California Vegetable Crops: Production and Markets

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CALIFORNIA VEGETABLE CROPS: PRODUCTION AND MARKETS

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TABLE OF CONTENTS

INTRODUCTION

California produced 17.3 million tons of vegetables and melons in 1992, worth some $3.7 billion or about 20% of the total cash receipts from crop and livestock sales that year. California accounted for 46 % of the nation's major vegetables and melons sold on the fresh market and 57% of the vegetables for processing. Among the vegetables in which California leads the nation are broccoli, carrots, cauliflower, celery, lettuce, honeydew melons, onions, and processing tomatoes.

Included in this report are 14 major California vegetable crops—asparagus, broccoli, bushberries (especially red raspberries), carrots, cauliflower, celery, sweet corn, lettuce, melons (especially cantaloupe and honeydew), mushrooms, onions, strawberries, and fresh and processing tomatoes. While there are others that could have been covered, from artichokes to zucchini, we chose to report on only those whose gross sales exceeded $20 million in 1991.

We describe each vegetable crop, make some comparisons between California and other states' production, discuss national consumption trends and the import/export situation, describe the location of production in California, and graph the trends in acreage, yields, and production over the last two decades. Appendix tables contain statistical data for commodities contained in this report. The authors acknowledge the helpful library research work performed by Sandy Fisher of the UC Agricultural Issues Center.

This is the second report of a series on trends in California crop production. The first, *California Field Crops: Location and Trends in Acreage, Yields, and Production,* is available as UC Giannini Foundation of Agricultural Economics, Information Series 94-1. A third report, in preparation, will update the 1985 publication *California Tree Fruits, Grapes, and Nuts: Location of Acreage and Trends in Acreage, Yields, and Production, 1946-1983,* UC Giannini Foundation of Agricultural Economics, Information Series 85-1. Additional copies of this report, and others in the series, are available from the Department of Agricultural Economics, University of California, Davis, CA 95616.

1. ASPARAGUS

Asparagus is a perennial crop. Spears that shoot up from the root crown are harvested several times from the same plant as they reach from 7 to 10 inches in height. After harvest, the plants grow tall ferns that are cut before the next spring's crop emerges. The crop is labor intensive, with labor costs representing as much as 50-60% of the crop's value at the farm gate (Cook et al.).

The plants begin to bear the second year after planting, but are not heavily harvested until the third year. Asparagus beds remain productive from eight to 15 years. (For more production information, see Sims, Souther, and Mullen.)

According to the 1987 Census of Agriculture, 3,033 U.S. farms harvested 97,335 acres of asparagus; almost 70% was irrigated. Many states have some asparagus acreage, but California leads with 35% of U.S. harvested acreage in 1991, followed by Washington with 30% and Michigan with 25% (Table 1.1).

Table 1.1. Harvested U.S. Asparagus Acreage and Production, 1991

State	Harvested area acres	Production 1000 cwt.
California	33,500	938
Washington	29,000	957
Michigan	23,500	259
New Jersey	1,400	24
U.S. total	95,300	2,253

Source: U.S. National Agricultural Statistics Service.

Harvested asparagus is sold fresh or to processors for canning or freezing. Over time, the proportions to each outlet have shifted. Between 1977 and 1981, an average of 43% of the U.S. crop was canned, 18% was frozen, and 39% was sold fresh (French and Willett). By the early 1980s, over half the crop was sold fresh. Table 1.2 shows the shift in shares to each outlet. By 1990, 59% of the total supply (including net imports) was sold fresh; 41%, processed (U.S. ERS).

These distributional changes are in response to a shift in consumer preferences toward fresh purchases of many vegetables. Per capita consumption data in Table 1.3 show the shift in usage for asparagus. However, increased fresh consumption has been at the expense of frozen asparagus, for total consumption has declined to about 1 lb. per person, over a period when total vegetable consumption increased 23%, from 92.4 lbs. to 113.7 lbs. per person (Putnam and Allshouse).

Table 1.2. Proportion of U.S. Production to Fresh and Processed Outlets

Year	Fresh	Canning	Freezing	Total processed
1950	0.360	0.505	0.135	0.640
1960	0.327	0.478	0.195	0.637
1970	0.343	0.471	0.187	0.657
1980	0.469	0.413	0.118	0.531
1985	0.539	0.317	0.144	0.461

Source: French and Willett

Table 1.3. U.S. Per Capita Use of Asparagus

Year	Fresh lbs.	Frozen lbs.	Canned lbs.	Total lbs.
1970	.4	.3	.6	1.3
1975	.4	.2	.6	1.2
1980	.3	.1	.4	.8
1985	.5	.1	.3	.9
1990	.6	.1	.3	1.0

Source: U.S. Economic Research Service.

