production, 1990

Leading States	Area 1000 acres	Yield tons/acre	Production 1000 tons
Minnesota	364	14.8	5,387
North Dakota	193	14.4	2,782
Idaho	186	25.7	4,780
California	168	26.5	4,452
Michigan	157	20.8	3,266
United States	1,378	20.0	27,593

Note: California represented 12% of U.S. sugar beet acreage in 1990, 133% of U.S. yield, and 16% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage.

The early development in the beet sugar industry was in the northern Midwest and Great Plains where freight rates from distant cane sugar sources were high. Beginning in the 1930s, the location of acreage and production changed significantly, influenced by increases in the irrigated West and decreases in the central and eastern regions of the nation. Because yields are higher in the West, the shift in production was greater than acreage shifts. High yields, along with larger farms and increased mechanization, have permitted relatively efficient production and processing in the western region. Expansion of sugar beet acreage in California accompanied the general shift in production to the West Coast. More recently, in the early 1980s, federal programs fostered expansion of sugar beet acreage in the Great Plains at the loss of production areas in the intermountain West, notably in Idaho and Utah.

The Regulatory Environment

Sugar is a highly controversial and politically charged commodity, nationally and internationally. Government intervention significantly affects sugar production, consumption, and trade. Many countries provide support for sugar producers, placing the cost on consumers and/or taxpayers. Sugar policy has a long history in the United States and programs of one sort or another have been in effect except in 1975-76 and 1980-81 when world prices surged to cyclical highs.

From 1934 until 1974, the U.S. sugar industry operated under the Sugar Act and its various amendments. Each October, the Secretary of Agriculture estimated the annual consumption and made appropriate allocations between domestic sugar cane and sugar beet production and imports to meet certain price objectives. The result of that policy was relative price stability and considerable encouragement to the domestic industry in that U.S. prices were generally above world prices.

All sugar beets were grown under contracts between growers and processors, with contracts subject to approval by the Secretary of Agriculture under the Sugar Act. Rather than producing under a fixed contract price, growers were promised a share of the net selling price received by the processor (net after deduction of marketing and transportation costs which differed among processors). Growers did not share in byproduct sales.

In 1974, two events radically affected the industry equilibrium: (1) Congress did not renew the expiring Sugar Act and (2) world sugar prices increased more than fivefold during the year, due in part to a shortfall in world supplies. Between 1974 and 1981, U.S. sugar policy entailed various short-term measures such as support prices, subsidies, direct payments, loan programs, tariffs, and import quotas, but U.S. prices became more closely correlated with world prices. After 1974, world prices turned downward as a result of many factors including buyer resistance, increased use of sugar substitutes, and better world crop expectations as acreage had increased in response to the record prices.

A return to more regulated sugar market was signaled in the Sugar Title of the Agriculture and Food Act of 1981. Regulation was implemented through price supports and variable levies (taxes) on imports keyed to a market stabilization price, and a system of import quotas. The Food Security Act of 1985 continued to provide market prices which protected domestic producers from persistently low prices of sugar in the world market.

Despite attempts to reduce government support of sugar in the 1991 farm bill, minimum market prices and import quotas continue to provide price protection to domestic producers. Had industrial market economies, including the United States, eliminated trade-distorting policies, U.S. sugar production was estimated to decline, perhaps by as much as 30 percent, while consumption would have been slightly higher due to lower consumer prices.

A Note on an Important Sugar Substitute

Corn sweeteners represent a large proportion of total U.S. caloric sweetener use. Much of the corn sweetener use is of high-fructose corn syrup which approaches the sweetness of sucrose from beet and cane. Although corn sweeteners cannot replace sucrose in all uses, they can in many, especially in processed food and beverage products. High and volatile sugar prices in the past have encouraged the growth of the corn sweetener industry. Domestic consumption of corn syrups has increased from 560 million gallons in 1975 to 1.8 billion gallons in 1989, an increase of about 330 percent in just 15 years.

California's Sugar Beet Production

There are four traditional production areas in California where sugar beets are grown in defined rotations with virtually every one of the principal California row crops (Table 11.3). San Joaquin Valley acreage increased substantially following the opening of a processing plant in Mendota in 1963, but has since declined. In 1990, 47 percent of the state's acreage was harvested in the San Joaquin Valley. San Joaquin and Fresno are the major producing counties, followed by Kern and Merced.

Table 11.3. Regional Location of Sugar Beet Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
Central Coast	240,900	293,500	505,200	364,800
Central Coast	33,744	22,341	22,700	3,900
Sacramento Valley	72,813	80,750	60,300	45,300
San Joaquin Valley	53,971	113,111	103,900	79,200
Southern California	50,898	71,712	39,300	36,800
Other Counties	—	—	2,800	2,800
State	206,600	320,500	229,000	168,000

The Sacramento Valley was once the most important beet production area in the state and still accounts for about one-fourth (27 percent) of the total acreage. Solano, Glenn, Yolo, Colusa, and Sacramento counties are ranked among the state's top 10 producers in 1990.

All of the acreage in the southern California region is located in Imperial County. In fact, Imperial has more beet acreage than any other county in the state—22 percent of the total state harvested acreage in 1990.

A fourth production area, the coastal counties, represented about one-fifth of the state's total acreage in the late 1950s. This area, including the Salinas Valley in Monterey County, enjoyed much higher yields than those in other parts of the state. Monterey County beet acreage, however, has declined as other higher-valued crops such as lettuce, broccoli, cauliflower, and grapes have replaced sugar beets in the Salinas Valley. In 1982, after 83 years of operation, the Spreckels plant near Salinas closed its doors due to the low volume of local beet production and the high cost of transporting beets from other parts of the state. Urbanization has reduced beet acreage in the southern coastal counties. In 1980, the central coast region had about 10 percent of the state's harvested acreage; in 1990, only 2 percent.

An emerging production area in the Tulelake Basin is projected to attract increased acreage—upwards of 5,000 acres in 1992. Changes in regional location of production over the last decade are shown in Figure 11.1.

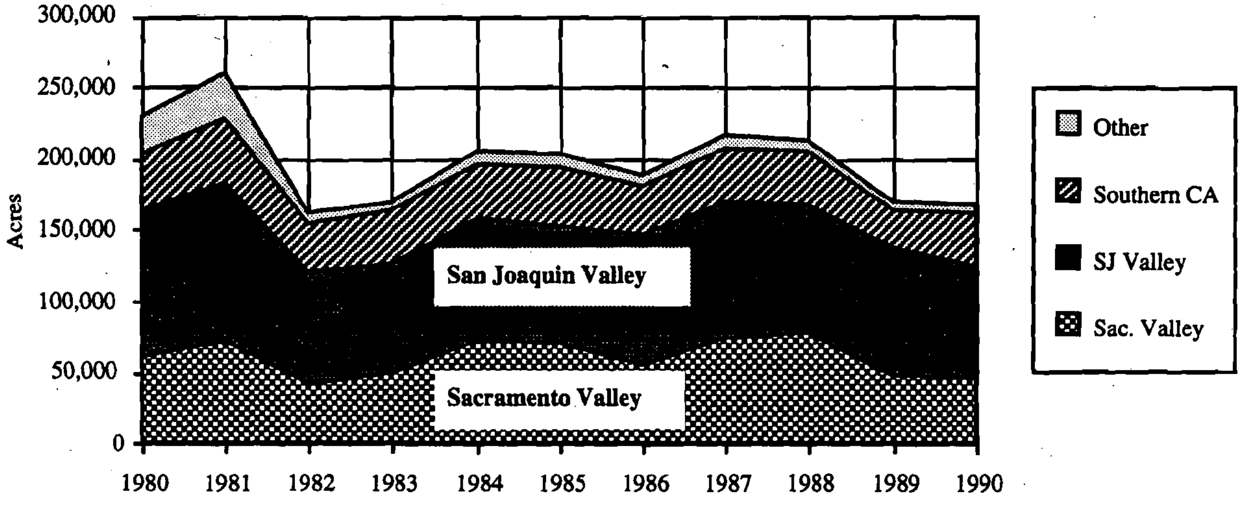
Acreage Trends

Changes in acreage from year to year are largely in response to changes in world sugar prices (and production), prices for crops in competition with beets, and government policies. Other factors are important as well. In the 1920s, a virus disease, curly top, transmitted by the leafhopper, limited California's beet acreage. Development of resistant varieties and control by spray programs raised yields and undoubtedly encouraged acreage expansion in the 1930s. A sharp dip in acreage in 1943-1945 was caused by wartime shortages of labor.