Washington Production

The state of Washington has traditionally produced for the processing market. Production was once on small diversified family farms in the south central and southeastern parts of the state (Cook et al.). Since the mid-1980s much larger acreages are being farmed with some operations from 350 acres to as much as 2,000 acres. (According to the 1987 Census of Agriculture, the average asparagus acreage per farm was just over 54 acres.) Since 1983, Washington has been increasing the share of crop sold to the fresh market. Presently, the state is evolving an efficient dual-market structure—shipping first to the fresh market, then shifting to processing when fresh prices decline.

Michigan Production

Most of Michigan's crop is processed: in 1980, about 30% was sold fresh; by 1990, only about 10% (Cook et al.). In 1987, 881 farms included asparagus as part of their farming operations, with an average asparagus acreage per farm of about 27 acres (U.S. Bureau of the Census). Michigan growers have reduced their labor costs by adopting a semi-mechanical harvesting method (Cook et al.). Gas-powered vehicles carry four to five workers along the rows. Workers snap off the sprouts rather than cutting them below the ground. Because of this

method, mainly cuts and tips are processed. Most spears processed in Michigan are shipped in from other states.

Imports/Exports

The United States exported 62 million lbs. of canned asparagus in 1963, the peak year. By 1972, canned exports were down to less than 5 million lbs. (French and Willett). This large export loss was in Europe, especially West Germany, as Taiwan imports took over. U.S. imports of canned asparagus range from 2 million lbs. to almost 6 million, depending on the year. In 1990, the United States imported 1.9 million lbs. of canned and almost 1 million lbs. of frozen asparagus (Cook et al.). Canned imports come from Mexico, Taiwan, China, Chile, and Peru; frozen imports come from Mexico, Canada, Chile, and Peru. However, Mexico has been shifting from processed to fresh shipments. Frozen shipments from Mexico were down to 152,000 lbs. in 1990, from a high of 4.5 million lbs. in 1987; canned shipments fell from 3.3 million lbs. in 1987 to 331,000 lbs. in 1990 (Cook et al.). The U.S. duty on processed asparagus presently is 17.5%.

U.S. exports of fresh asparagus have almost doubled over the decade of the 1980s, from just under 20 million lbs. in the early 1980s to 42.6 million in 1989 and 39.7 million in 1990 (U.S. ERS). Meanwhile, imports of fresh asparagus increased severalfold over the same time period, from 7 to 9 million lbs. in the early 1980s to 43.8 million in 1990. In 1990, 75% of U.S. fresh asparagus imports were from Mexico where their two seasonal crops (January-March and June-September) bracket the U.S. season (Cook et al.). Mexico's major crop comes in January through March, so U.S. growers complain that these imports "take the edge off the high prices once enjoyed in the early spring." The U.S. duty currently is 25% except between September 15th and November 15th when it drops to 5% (Cook et al.).

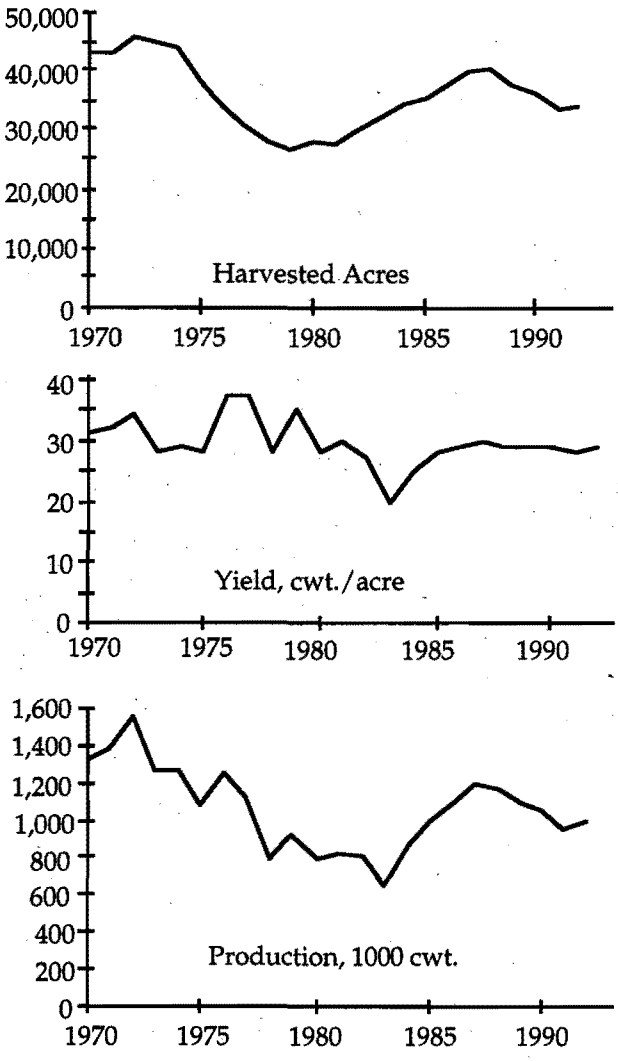
California Production

Ninety-five percent of California's crop is now sold fresh, eliminating California's earlier dual (i.e., fresh/processing) structure. The principal production area is the Stockton Delta—San Joaquin and Contra Costa counties—with over 20 thousand acres (Cook et al.). The desert valleys (Imperial and Riverside counties) increased acreage from 3,000 to 4,000 acres in the 1980s to about 10,000 in 1988, dropping back to 5,000 in 1989-1990. Salinas Valley acreage (Monterey County) also increased from 3,000 acres in 1980 to about 5,000 in 1990. The cooler temperatures on the coast and in the Salinas Valley bring higher yields because a longer harvest period is possible. Yields are about 1.45 tons/acre in the Delta, 1.77 tons in the desert, and over 3 tons in Salinas and the coast (Cook et al.).