After the war, acreage expanded sharply, reaching a peak in 1950; mechanization of harvest contributed to this expansion (Figure 11.2a). In 1951, cotton allotments were removed, so sugar beet acreage dropped in cotton-producing areas. Acreage in 1955 was limited through control of contracts by processors, who carried over substantial inventories from the 1954 crop and which were marketed under federal quotas.

Acreage allotments were in effect from 1955 to 1961. Allotments were removed for the 1962 through 1964 crops, and sugar beet acreage in California expanded sharply, peaking at about 350,000 acres. Allotments were once again imposed in 1965 and 1966. Some of the acreage increase in 1964 may have been in anticipation of allotments. The sharp decline to 200,000 acres in 1967 was also due to adverse changes in price and to other consequences of expanded acreage, such as inexperienced growers and production on lower quality land. Successive seasons with yield losses attributed to aphid-borne viruses also contributed to disillusionment of growers with the crop. Reversal of the downward trend in 1968 was triggered by favorable sugar prices with acreage nearly attaining its 1964 peak in 1971.

Figure 11.1. Regional Location of Sugar Beet Acreage, 1980-1990



Despite the continuation of good sugar prices, higher prices for competing crops led to a beet acreage decline through 1974. The sharp increase in 1975 was in response to the extraordinary 1974 price for sugar. Since the mid-1970s, acreage has continued to respond to world sugar prices (of the previous year) and to prices of alternative crops.

More recently, acreage has been affected by drought-induced water shortages in traditional areas of production. Beet yellows virus, low prices, Rhizomania-infested fields, and water shortages reduced acreage since 1988. The removal, in 1990, of a nematocide to counter threats of Rhizomania and Cyst nematodes is likely also to result in further reductions of acreage in California. Figure 11.1 shows the declining importance of the Central Coast (other) region, more constant acreage in Southern California (Imperial Valley) and nearly proportional reductions of acreage in the Sacramento and San Joaquin Valleys over the decade of the 1980s.

Yield and Production Trends

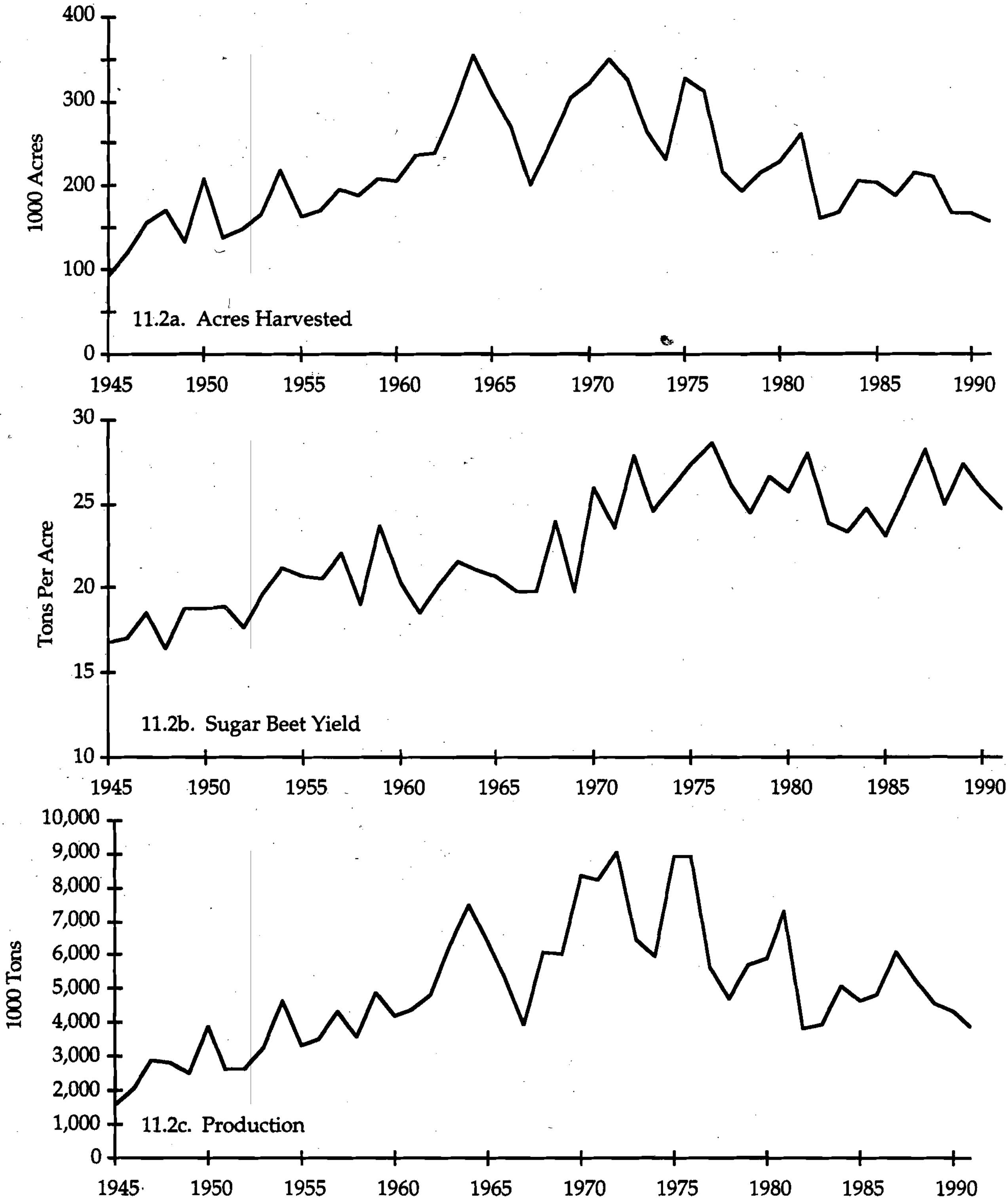
A gradual increase in yields from the mid-1930s to the mid-1950s can be attributed to increased fertilization rates (particularly nitrogen) and generally improved cultural practices. Between 1955 and 1967 (except for two or three favorable years) yields showed no improvement (Figure 11.2b). Probable reasons include damage from yellows virus diseases, later plantings to avoid virus diseases, acreage expansion bringing in lower-quality land and inexperienced growers, and the shift in acreage from the highly productive coastal to inland areas. In California, many crops compete for the state's best land. As higher-valued crops are planted on prime acres and sugar beet production moves to land of lesser quality, average yields decline.

Overwintering crops in the field is a practice that began in northern California in 1950 when farmers could not get into their fields to harvest their beets because of early heavy rains in the fall. The following spring, the beet crop was found to have increased in tonnage. Processors have since encouraged the overwintering practice because it allows them to extend their processing season from early spring through late fall. Thus, sugar beet is a crop that can be planted or harvested in virtually every month of the year in one or more of the traditional production areas. Because overwintered beets tend to increase in tonnage and sugar yield, there has been some tendency towards more overwintered plantings in recent years.

Yields were markedly higher in 1968, a year in which a relatively dry spring permitted early plantings, when there were few overwintered beets, and aphid activity (associated with yellow viruses) was low. In order to reduce the yellow-virus problem, beet-free periods are often established over an entire production area. During the 1970s, yields improved notably due to better control of yellows viruses, more productive and disease-resistant hybrids, better stand establishment, improved weed control and irrigation methods, and the development of precision planters and mechanical thinners which eliminated much of the hand labor previously required. Beet yellows virus is periodically a problem, reducing yields in the Central Valley. Outbreaks during the 1980s reduced yields in several years. The most recent decline in yields is, in part, affected by the April 1990 removal of the nematocide, Telone II.

Annual yield variability often accentuates variability in production which normally closely tracks acreage changes (Figure 11.2c). Increased yields in the 1970s meant relatively greater production even in low-acreage years; relatively high yields in 1986 and in 1989, had similar effects offsetting acreage declines from the previous year.

Figure 11.2. California Sugar Beets:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



12. SWEET POTATOES

Background

Sweet potatoes are classified as moist (soft-fleshed) or dry (firm-fleshed) types. The moist are known in the market as "yams" (botanically incorrect) and the dry as "sweet potatoes" or "sweets," although both belong to the same species in the morning-glory family. The chief difference between the two is in the amount of sugar that is converted from starch in the process of cooking or baking the sweet potato. The moist type yields a more moist, softer consistency and is noticeably sweeter than the dry type. Varieties of the moist, or "yam" type are the most popular throughout the United States, but there are specific markets on the Pacific Coast for the dry "sweet potato."

The sweet potato has been used as food for many years. It is of tropical or subtropical origin, originating in Central America, northern tropical South America, and in the Caribbean. Production in the United States was importantly influenced by outstanding strains of the Puerto Rico variety that was introduced into Florida in 1908 and introduced commercially in Louisiana in the 1930s.

The United States is not a major sweet potato country from a global perspective. Requiring tropical or warm temperature regions with frost free periods, it is not surprising that sweet potato production is largest in the tropics and subtropics. An excellent source of potassium and vitamins A and C, sweet potatoes are an important staple nutrient, especially in Asia and Africa, the two leading producing areas of the world. They are a secondary source of energy food in the Western Hemisphere, with Brazil the lead producer in the region.

The United States ranks only 20th in harvested area in sweet potatoes worldwide, with both area in production and production output being less than 1 percent of the world aggregate (Table 12.1). Nonetheless, sweet potatoes are an important economic crop in several areas of the United States, including California.

California is third in national acreage and production behind North Carolina and Louisiana (Table 12.2). Both states produce for fresh and processed markets, while California's production is primarily for fresh market outlets, although there has been a traditional canning demand for the product as well. California's production amounted to 15 percent of total U.S. production in 1992 and yields were above the national average.

Sweet potatoes are available year-round. Harvest periods vary by state but run from mid-June to mid-November. Sweet potatoes are either immediately marketed, or cured and placed in storage where they can be stored up to seven months. High-quality fresh-market sweet potatoes can command grower prices as much as four times as high as processing-grade products.

Table 12.1. World Sweet Potato Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
Uganda	420	4,286	1,800
Thailand	10	9,709	100
Indonesia	208	9,500	1,976
Tanzania	232	1,253	291
India	150	7,969	1,195
United States	32	16,571	522
World	9,260	13,628	126,187

Note: The United States represented 0.35% of the world's sweet potato area in 1991, 122% of the yield, and 0.4% of the production.

Table 12.2. U.S. Sweet Potato Production, 1990

Leading States	Area 1000 acres	Production 1000 cwt.
North Carolina	34.0	4,930
Louisiana	21.0	3,360
California	8.9	1,558
Texas	6.2	372
Alabama	4.9	637
United States	90.4	13,020

Note: California represented 9.8% of U.S. sweet potato acreage in 1990 and 12% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage.

Total U.S. production has ranged from 11 to 13 million hundredweight since 1976 without any discernible trends. U.S. consumption of fresh sweet potatoes has ranged from 4 to 5 pounds per capita over the past 15 years, again without significant trend. Processed (canned and frozen) products are mostly produced in the southeastern production areas where production costs are considerably lower; most of Louisiana's production is processed.

California's Sweet Potato Production

Sweet potatoes thrive during hot days with maximum sunshine and warm nights and require well-drained, sandy or light sandy soils for high yields and best appearance, e.g., color and smoothness, for consumer acceptance of the fresh product. Production is initiated by planting seed stock in hot beds in March and transplanting into the field in late April and May. Harvest occurs in August and September. The crop is storable for up to nine months, with much of the crop marketed during the summer and fall through the winter holidays on California and western U.S. markets. California fresh market shipments are largest in November and December accounting for over a quarter of national fresh market shipments. (During the same period of time North Carolina being closer to large eastern markets tallies nearly half of total national fresh market shipments).

Location of Production

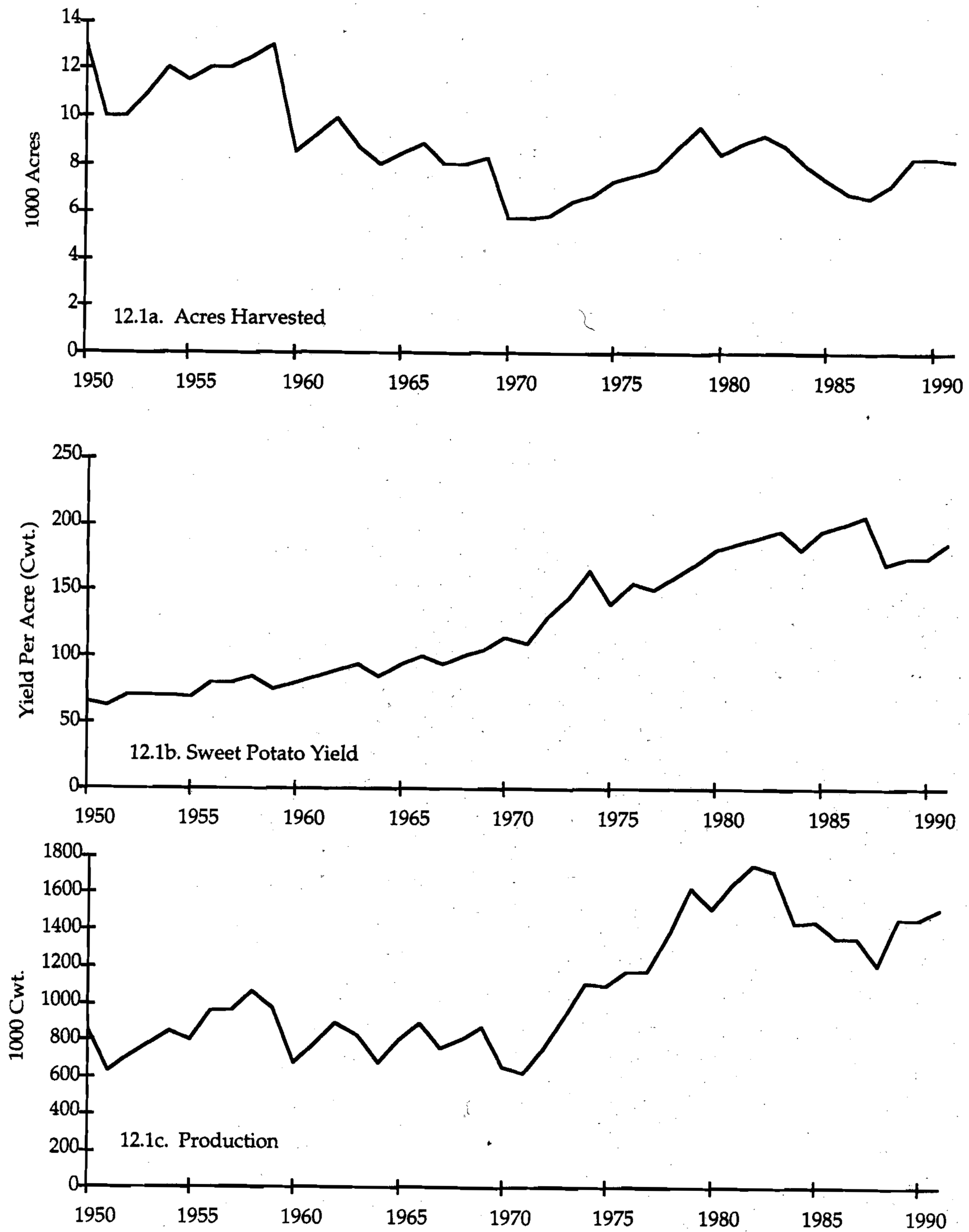
Virtually all sweet potato acreage is located in the San Joaquin Valley. Commercial production there is centered in the Livingston-Atwater district of Merced County in the northern San Joaquin Valley where there is a stable industry of long-standing growers. Merced County accounted for over 6,000 of the state's sweet potato acreage. Substantial acreage was also reported in 1990 in Fresno County (1,370 acres) and Stanislaus County (714 acres). There is a very small amount of production scattered elsewhere in the state, including unreported acreage (to protect confidentiality) in San Bernardino and San Diego counties rose during the 1950s in response to growing markets for fresh and canned sweet potatoes (Figure 12.1a).

Changes in Acreage, Yields and Production

California's sweet potato acreage and production. It then declined during the 1960s because of growth in the North Carolina fresh sweet potato industry, development of improved storage technologies, and rising transportation costs for the California product, all of which shrank fresh market opportunities for western sweet potatoes. During the 1970s, acreage and production increased, as California recaptured some of the national market served growing California and western markets. To its advantage, California's production is less weather determined (all acreage is irrigated) and is more attractive to consumers. The southeast's production is much more vulnerable to weather conditions that affect both size and quality of production. Acreage during the 1980s has varied between 9,200 acres in 1982 and 6,600 in 1987. California acreage and production decisions are affected by U.S. production levels and stocks.