The desert valleys begin harvest in early January, or even late December, and continue through March. The Delta harvest begins in late February, peaking in early April, continuing through May. The Salinas Valley peaks at the beginning of April and tapers off into the summer (Cook et al.).

Figure 1 shows the statewide trends in harvested acreage, yield, and production. (Data for the graphs are found in Appendix Table 1.) Note that reported yield is not the same as potential yield of the plants. Continuing the harvest to full potential depends on market conditions.

Figure 1. California Asparagus, 1970-1992



Source: California Agricultural Statistics Service.

2. BROCCOLI

Broccoli is one of many cole crops, where "cole" probably originated from the Latin, meaning stem (Yamaguchi). Other such cool season cole crops include cabbage, cauliflower (see Section 5), and brussels sprouts. Broccoli, grown as an annual crop, produces a large central head on a thick stem that is harvested before the buds flower (Snyder). After harvest, secondary heads develop but are not commercially harvested. Broccoli originated in the Mediterranean region and was not grown in the United States until Italian immigrants brought seed to California in about 1930.

U.S. per capita consumption of broccoli has increased faster than any other vegetable over the last two decades (Table 2.1). The increase is partly due to consumers' appreciation for broccoli's dietary value. Fresh consumption increased almost sevenfold between 1970 and 1990, while processed use (mostly frozen) more than doubled.

Table 2.1. U.S. Per Capita Use of Broccoli

Year	Fresh lbs.	Processed lbs.	Total lbs.
1970	0.5	1.0	1.5
1975	1.0	1.0	2.0
1980	1.4	1.4	2.8
1985	2.6	1.9	4.5
1990	3.4	2.2	5.6

Source: U.S. Economic Research Service.

During a period of 20 years, increased demand encouraged growers to greatly expand acreage and attracted imports. U.S. growers rapidly increased the area in broccoli from 41,140 harvested acres in 1970 to 110,800 in 1990 (U.S. ERS). Most of the increased production was for the fresh market. In 1970, the U.S. processed broccoli outlet was twice the fresh sales (2.2 million cwt. vs. 977 thousand cwt.); by 1990, the fresh quantity was over four times the amount processed (9.8 million cwt. vs. 2.5 million).

In 1980, California cultivated 93% of the nation's broccoli acreage, but as other states entered or expanded acreage, California's share decreased. Still, in 1990, 88% percent of the nation's broccoli acreage was in California. Three other states, Texas, Arizona, and Oregon harvest substantial acreage (Table 2.2), and many other states have some broccoli acreage. The 1987 Census of Agriculture lists (among others) Maine with 2,367 acres; Illinois, 1,348 acres; Wisconsin, 1,023 acres; Washington, 623 acres; Michigan, 514 acres; and Ohio, 388 acres. The acreages of these minor production states are not captured in the total shown in Table 2.2.

Table 2.2. U.S. Broccoli Acreage and Production, 1991

State	Harvested area acres	Production 1000 cwt.
California	88,000	10,120
Arizona	6,500	618
Oregon	3,100	248
Texas	3,400	204
U.S. total	101,000	11,190

Source: U.S. National Agricultural Statistics Service.

In California and other states, traditional field crop farmers have switched some acreage to broccoli and other vegetables in the interest of diversification (Cook). While this change represents only a very small percentage decrease in grain acreage (not appreciably affecting supply), it amounts to a much larger percentage increase in vegetable production that could adversely affect growers' prices.

Maine, a relatively new entry in the fresh broccoli market, has a large transportation advantage over California to East Coast population centers, as do Illinois producers to the Chicago market. California growers still have a climatic and marketing advantage over other regions by being able to ship fresh broccoli year round, even though they face increased competition in the summer and early fall seasons from other states' production. In recent years, this increasing competition appears to have stabilized as traditional field crop farmers wanting to diversify into vegetables have run up against a high risk marketing environment for fresh vegetables.

Imports/Exports

Increased U.S. consumer demand for broccoli also attracted significant imports (Table 2.3). Fresh imports increased from practically nothing in 1970 to 667 thousand lbs. in 1980, to over 21 million lbs. in 1990 (compared to a 990 million pound fresh domestic harvest). Frozen broccoli imports increased from none in 1970 to 23.9 million lbs. in 1980, to 242.5 million lbs. in 1990, equaling the domestic quantity harvested for processing that year (U.S. ERS). In fact, imported frozen broccoli has represented over 50 percent of domestic consumption in recent years. In contrast, fresh

broccoli imports still amount to only 2 percent of U.S. fresh production, and fresh exports are over eight times greater than fresh imports.