Yields have trended upward throughout the post-World War II period (Table 12.1b). Recent drought conditions may have affected yields since sweet potatoes, grown on sandy or light sandy soils, suffer from lack of moisture during the growing season. Loss of fumigant pesticides and possible deterioration of seed quality may have also contributed. New varieties from USDA and university experiment stations in the southeast (North Carolina, Georgia, Louisiana) are tested and evaluated in Merced County for their adaptation to California commercial conditions. Yields are expected to increase slightly in the future. Production (Figure 12.1c) reflects the upward trend in yields.

**Figure 12.1. California Sweet Potatoes:
Harvested Acreage (a), Yield (b), Production (c), 1950-1991**



Background

Wheat is produced on about one-sixth of the world's cropland and represents about one-third of the world's grain production and about one-half the world's grain trade. The United States ranks third behind the former Soviet Union and China, the world's leaders in quantity produced (Table 13.1). However, both of these nations generally use far more than is grown domestically while the United States over the last decade has exported well over half its crop. The average U.S. yield is very near the world average. In recent years, U.S. acreage and production has amounted to 10 to 12 percent of world totals, depending on markets and government programs.

Table 13.1. World Wheat Production, 1991

Leading Countries	Area 1000 ha.	Yield kg./ha.	Production 1000 MT
Former USSR	45,976	1,740	80,000
China	30,151	3,151	95,003
India	23,977	2,274	54,522
United States	23,347	2,309	53,915
Canada	14,515	2,261	32,822
World	223,806	2,462	550,993

Note: The United States represented 10.4% of the world's wheat area in 1991, 94% of the yield, and 9.8% of the production.

Domestic demand has been relatively stable over time. Steadily increasing yields due to the development of better varieties and other technological changes produced large surpluses from 1950 through the early 1970s. Accordingly, various government policies to limit production were implemented. Then, poor weather conditions in much of the world in 1972 resulted in unprecedented demand for U.S. wheat, temporarily solving the perennial surplus problem.

Acreage increased in response to heavy export demands through 1980, but then a surplus situation once again developed as exports fell by nearly half by 1985. Pressures to curtail production and to enhance exports were major components of farm legislation during the 1980s.

Currently, roughly a third of annual production is exported—37 percent in 1989. Major importers of U.S. wheat in 1988-89 were, in rank order, China, the former Soviet Union, Japan, Pakistan, Korea, Algeria, and the Philippines. Together these seven countries imported 58 percent of U.S. wheat exports. Other important importers of U.S. wheat (and wheat flour) in the 1980s included India, Morocco, and Egypt. Major importers of California wheat in the late 1980s included Bangladesh, Bolivia, Indonesia, the former Soviet Union, and Mexico.

Wheat is grown commercially throughout the United States, in 42 states in 1990. With yields over twice the national average, California's relatively minor levels of acreage (ranked 19th) and production (18th) are still important to operators of both dryland and irrigated farms. California's acreage amounts to less than 1 percent of U.S. acreage; production is less than 2 percent (Table 13.2).

Table 13.2. U.S. Wheat Production, 1990

Leading States	Area 1000 acres	Yield lbs./acre	Production 1000 cwt.
Kansas	11,800	40	472,000
North Dakota	10,910	35.3	385,220
Oklahoma	6,300	32	201,600
Montana	5,185	28.1	145,865
Texas	4,200	31	130,200
California	614	78	47,906
United States	69,353	39.5	2,738,594

Note: California represented 0.9% of U.S. wheat acreage in 1990, 197% of U.S. yield, and 1.7% of U.S. production. The states above are ranked 1st through 5th, respectively, in acreage; California ranked 19th in the nation.

There are now six different classes of wheat harvested in several distinct production regions of the United States. Nearly one-half of the U.S. wheat crop is of the *hard red winter* class which is high in protein and is used primarily to produce bread flour. This type is grown in Colorado, Kansas, Montana, Nebraska, Oklahoma, and Texas. Due to the timing of its market entry, the majority of California's production is classed as "hard red winter" even though it consists mostly of spring varieties grown as winter wheat. *Hard red spring* wheat, about 20 percent of the total, is also high in protein and is used in breads. Both reds are often blended with other lower-protein types of wheat. Hard red spring wheat grows in Minnesota, Montana, North and South Dakota. Another class of high protein spring wheat grown in the same region is *durum*, representing about 4 percent of the wheat crop, and used primarily used for semolina to make macaroni, spaghetti, and other pastas.

Durum production in California is centered in the Imperial Valley.

Soft red winter wheat (17 percent) and *soft* and *hard white* wheats (10 percent), lower in protein, are used in pastries, crackers, biscuits, and cakes. Soft red winter wheat is produced in Illinois, Indiana, Ohio, Missouri and, more recently, in the southeastern United States. White wheats are grown mainly in Washington, Idaho, and Oregon, but there is also some white wheat production in California.

The United States exports all five classes of wheat. In general, importing nations differ for each of the three classes of wheat grown in California. For *hard red winter* wheat, the major importers of bread flour quality products include the former Soviet Union, China, Japan, Morocco, Poland, and, at one time, Iraq. *White* wheat is imported mostly by Asian countries, primarily South Korea and Japan, where it is used for noodle products. Less than 5 percent of wheat exports are *durum*; the largest importer has been Algeria. All types may be used as feed in years of low prices.

California's Wheat Production

Wheat production in California began during the mission period with seed brought from Mexico by the padres. After the Mexican revolution, early California settlers also grew some wheat, but it was the gold rush and its associated increased demand for food that ushered in California's great wheat era. Production was concentrated in the vast Central Valley. By 1888, California's wheat production ranked second in the nation when 42 million bushels were harvested on 3 million acres.

After this peak, California wheat acreage declined as high-value irrigated crops were introduced to the Valley and as high-yielding barley replaced much of the wheat in dry farmed areas. In the first half of the 20th century, acreage averaged somewhat less than 750,000 acres. Soft white wheats were grown almost exclusively and were used primarily for livestock and poultry feed although some food use was made possible by blending with harder types.

Location of production

Distribution of wheat production across the state is shown in Table 13.3 for 1960, 1970, 1980 and 1990. State acreage has more than tripled over the period 1960-1980, and nearly three-fourths of the acreage was in the Central Valley.

Although wheat is grown throughout the Central Valley, the major production counties (normally with production on 40,000 acres, or more),include Solano and Yolo in the Sacramento Valley, and Kings, San Joaquin, and Tulare in the San Joaquin Valley. Imperial County is also a major production county.

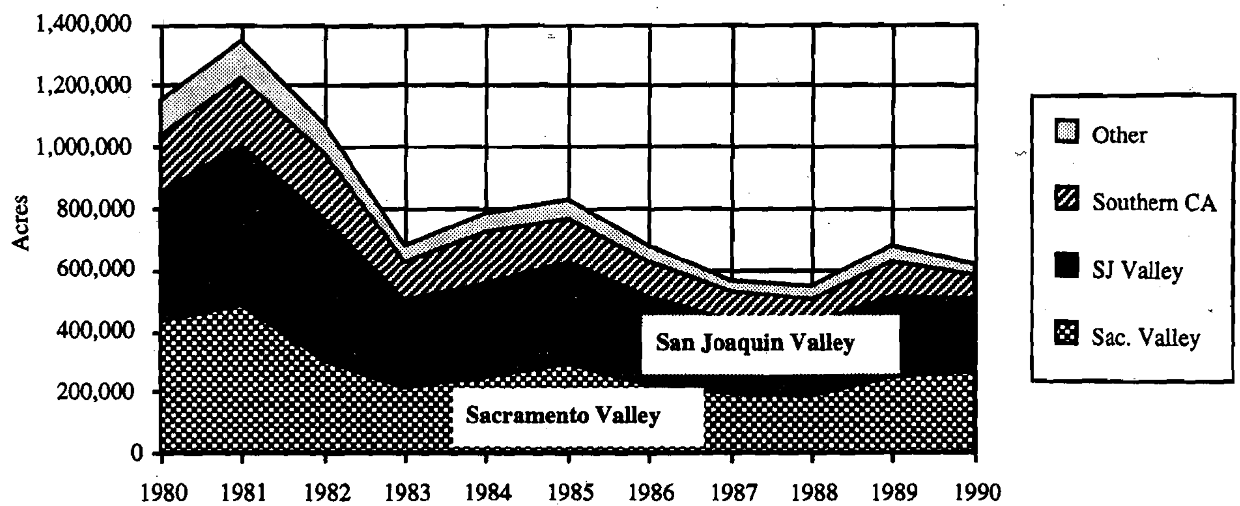
In 1981, acreage in red varieties represented about 84 percent of the total acreage, white varieties had fallen to less than 3 percent, and the remainder (13 percent) was durum. Acreage in durum, the high protein wheat used primarily in semolina, exhibited considerable variation in the late 1970s. A significant shift in production took place from its traditional location in the Tulelake Basin of Siskiyou and Modoc counties to the Imperial Valley. An important advantage of the new location is that farmers' decisions to plant can be made after observation of fall durum prices in its main region, the Dakotas. California durum is now grown as a winter-spring harvested wheat and, as such, growers can exploit "old crop" prices established by existing durum supplies from the major production area.

The 1980 wheat acreage was immediately followed by a record high of 1,345,000 acres in 1981, but fell to 680,000 in 1983 and has gradually declined to only 619,000 in 1990 (Figure 13.1).

Table 13.3. Regional Location of Wheat Acreage, by decades, 1960-1990

Region	1960	1970	1980	1990
		acres		
North Coast	500	200	—	—
North Central	15,450	11,500	18,500	13,000
North East	18,350	13,600	10,500	4,300
Central Coast	96,150	73,000	77,000	18,900
Sacramento Valley	69,050	141,000	429,000	264,000
San Joaquin Valley	97,450	174,000	421,000	238,300
Mountain	10,150	10,650	8,000	2,100
Southern California	39,900	111,000	186,000	78,400
State	347,000	534,750	1,150,000	619,000

Figure 13.1. Regional Location of Wheat Acreage, 1980-1990



Declines effected both red and durum varieties. In 1990, a drought year which affected dryland production, over 80 percent of the acreage was in the Central Valley and only 9 percent of the state's acreage was durum. While acreage declines over the decade of the 1980s occurred in all of the major production regions, there appears to have been more variability in acreage in the Sacramento Valley than in the other regions, where declines were more gradual in nature.

Trends in acreage, yields, and production

The acreage decline in the 1950s and early 1960s (Figure 13.2a) is due mainly to governmental programs which controlled wheat production nationwide and a price structure for wheat which could not compete for feed usage with barley and other feed grains. During that period wheat predominantly went to the milling industry or into government storage; it is estimated that only about 10 percent was used for feed. The Food and Agriculture Act of 1965, with its change in pricing policy, redirected wheat into feed use, primarily in poultry and dairy rations. Roughly half of California's wheat production found its end use in the livestock feeding industry in the late 1960s.

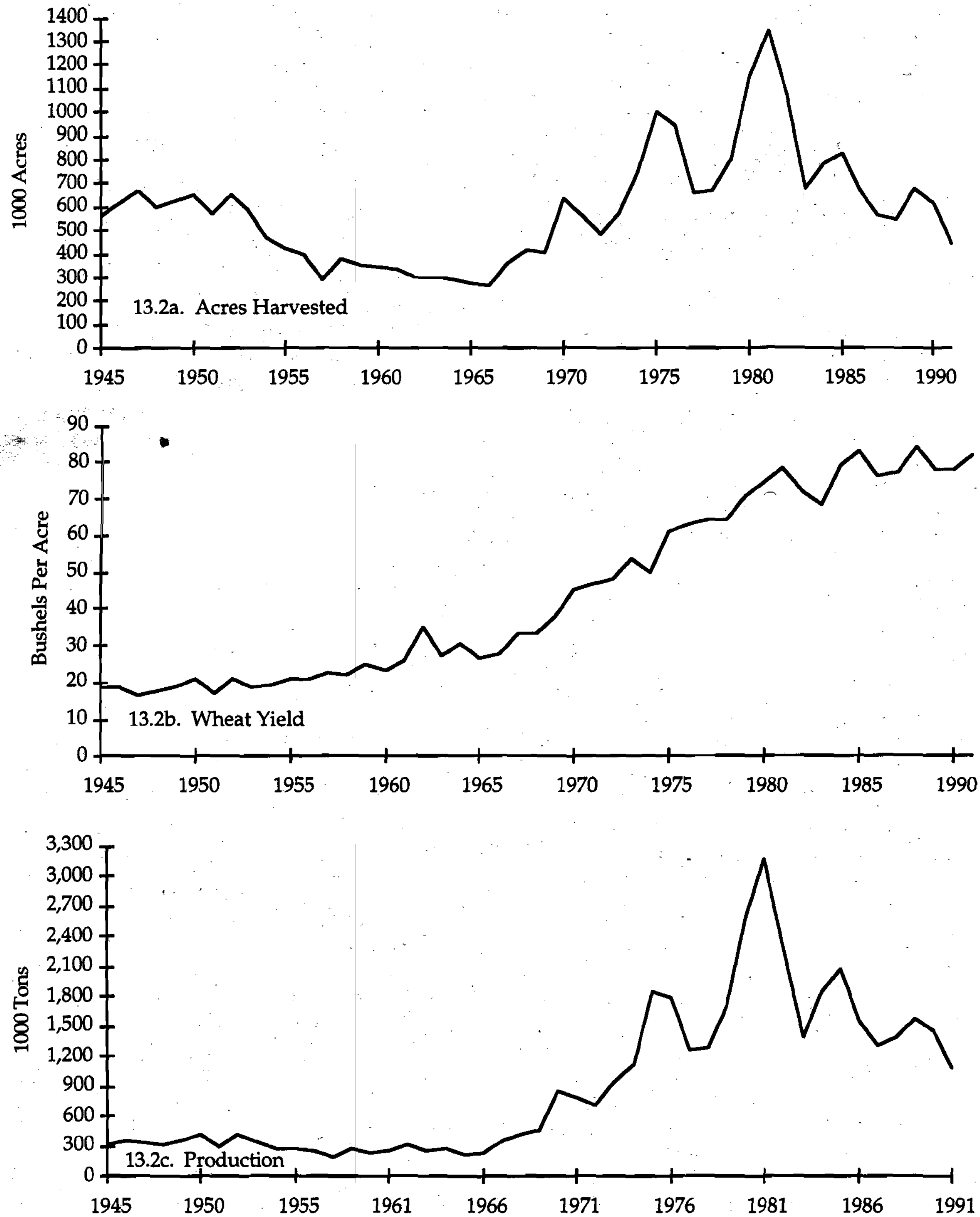
The dramatic increases in acreage, yields, and production after 1966 (Figures 13.2a, 13.2b, and 13.2c) are due mainly to the introduction of high-yielding, hard, red grain, semi-dwarf varieties, resistant to stripe rust disease and to lodging, developed at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. Breeding, selection, and development of wheat varieties for California have been carried on by the University and private industry.

Before the introduction of semi-dwarf reds, the bulk of California wheat production was dry farmed, and the predominant wheat type was lower-protein white wheat used mainly for feed. New varieties moved wheat production to irrigated areas. The resistance to lodging of the sturdy semi-dwarf types permitted irrigation and increased fertilization which in turn nearly tripled yields from their mid-1960s level (Figure 13.2b). Today, the great majority (upwards of three-fourths) of the state's wheat acreage is irrigated. The new varieties also changed California's production to bread types with more attractive export opportunities. The California Wheat Commission is actively involved in market development and research for improved quality and varieties.

"Mexican reds" were first adopted in the 1960s in the Sacramento Valley where soft whites had been the predominant types. Most varieties are of spring growth habit but are planted in the fall and are marketed as hard red winter wheats. Although the grain of several of the main varieties were of lower quality than other U.S. hard red winter wheats, i.e., not as good for use in leavened bread, nutritional qualities were comparable and yields were unsurpassed. By 1968, soft whites which were very susceptible to stripe rust were almost entirely supplanted by hard reds in the Sacramento Valley. By the mid-1970s, over seven times as many acres in the state were planted in hard reds as in soft whites.

University and private industry researchers have since improved the protein quality of the reds without sacrificing yields. Production of new improved bread-type varieties is best suited to San Joaquin Valley conditions; most of the production in the Sacramento Valley does not as easily meet quality standards for bread. Much of the California crop is used by importing countries in

Figure 13.2. California Wheat:
Harvested Acreage (a), Yield (b), Production (c), 1945-1991



making unleavened bread or is blended with other flours.