Table 2.3. U.S. Imports of Fresh and Frozen Broccoli and U.S. Fresh Broccoli Exports

Year	Fresh	Imports frozen	Exports fresh
	1000 lbs.	1000 lbs.	1000 lbs.
1970	—	—	—
1975	—	—	—
1980	667	23,899	63,531
1985	4,461	77,147	104,913
1990	21,270	242,552	171,752

Source: U.S. Economic Research Service.

The bulk of both fresh and frozen imports comes from Mexico. In 1986, 96.8 million lbs. of frozen broccoli came from Mexico, while 18.1 million lbs. came from Guatemala and 2.2 million lbs. from other countries (Runsten and Moulton). Also in 1986, 8.0 million pounds of fresh broccoli were shipped in from Mexico, while other countries' exports amounted to less than 0.5 million lbs. (Cook and Amon).

Runsten and Moulton report that the frozen vegetable industry got started in Mexico in the late 1960s when General Foods and Birdseye contracted with large growers in the Bajio region who used existing strawberry freezing plants to process vegetables. Soon independent Mexican growers began to operate processing plants to freeze broccoli for the private label and institutional markets. The industry rapidly expanded in the 1980s as other brand names entered and new plants were constructed. By the late 1980s, 92-94% of Mexican frozen vegetable exports were broccoli (and cauliflower).

In the mid-1980s, producing and processing broccoli in Mexico cost about half what it did in California (Cook et al.). Not only were labor costs much lower, energy (both for pumping irrigation water and at the plant level), fertilizer, and other inputs were subsidized by the government. Even transportation costs to U.S. East Coast markets by way of Texas were less than from California (Runsten and Moulton). Hence, despite Mexican yields being lower than in California (about 25% lower than in the Salinas Valley), the Mexican freezing industry was highly competitive. Mexico's big advantage was at the processing plant level, where broccoli could be hand trimmed into various products at a relatively low cost. The cost advantage more than overcame the 17.5% duty on imported processed broccoli—a tariff that will be phased out if the North American Free Trade Agreement is ratified.

The extraordinary growth in frozen broccoli imports not only affected U.S. growers contracted with processors, but also fresh market producers who became less able to divert product to processing whenever prices were low in the fresh market (Cook).

The dramatic increase in U.S. market share achieved by the Mexican frozen broccoli industry is stabilizing. Radical changes in Mexican agricultural policies are eliminating subsidies for water, energy, diesel, fertilizer and other inputs. An overvalued peso since 1987 has also contributed to a major increase in dollar-denominated Mexican frozen broccoli costs, relative to the 1980s. Meanwhile, increasing yields and efficiency in California have maintained per unit costs at the 1980s level. Both U.S. and Mexican freezers are facing a recent flattening in U.S. demand for frozen broccoli; when combined with Mexico's increasing cost structure, the Mexican frozen vegetable industry is currently undergoing a cost-price squeeze that may limit its expansion.

Fresh broccoli exports from Mexico are never expected to represent the competitive threat that frozen broccoli has, because Mexico's cost advantage is primarily at the processing rather than the production level. Secondly, Mexico's cole crop production is concentrated in central Mexico in the Bajio for agronomic/climatic reasons. Shipping costs from the Bajio to the U.S. border decrease Mexico's competitiveness in the fresh market.

California Production

As previously mentioned, producing broccoli for processing used to dominate the California market. Broccoli fit well into rotations, capital costs of entry were low, and many single-firm processing plants competed in a market dominated by large corporations (Runsten and Moulton).

In the early 1980s, increased consumer demand for fresh broccoli and a technological change to field-packing equipment facilitated the entry of many new growers able to harvest and ship their own fresh broccoli (Runsten and Moulton). California's share of the crop to processing fell from 70% in 1970 to 44% in 1980 to 19% in 1990, as fresh broccoli took over a greater share of a rapidly expanding market (Figure 2 and Table 2.4). However, the largest broccoli producers continue to sell to both markets, using the processing market as a residual allocation whenever fresh prices are less favorable.

Table 2.4. Shares of California Broccoli Production to Processing and Fresh Outlets

	% to processing	% to fresh
1970	70.3	29.7
1975	47.2	52.8
1980	44.4	55.5
1985	33.0	67.0
1990	18.7	83.3

Source: California Agricultural Statistics Service.

Two coastal valleys in California, Salinas (Monterey County) and Santa Maria (Santa Barbara County), ship fresh broccoli year-round, though Salinas shipments fall off during the winter months. In 1980, these valleys accounted for nearly all California's and 90% of the nation's broccoli. However, with increased demand for broccoli, the development of new varieties adapted to various climatic and soil conditions, and the availability of field-harvesting equipment allowing any grower to become a shipper, many other regions in the state and nation have entered the market. Today these two valleys account for 65% of a much larger national fresh broccoli market.