Soft white wheat is grown only on very limited acreage in the Central Valley. It is grown on a wider scale in the North Central and North East production regions where it is destined primarily for feed uses or for export through Pacific Northwest ports. A high quality, hard white bread-wheat variety, Klasic, adapted to growing conditions in the Central Valley, currently (1992) occupies 40,000 acres in that region. It has further potential if sufficient volume is produced to respond to marketing channel requirements for the Asian market.

Attractive export market opportunities drove the expansion of wheat acreages in the 1970s and the early 1980s. Faced with large stocks of wheat after export markets collapsed and government holdings grew large in 1982, the PIK (Payment-in-kind) program cut acreage in half in 1983 (Figure 13.2a). Subsequent farm programs and the drought further reduced acreage to only 442,000 in 1991. Post-drought, 1992, acreage is estimated to have risen to about 600 thousand acres.

Yield advances since the 1960s have been tempered in the 1980s by heavy rains which contributed to disease problems for the 1983 and 1986 crops and by suppressed yields because of less than optimal irrigation during drought years (Figure 13.2b). Production of wheat in California through the mid 1960s was rather constant, being the product of declining acreage and rising yields. Rising acreage and continued yield increases amplified growth in California wheat production through the 1970s. Production, since 1980, has been chiefly influenced by changes in acreage as yield advances have slowed (Figure 13.2c).

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APPENDIX

Statistical data for commodities included in this report.

California Field Crops: Trends in Acreage, Yield, and Production

1.2 Alfalfa Hay

	1000 acres	tons/acre	1000 tons
1945	1,026	4.20	4,309
1946	1,005	4.60	4,623
1947	1,005	4.70	4,724
1948	925	4.50	4,162
1949	962	4.45	4,281
1950	1,058	4.70	4,973
1951	963	4.75	4,574
1952	1,002	4.70	4,709
1953	1,062	4.60	4,885
1954	1,094	4.80	5,251
1955	1,182	4.60	5,437
1956	1,206	4.50	5,427
1957	1,170	4.85	5,674
1958	1,135	5.00	5,675
1959	1,146	5.20	5,959
1960	1,192	5.00	5,960
1961	1,204	5.10	6,140
1962	1,120	5.20	5,824
1963	1,131	5.60	6,334
1964	1,176	5.55	6,527
1965	1,176	5.35	6,292
1966	1,141	5.60	6,390
1967	1,164	5.30	6,169
1968	1,152	5.70	6,566
1969	1,129	5.50	6,210
1970	1,152	5.60	6,451
1971	1,210	5.70	6,897
1972	1,198	6.00	7,188
1973	1,190	5.80	6,902
1974	1,150	5.90	6,785
1975	1,120	5.90	6,608
1976	1,100	6.00	6,600
1977	1,140	5.85	6,669
1978	1,090	5.45	5,941
1979	1,050	6.00	6,300
1980	1,030	6.40	6,592
1981	1,050	6.30	6,615
1982	960	6.70	6,432
1983	950	6.40	6,080
1984	1,020	6.50	6,630
1985	1,030	6.50	6,695
1986	1,080	6.60	7,128
1987	1,080	6.70	7,236
1988	1,100	6.60	7,260
1989	1,020	6.70	6,834
1990	1,060	6.60	6,996
1991	1,050	6.70	7,035

2.2 Alfalfa Seed

	1000 acres	lbs/acre	Production (1000 lbs.)	Certified
1945	27	115	3,100	
1946	30	175	5,200	
1947	35	205	7,200	228
1948	21	215	4,500	446
1949	63	220	13,900	1,118
1950	115	270	31,000	4,502
1951	77	325	25,000	12,401
1952	84	475	39,900	30,944
1953	99	455	45,045	33,902
1954	127	450	57,150	35,669
1955	192	445	85,440	59,205
1956	188	415	78,020	51,335
1957	188	450	84,600	63,150
1958	167	390	65,130	47,549
1959	153	380	58,140	42,421
1960	141	390	54,990	39,659
1961	137	370	50,690	31,306
1962	115	350	40,250	20,455
1963	104	415	43,160	22,947
1964	106	450	47,700	28,959
1965	110	440	48,400	32,460
1966	105	420	44,100	26,700
1967	97	460	44,620	30,044
1968	103	480	49,440	30,600
1969	96	345	33,120	18,552
1970	104	425	44,200	25,710
1971	91	445	40,495	27,512
1972	67	470	31,490	20,970
1973	56	455	25,480	15,417
1974	66	495	32,670	18,060
1975	51	575	29,325	21,582
1976	48	585	28,080	16,200
1977	50	620	31,000	22,700
1978	64	280	17,920	11,080
1979	80	435	34,800	26,175
1980	78	520	40,560	30,600
1981	94	580	54,520	42,240
1982	n/a	n/a	n/a	n/a
1983	62	630	39,060	28,415
1984	81	685	55,485	47,805
1985	82	585	47,970	38,600
1986	93	500	46,500	38,443
1987	67	605	40,541	33,522
1988	67	529	35,466	29,273
1989	67	489	32,755	26,611
1990	71	494	35,065	27,514
1991	68	603	41,012	35,468

3.2 Barley

	1000 acres	bu./acre	1000 bu.[a]
1945	1,486	28.0	41,608
1946	1,486	33.0	49,038
1947	1,545	29.0	44,805
1948	1,622	31.0	50,282
1949	1,590	32.0	50,880
1950	1,765	34.0	60,010
1951	1,412	32.0	45,184
1952	1,497	37.5	56,138
1953	1,557	36.0	56,052
1954	1,915	38.0	72,770
1955	1,838	39.0	71,682
1956	1,801	38.0	68,438
1957	1,891	44.0	83,204
1958	1,740	38.0	66,120
1959	1,618	43.0	69,574
1960	1,586	46.0	72,956
1961	1,538	48.0	73,824
1962	1,461	51.0	74,511
1963	1,446	48.0	69,408
1964	1,388	55.0	76,340
1965	1,402	51.0	71,502
1966	1,318	51.0	67,218
1967	1,450	52.0	75,400
1968	1,350	50.0	67,500
1969	1,077	47.0	50,619
1970	1,130	52.0	58,760
1971	1,006	53.0	53,318
1972	926	55.0	50,930
1973	940	51.0	47,940
1974	877	52.0	45,604
1975	1,060	57.0	60,420
1976	1,010	56.0	56,560
1977	950	56.0	53,200
1978	950	48.0	45,600
1979	790	60.0	47,400
1980	712	62.1	44,144
1981	640	62.9	40,320
1982	620	62.1	38,440
1983	490	60.0	29,400
1984	460	62.9	28,980
1985	420	59.2	24,780
1986	400	59.2	23,600
1987	330	54.2	17,820
1988	280	60.8	17,080
1989	250	57.9	14,500
1990	230	58.0	13,340
1991	160	59.0	9,440

[a]To obtain the numbers in 1000 tons (as in Figure 3.2), divide by 41.6667.

4.3. Dry Beans

	1000 acres	lbs/acre	1000 cwt.
1945	307	1,066	3,274
1946	283	1,153	3,264
1947	323	1,229	3,970
1948	368	1,348	4,960
1949	358	1,312	4,696
1950	311	1,331	4,138
1951	350	1,345	4,709
1952	295	1,313	3,873
1953	283	1,408	3,985
1954	318	1,450	4,610
1955	323	1,272	4,109
1956	276	1,457	4,021
1957	267	1,347	3,596
1958	298	1,373	4,091
1959	254	1,442	3,662
1960	221	1,403	3,100
1961	241	1,393	3,356
1962	219	1,477	3,234
1963	225	1,478	3,325
1964	195	1,434	2,796
1965	206	1,429	2,943
1966	223	1,434	3,197
1967	189	1,389	2,626
1968	214	1,556	3,330
1969	204	1,439	2,936
1970	174	1,532	2,666
1971	148	1,447	2,141
1972	157	1,567	2,460
1973	161	1,682	2,708
1974	227	1,758	3,991
1975	154	1,692	2,606
1976	179	1,564	2,800
1977	169	1,708	2,887
1978	216	1,538	3,323
1979	207	1,739	3,600
1980	213	1,790	3,813
1981	224	1,833	4,105
1982	210	1,707	3,585
1983	143	1,687	2,412
1984	191	1,685	3,218
1985	178	2,002	3,563
1986	155	1,846	2,862
1987	168	1,868	3,138
1988	147	1,963	2,885
1989	180	1,865	3,357
1990	166	1,842	3,058
1991	144	2,172	3,127

4.2. Dry Bean Acreage by Variety (1000 acres)

	Large limas	Baby limas	Small whites	Pinks	Blackeyes	Red kidney	Garbanzos
1945	87	79	32	31	49	6	7
1946	67	82	24	38	42	8	7
1947	70	79	34	44	60	10	5
1948	70	75	43	53	94	13	1
1949	92	83	41	60	43	12	4
1950	71	72	29	39	66	8	8
1951	68	52	41	60	82	17	2
1952	81	28	32	47	61	16	5
1953	68	36	32	42	66	12	2
1954	73	43	36	58	61	11	5
1955	72	24	42	49	89	14	4
1956	60	30	35	37	55	23	10
1957	61	17	38	37	72	17	7
1958	66	22	41	44	76	20	9
1959	59	23	45	25	65	15	9
1960	49	25	29	30	50	19	10
1961	47	28	24	38	78	15	1
1962	53	30	27	26	50	17	3
1963	48	30	28	23	63	18	6
1964	42	18	24	19	60	19	6
1965	46	13	25	21	58	24	9
1966	39	20	27	20	68	27	11
1967	49	16	25	16	44	20	8
1968	44	29	25	15	57	22	7
1969	45	26	27	10	43	32	11
1970	34	26	17	11	43	25	11
1971	25	22	17	9	33	25	13
1972	26	18	17	6	51	25	10
1973	31	20	16	4	47	26	11
1974	33	28	27	14	65	40	10
1975	24	20	11	12	31	33	15
1976	35	21	16	12	37	42	9
1977	31	22	12	9	44	38	9
1978	29	25	9	13	57	63	13
1979	27	29	3	14	59	45	18
1980	34	19	4	44	43	55	8
1981	30	29	7	42	53	46	6
1982	28	25	6	13	67	53	8
1983	26	24	2	11	40	24	7
1984	36	28	3	14	55	47	3
1985	44	28	—	13	40	39	5
1986	19	30	—	18	42	35	6
1987	21	21	3	6	63	45	4
1988	28	29	2	5	43	31	1
1989	32	35	—	16	39	47	—
1990	23	25	—	17	46	45	—
1991	27	39	—	—	41	—	—

5.2. Corn

	1000 acres	bu./acre	1000 bu.[a]
1945	29	34.0	986
1946	32	35.0	1,120
1947	27	35.0	945
1948	30	36.5	1,095
1949	31	40.0	1,240
1950	42	43.0	1,806
1951	30	47.0	1,410
1952	39	48.0	1,872
1953	37	46.0	1,702
1954	103	57.0	5,871
1955	184	66.0	12,144
1956	173	72.0	12,456
1957	216	74.0	15,984
1958	176	70.0	12,320
1959	167	71.0	11,857
1960	130	72.0	9,360
1961	91	72.0	6,552
1962	77	77.0	5,929
1963	98	77.0	7,546
1964	107	82.0	8,774
1965	144	89.0	12,816
1966	180	92.0	16,560
1967	220	84.0	18,480
1968	185	95.0	17,575
1969	177	92.0	16,284
1970	203	98.0	19,894
1971	250	94.0	23,500
1972	215	100.0	21,500
1973	235	105.0	24,675
1974	225	107.0	24,075
1975	254	109.0	27,686
1976	290	110.0	31,900
1977	247	116.0	28,652
1978	281	126.0	35,406
1979	260	117.0	30,420
1980	270	135.0	36,450
1981	275	130.0	35,750
1982	330	130.0	42,900
1983	260	127.9	33,280
1984	375	136.1	51,000
1985	320	145.1	46,400
1986	250	152.0	38,000
1987	221	160.0	35,360
1988	187	145.0	27,115
1989	185	160.0	29,579
1990	160	160.0	25,600
1991	115	160.0	18,400

[a]To obtain the numbers in 1000 tons (as in Figure 5.2), divide by 35.7143.

6.2. Cotton

	1000 acres	lbs/acre	1000 bales
1945	317	535	353
1946	358	613	458
1947	534	693	772
1948	804	576	968
1949	925	656	1,268
1950	581	805	978
1951	1,305	648	1,765
1952	1,386	628	1,818
1953	1,340	632	1,768
1954	883	806	1,487
1955	745	774	1,205
1956	749	924	1,446
1957	711	1,035	1,537
1958	732	1,049	1,604
1959	875	1,055	1,929
1960	946	981	1,939
1961	816	990	1,689
1962	809	1,132	1,907
1963	730	1,124	1,710
1964	743	1,133	1,754
1965	725	1,116	1,686
1966	618	952	1,225
1967	588	847	1,038
1968	687	1,097	1,569
1969	701	899	1,312
1970	662	841	1,160
1971	741	723	1,117
1972	863	982	1,765
1973	942	891	1,749
1974	1,238	1,006	2,595
1975	875	1,072	1,954
1976	1,120	1,064	2,482
1977	1,390	964	2,790
1978	1,455	640	1,940
1979	1,635	1,000	3,408
1980	1,540	969	3,109
1981	1,530	1,109	3,535
1982	1,370	1,077	3,073
1983	950	996	1,971
1984	1,400	999	2,913
1985	1,320	1,132	3,114
1986	990	1,088	2,245
1987	1,141	1,258	2,991
1988	1,337	1,015	2,827
1989	1,058	1,226	2,701
1990	1,116	1,201	2,791
1991	1,041	1,242	2,694

7.2. Potatoes

	1000 acres	cwt./acre	1000 cwt.
1950	120.8	232	28,012
1951	87.9	249	21,849
1952	96.2	252	24,276
1953	130.2	225	29,280
1954	95.3	245	23,324
1955	115.6	252	29,189
1956	106.8	241	25,722
1957	114.1	274	31,262
1958	122.6	241	29,541
1959	98.1	283	27,728
1960	102.9	279	28,757
1961	113.7	304	34,599
1962	98.1	287	28,202
1963	98.5	301	29,619
1964	89.1	305	27,201
1965	107.2	301	32,217
1966	114.0	308	35,166
1967	110.3	302	33,331
1968	91.2	322	29,629
1969	91.9	317	29,093
1970	87.5	340	29,760
1971	82.6	321	26,545
1972	67.7	325	22,032
1973	69.6	311	21,649
1974	70.5	351	24,716
1975	59.9	351	21,015
1976	66.0	364	24,044
1977	60.7	361	21,890
1978	57.2	312	17,854
1979	56.2	372	20,911
1980	50.5	370	18,692
1981	56.3	374	21,071
1982	56.2	376	21,145
1983	56.2	355	19,949
1984	60.4	377	22,767
1985	61.6	375	23,077
1986	48.4	381	18,451
1987	50.6	376	19,039
1988	47.2	355	16,765
1989	48.7	366	17,831
1990	50.0	356	17,783
1991	45.7	364	16,626

8.2. Rice

	1000 acres	lbs./acre	1000 cwt.
1945	235	2,665	6,262
1946	261	3,032	7,913
1947	256	3,139	8,035
1948	256	2,669	6,832
1949	305	3,350	10,218
1950	238	3,475	8,270
1951	324	3,300	10,692
1952	337	3,475	11,711
1953	425	2,900	12,325
1954	477	2,550	12,164
1955	329	3,450	11,350
1956	286	4,200	12,012
1957	226	4,300	9,718
1958	249	4,450	11,080
1959	285	4,650	13,252
1960	288	4,775	13,752
1961	290	4,800	13,920
1962	323	4,950	15,988
1963	324	4,325	14,013
1964	327	5,050	16,514
1965	327	4,900	16,023
1966	360	5,500	19,800
1967	360	4,900	17,640
1968	432	5,325	23,004
1969	389	5,525	21,492
1970	331	5,700	18,867
1971	331	5,200	17,212
1972	331	5,700	18,868
1973	401	5,616	22,521
1974	477	5,290	25,221
1975	525	5,750	30,179
1976	399	5,520	22,017
1977	308	5,810	17,913
1978	490	5,220	25,578
1979	522	6,520	34,042
1980	565	6,440	36,386
1981	593	6,900	40,924
1982	535	6,700	35,848
1983	328	7,040	23,089
1984	450	7,120	32,060
1985	390	7,300	28,468
1986	360	7,700	27,727
1987	370	7,550	27,935
1988	425	7,020	29,840
1989	410	7,900	32,390
1990	395	7,700	30,429
1991	325	7,800	25,350