Although broccoli is a cool season crop, new varieties now allow it to be grown in locations such as the Imperial, Coachella, and San Joaquin valleys. Yields are highest in Santa Maria, at 14.2 thousand lbs./acre, compared to 12.4 thousand lbs. in the Salinas Valley and 10.7 thousand lbs. in the Imperial Valley (Cook et al.). Table 2.5 reports broccoli acreage and production by county in 1990.

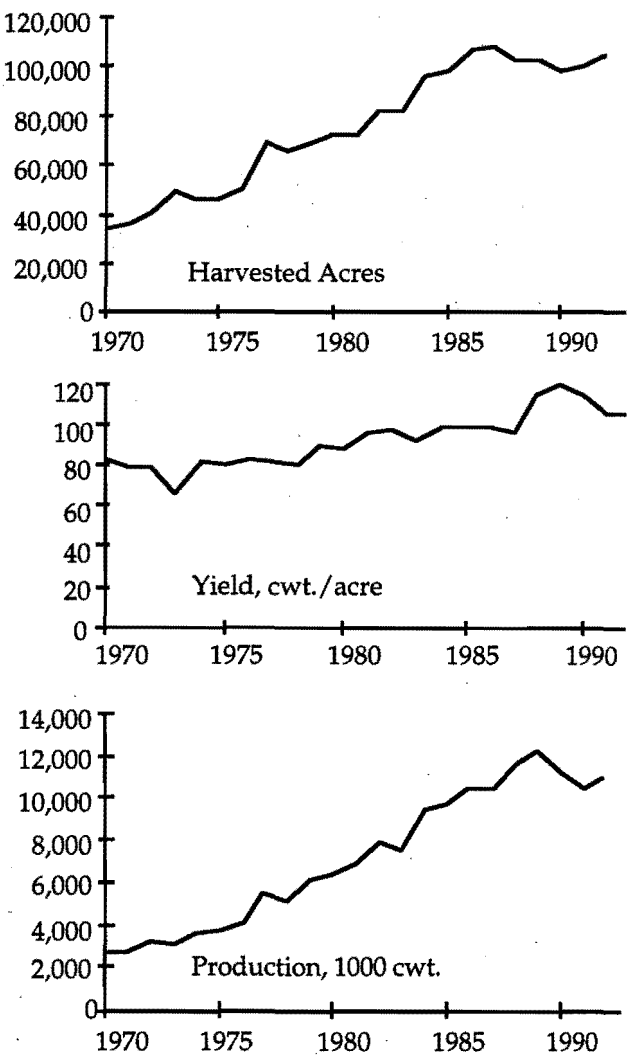
Table 2.5. Location of California Broccoli Production, 1990

Counties reporting	Harvested area acres	Production tons
Fresh Market		
Monterey	40,000	233,000
Santa Barbara	11,342	77,255
Imperial	10,484	60,662
San Luis Obispo	3,712	28,857
Kings	552	2,484
Processing		
Monterey	8,700	48,600
Santa Barbara	5,048	22,615
San Luis Obispo	1,863	9,315
Unspecified		
Fresno	4,980	41,800
Riverside	2,797	13,027
Ventura	2,791	16,164
San Benito	1,785	11,960
Stanislaus	1,340	4,690
Santa Clara	375	1,688

Source: California Agricultural Statistics Service.

Figure 2 shows that California's broccoli acreage more than tripled between 1970 and 1987. Acreage dropped after its 1987 peak, down to 100,000 acres in 1990. Yields that have gradually improved over the time period, jumped another 1,900 lbs. between 1987 and 1988, peaking at 12,000 lbs./acre in 1989. Increasing acreage and yields resulted in rapidly climbing production, from less than 300 million lbs. in 1970 (2,786,000 cwt.) to 1.2 billion lbs. at a peak in 1989. Production in 1991 was down slightly to just over 1 billion lbs. (10,500,000 cwt.). (Data for Figure 2 are found in Appendix Table 2.)

Figure 2. California Broccoli, 1970-1992



Source: California Agricultural Statistics Service.

3. BUSHBERRIES

Bushberries include caneberries, such as raspberries and blackberries, and blueberries and cranberries. In 1990, California had only 8 acres of blueberries and no cranberry acreage. At present, the state's most important caneberry is the red raspberry.

A caneberry is a cluster of tiny juice-filled sacks each containing a single seed, joined together by filaments to a core (Oregon Caneberry Commission, OCC). Varieties include the red raspberry, black raspberry, blackberry, and various hybrids, including Boysenberries, Loganberries, Youngberries, and Olallieberries.

Caneberries are so called because the plants annually produce leafy canes. Canes grown the first year bear fruit the second year. These canes then die and are removed after harvest (Holveck).

One difference between raspberries and blackberries is that a raspberry softens when ripe and loosens from its core which stays with the plant, while the receptacle of blackberries and most hybrids stays with the berry when harvested.

There are only a few geographical pockets in the world ideal for growing caneberries. Mild winters and cool summers are needed for highly productive plants that yield berries with superior flavor (OCC). The Pacific Northwest—Oregon, Washington, and British Columbia—is the leading caneberry production area.

All caneberries except black raspberries (blackcap) are trained on wire strung between posts. They are harvested by hand or machine, depending on the size of the operation, the variety, and whether the berry is allocated either to the fresh or the processed market. A machine harvester looks like a large box moving through the field as it straddles the rows. It has a set of beaters on each side of a row that knocks the berries off the plant onto a conveyor belt that passes by workers who sort them and pack crates (Holveck).

Blackberries

In some areas, blackberries are so abundant that settlers had to wage an endless battle and growers today continue to struggle with this stubborn, thorny tangled bramble (Cornog). The fruit of this briar partly redeems it.

Another problem with blackberries is their thorny canes (Holveck). The thorns may become imbedded in the berry, especially when machine harvested, and are very difficult to remove by sorting. Breeders continue to try to develop a blackberry with good fruit flavor that is genetically thornless.

Commercial blackberries are either erect (bush), semi-erect, or trailing, with trailing being the most common type (Cornog). Many varieties have been developed. Examples include the thornless evergreen and the Marion blackberries important in Oregon agriculture. Raspberry-blackberry hybrids tend more toward blackberry characteristics (Crandall and Daubeny).

Many states report blackberry acreage in the 1987 Census of Agriculture, but Oregon represented two-thirds of the nation's total with its 4,472 acres producing 27.3 million lbs. California was second with 345 acres and 2.7 million lbs.; Texas, third with 240 acres and 276,032 lbs.

Boysenberries

The Boysenberry, a chance seedling of Rudolf Boysen, is a very large blackberry, deep maroon, tart and aromatic, medium firm berry with relatively large seeds (OCC). It is a cross between a Loganberry and a Himalaya (Holveck). It was popularized by Walter Knott at the Knott's Berry Farm in Buena Park, California (LaVine).

A California Department of Agriculture survey in the mid-1960s reported that just over half of the crop was used for frozen and fresh pies, 32.2% for preserves, 8.4% jellies, 4.2% syrup, 3.6% yogurt, and 1.3% juice and extract (Baker and Butterfield).

The 1987 Census of Agriculture counted 1,198 acres of Boysenberries in the nation that yielded a total of 6.5 million lbs. of berries. On 386 acres, California produced 3.5 million lbs. (54%), while Oregon, on 787 acres, harvested 3.0 million lbs. By 1990, Oregon harvested 1,000 acres of Boysenberries (OASS).

In 1983, Bringhurst reported that about 420 acres of Boysenberries were grown in two California districts: Fresno-Tulare and San Joaquin-Stanislaus. By 1990, Boysenberry area was down to 203 acres, 95 of which were in Stanislaus County. Production costs are high, and harvest is difficult especially because the leaf-like cap adheres to the receptacle (Bringhurst). Still, the 1990 Boysenberry crop brought California growers $1.5 million (CASS).

Olallieberry

Olallieberries, glossy black berries slightly longer than a Boysenberry. According to LaVine, they were created by George F. Waldo of the U.S. Department of Agriculture when he crossed a black Loganberry and a Youngberry, which in turn is a Loganberry-dewberry cross, created by a Mr. Young.

Because of their juiciness, olallieberries are also sometimes called nectarberries (Cornog). In California, olallieberries once grew mainly in the Pajaro Valley of Santa Cruz County, but acreage is down because of urban development (Bringhurst). In 1980 there were 400 acres of olallieberries in that state; by 1990, only 200 remained; production was down from 36,000 cwt. to 22,000 cwt. (CASS).

Loganberries

The Loganberry was the product of a hobby plant breeder in Logan Heights, California. The result is actually a mistake. The breeder, Judge J.H. Logan, crossed two blackberries and planted them next to an old red raspberry plant. The blossoms cross pollinated and produced several raspberry-blackberry seedlings—Loganberry plants (Holveck).

Loganberries are often used to cross with other berries, providing them with some desired tartness. By itself, however, the Logan has not been popular because of its tart taste. Also, the berry's softness makes machine harvest impossible, discouraging large-scale production. The Loganberry was once the California's most popular blackberry (in the 1920s), but a virus led to its decline (Cornog). Now, almost all Loganberries come from Oregon. In 1987, 234 acres were in Oregon of a total of 240 acres in the nation, according to the Census of Agriculture.

Raspberries

The raspberry is a close relative of the rose, native to temperate zones of Europe, Asia, and America (Cornog). The berry was known to the Greeks; hence, its scientific name, *Rubus idaea*—red berries on Mt. Ida in Crete. Midwives traditionally administered raspberry leaves in a tea; during World War II, a child-bearing, for-pain drug, fragerine, was developed. Raspberry color varies from a distinctively sweet yellow berry to a deep purple one, almost black (Cornog), with the red color predominating.