9.2. Safflower

	1000 acres	lbs./acre	1000 tons
1957	74	1,540	57
1958	84	1,400	59
1959	135	1,750	118
1960	167	1,620	135
1961	198	1,430	142
1962	261	2,110	275
1963	301	2,010	302
1964	259	2,070	268
1965	284	2,110	299
1966	341	2,000	341
1967	300	1,850	278
1968	165	2,170	179
1969	216	2,009	217
1970	201	1,870	188
1971	242	1,959	237
1972	235	1,710	201
1973	145	1,697	123
1974	159	1,950	155
1975	146	2,219	162
1976	54	2,148	58
1977	130	2,138	139
1978	170	1,529	130
1979	145	1,655	120
1980	87	2,391	104
1981	72	2,444	88
1982	98	2,245	110
1983	69	1,536	53
1984	101	2,059	104
1985	90	2,133	96
1986	127	1,921	122
1987	106	2,302	122

10.1. Grain Sorghum

	1000 acres	bu./acre	1000 tons
1945	102	39.0	3,978
1946	145	42.0	6,090
1947	70	38.5	2,695
1948	116	37.5	4,350
1949	71	39.0	2,769
1950	114	41.0	4,674
1951	65	40.0	2,600
1952	95	45.0	4,275
1953	99	47.0	4,653
1954	140	52.0	7,280
1955	162	60.0	9,720
1956	179	60.5	10,830
1957	229	60.0	13,740
1958	260	57.0	14,820
1959	260	63.5	16,510
1960	233	67.0	15,611
1961	200	69.0	13,800
1962	210	67.0	14,070
1963	246	69.0	16,974
1964	280	70.0	19,600
1965	316	75.0	23,700
1966	382	72.0	27,504
1967	424	65.0	27,560
1968	330	70.0	23,100
1969	340	70.0	23,800
1970	290	74.0	21,460
1971	296	71.0	21,016
1972	242	72.0	17,424
1973	287	70.0	20,090
1974	210	72.0	15,120
1975	207	72.0	14,904
1976	210	71.0	14,910
1977	132	73.0	9,636
1978	135	71.0	9,585
1979	140	75.0	10,500
1980	152	72.9	11,096
1981	92	73.9	6,808
1982	70	77.1	5,390
1983	45	81.1	3,645
1984	48	82.1	3,936
1985	36	82.9	2,988
1986	29	85.0	2,465
1987	20	90.0	1,800
1988	15	80.0	1.200
1989	9	90.0	810

11.2 Sugar Beets

	1000 acres	tons/acre	1000 tons
1945	93.0	16.8	1,565
1946	122.0	17.1	2,081
1947	156.0	18.6	2,897
1948	172.0	16.4	2,817
1949	134.0	18.8	2,519
1950	209.0	18.8	3,927
1951	139.6	18.9	2,643
1952	149.1	17.7	2,636
1953	167.3	19.7	3,289
1954	218.5	21.2	4,632
1955	162.7	20.7	3,365
1956	170.8	20.5	3,500
1957	195.5	22.1	4,316
1958	189.7	19.0	3,595
1959	208.3	23.7	4,928
1960	206.6	20.3	4,198
1961	235.7	18.6	4,388
1962	238.6	20.2	4,825
1963	292.0	21.5	6,278
1964	353.5	21.0	7,439
1965	309.7	20.7	6,402
1966	269.7	19.8	5,332
1967	200.8	19.8	3,983
1968	254.2	23.9	6,081
1969	305.0	19.8	6,046
1970	320.5	26.0	8,342
1971	348.8	23.6	8,217
1972	324.6	27.8	9,031
1973	262.6	24.6	6,447
1974	230.0	25.9	5,948
1975	326.3	27.3	8,892
1976	312.0	28.6	8,912
1977	217.0	26.1	5,664
1978	194.0	24.5	4,745
1979	215.0	26.6	5,719
1980	229.0	25.7	5,885
1981	260.0	27.9	7,254
1982	162.0	23.8	3,852
1983	169.0	23.3	3,938
1984	206.0	24.7	5,088
1985	203.0	23.0	4,669
1986	189.0	25.5	4,820
1987	216.0	28.2	6,091
1988	212.0	25.0	5,300
1989	169.0	27.3	4,614
1990	168.0	25.8	4,334
1991	159.0	24.7	3,927

12.1. Sweet Potatoes

	1000 acres	cwt./acre	1000 cwt.
1950	13.0	66	858
1951	10.0	63	630
1952	10.0	71	710
1953	11.0	71	781
1954	12.0	71	852
1955	11.5	70	805
1956	12.0	80	960
1957	12.0	80	960
1958	12.5	85	1,062
1959	13.0	75	975
1960	8.5	80	680
1961	9.2	85	782
1962	9.9	90	891
1963	8.7	95	826
1964	8.0	85	680
1965	8.4	95	798
1966	8.9	100	890
1967	8.0	95	760
1968	8.0	100	800
1969	8.3	105	872
1970	5.7	115	656
1971	5.7	110	627
1972	5.8	130	754
1973	6.4	145	928
1974	6.7	165	1,106
1975	7.3	140	1,102
1976	7.6	155	1,178
1977	7.8	150	1,170
1978	8.7	160	1,392
1979	9.6	170	1,632
1980	8.4	180	1,512
1981	8.9	185	1,647
1982	9.2	190	1,748
1983	8.8	195	1,716
1984	8.0	180	1,440
1985	7.4	195	1,443
1986	6.8	200	1,360
1987	6.6	205	1,353
1988	7.1	170	1,207
1989	8.3	175	1,453
1990	8.3	175	1,453
1991	7.9	185	1,462

13.2. Wheat

	1000 acres	bu./acre	1000 bu.[a]
1945	563	19.0	10,697
1946	619	19.0	11,761
1947	669	16.5	11,038
1948	602	17.5	10,535
1949	626	18.5	11,581
1950	651	21.0	13,671
1951	573	17.0	9,741
1952	653	21.0	13,713
1953	594	19.0	11,286
1954	470	19.5	9,165
1955	423	21.0	8,883
1956	401	21.3	8,541
1957	288	22.5	6,481
1958	377	22.4	8,450
1959	356	24.9	8,879
1960	347	23.4	8,124
1961	337	25.9	8,737
1962	301	35.1	10,564
1963	298	27.3	8,133
1964	291	30.6	8,905
1965	278	26.6	7,383
1966	270	27.6	7,455
1967	364	33.5	12,180
1968	415	33.5	13,919
1969	405	38.0	15,380
1970	630	45.3	28,550
1971	568	46.9	26,626
1972	487	47.9	23,340
1973	572	54.0	30,880
1974	750	50.0	37,500
1975	1,001	61.2	61,241
1976	940	63.5	59,720
1977	660	64.5	42,548
1978	665	64.2	42,725
1979	800	70.6	56,450
1980	1,150	74.3	85,500
1981	1,345	78.5	105,547
1982	1,075	71.8	77,177
1983	680	68.5	46,560
1984	784	78.9	61,840
1985	830	83.0	68,860
1986	675	76.3	51,527
1987	567	77.4	43,890
1988	549	84.3	46,277
1989	675	77.9	52,607
1990	619	77.7	48,167
1991	442	81.7	36,167

[a] To obtain the numbers in 1000 tons (as in Figure 13.2), multiply by 60 and divide by 2,000.

II. Acreage by Subsector

	Field Crops	Tree Fruit & Nuts	Vegetables	Total
1981	7,025,000	1,769,970	857,020	9,532,616
1982	6,375,000	1,821,770	926,437	9,651,990
1983	4,971,000	1,865,070	929,056	7,765,126
1984	5,947,000	1,913,930	979,201	8,840,131
1985	5,788,000	1,956,100	970,298	8,714,398
1986	5,290,000	1,954,600	979,218	8,223,818
1987	5,123,000	1,970,489	1,077,385	8,170,874
1988	5,289,000	1,959,850	1,106,599	8,355,449
1989	5,124,000	1,952,750	1,114,261	8,191,011
1990	4,992,000	1,954,158	1,168,595	8,114,753
1991	4,523,000	1,949,000	1,124,000	7,596,000

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