Red cultivars are divided by their place of origin—the Pacific Northwest or Britain (Crandall and Daubeny), with the PNW berries being a brighter, glossier red. The principal variety for the last 35 years has been the Willamette. Today, new higher-yielding cultivars are being developed for the fresh market. The Willamette remains the most important processing berry, suitable for mechanical harvesting.

Many states report raspberry acreage in the 1987 Census of Agriculture. Oregon and Washington together accounted for 64% of the nation's total (Table 3.1).

Table 3.1. Leading States in Raspberry Production, 1987

State	Harvested area acres	Production 1000 cwt.
Oregon	5,754	26,269
Washington	4,185	25,414
California	1,330	8,393
Michigan	861	1,394
New York	497	688
U.S. total	15,484	66,215

Source: U.S. Bureau of the Census.

Red raspberry acreage in Oregon and Washington increased steadily through the 1970s and 1980s (Holveck). In 1980, the two states together had 4,900 acres; in 1985, there were 6,000 acres (OASS, *Berry Crops Summary*). Table 3.1 reports 9,939 acres for the two states in 1987. According to OASS data, acreage is down somewhat since then: There were 8,800 acres in the two states in 1990; 8,500 in 1991.

British Columbia is also an important Pacific Northwest red raspberry producer, with utilized production of over 40 million pounds in 1989, compared to Washington's 29 million and Oregon's 25 million (Schroeder). Imports to the United States from Canada are mostly to the fresh market. Since the mid-1980s, U.S. imports of fresh and frozen berries from Chile have increased—in 1989, 2.9 million pounds of fresh and 3.9 million pounds of frozen red raspberries were imported. Poland, Yugoslavia, and Romania are also important red raspberry production areas.

Most (about 85%) U.S. raspberries are processed. Most berries to processing are harvested by a machine that straddles the row, shakes the canes, and catches the berries. When raspberries ripen, they soften and loosen from the receptacle and will fall off easily when shaken. The berries fall onto a conveyor belt that passes by workers who sort them and pack crates.

Processed berries are packed into a variety of containers; the most common is the 55 gallon drum (Holveck). These drums are frozen and placed in storage awaiting further processing or sale to another type of processor. Berry packers produce IQF (individually quick frozen) berries, straight or sugared frozen berries, canned berries, berry juices, purees, and concentrates. Other processors buy them for use in flavoring jams, jellies, syrups, and ice cream, and for fillings in baked goods.

Lamonte and O'Rourke note the sharp increase in demand for processing raspberries since the late 1960s, with the surge mostly accounted for by dairy

industry uses, especially yogurts. Red raspberry flavor is second only to strawberry in yogurt, ice cream, and sherbet.

Because of a shelf life of only a few days, fresh sales have tended to be to nearby population centers. Recently, improved handling including forced-air cooling, and firmer-fruit cultivars have opened up opportunities for much broader marketing (Crandall and Daubeny). In fact, fresh berries are now available in North America and Europe from the Southern Hemisphere during our winter months.

Location of and Trends in California Red Raspberry Production

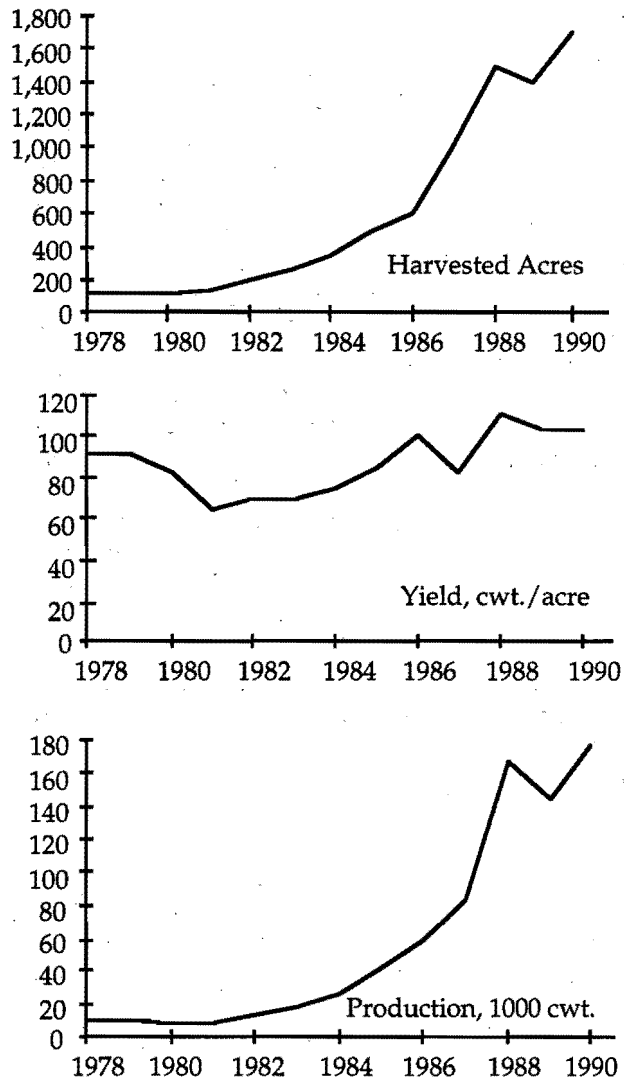
Nearly all of California's red raspberry acreage is in the Monterey Bay area. Of the state's total area in 1990 (1,669 acres), 723 acres were in Monterey County and 894 were in Santa Cruz County (CASS).

Figure 3 and Appendix Table 3 give the trends in raspberry acreage, yields, and production from 1978 through 1990. There were no estimates published in 1991, but in 1992, 1,500 acres were harvested, yielding an average of 107 cwt./acre, for a total production of 161,000 cwt.

Bringhurst writes in the early 1980s (p. 159), "Red raspberries have never been a very important crop in California. Over the last decade the acreage of these berries has fluctuated between a mere 90 to 120 acres, mostly in Santa Cruz and Sonoma counties ... The California acreage in red raspberries is likely to continue at about the present modest level, all that is warranted under the present and foreseeable market and competitive situations." Just as *The Guidebook to California Agriculture* was being published (1983), acreage and production began climbing steeply. By 1990, 1,700 acres were planted in red raspberries and production had increased almost 18 times.

The expansion is a combination of factors—increased demand for processed uses (noted by Lamonte and O'Rourke) and the development of better handling methods and new cultivars better suited for the fresh market. The greater availability of high-quality berries on the fresh market leads to greater demand for the freshberries, as consumers enjoy them and anticipate purchasing more of them.

Figure 3. California Raspberries, 1978-1990.



Source: California Agricultural Statistics Service.

Miscellaneous Berries

Besides red raspberries, olallieberries, and Boysenberries, CASS reports miscellaneous berry acreage in several other counties. In 1990, there were 249 acres of unspecified bushberries harvested in Santa Cruz County, 68 acres in Monterey County, 50 acres in San Luis Obispo County, 28 acres in Santa Clara County, and 162 acres in other counties, for a total of 557 acres producing 2,482 tons of unspecified bushberries worth $8.8 million.

4. CARROTS

Carrots, along with celery, belong to the parsley family or umbelliferae (Yamaguchi). Native to western Asia (Afghanistan), wild types are found in Asia, Europe, Africa, and North America. Carrots were first used for medical purposes, but were used for food before the 10th Century.

The edible portion of the plant consists of a large tap root of varying size and shape, that can grow up to 36 inches long. A cross section of this root reveals an outer core, including a thin periderm of cork cells and a band of secondary phloem (where the sugars are stored) and an inner core made up of secondary xylem and pith (McCollum). A quality carrot has a large outer core relative to its pithy part. Out from the tap root grows an extensive, fine, absorbing root system. The top stems and leaves branch out in umbrella fashion, like parsley. Although orange is the most familiar color for carrots, they also come in yellow, red, purple, and even black (dark purple) (Yamaguchi). Among perishable fresh vegetables, carrots are thought of as "hardware" because of their relatively long storability (Mayberry).

Carrots are a cool season crop and adaptable to a wide range of climates. However, they are susceptible to damage by frost and will bolt (flower) if subjected to cold for an extended time (Yamaguchi), while high temperatures will cause woody flesh and poor flavor (Mayberry). Still, carrots are easy to grow, have relatively few disease or insect problems, and may be mechanically harvested.

Because of their taste, color, relative ease of growing and shipping, and long storage life, they are cultivated all over the world. U.N. FAO data show that of the 13 million metric tons harvested in 1990, 614,000 MT were grown in Africa, 1.7 million MT in North and Central America (1.3 million MT in the United States), 667,000 MT in South America, 4.0 million MT in Asia (2.7 million MT in China), 3.9 million MT in Europe, and 189,000 MT in Oceania (150,000 MT in Australia).

The many cultivars of carrots may be generally grouped as blunt—short with a length less than four times the diameter—or pointed—long, more than four times the diameter (McCollum). Hybrids provide uniformity of shape and color. Processing carrots tend to be shorter and fatter than those grown for the fresh market (Mayberry).

Carrots are harvested in about 65 to 85 days after planting, depending on the temperature (Yamaguchi). Topping them increases the storage life because the tops draw moisture and nutrients from the carrot. Processing carrots tend to be left in the ground longer to let more color develop with maturity. In the United States, most carrots for fresh sales and for processing are harvested mechanically. Only bunch carrots, sold fresh with their tops, are hand harvested.

U.S. per capita consumption of processing carrots has remained fairly steady, while fresh consumption has increased (Table 4.1). The U.S. ERS breaks down processing data into per capita farm-weight equivalents to canning and freezing, with the shares to each staying constant between 1970 and 1990 at about three-fourths to freezing; one-fourth to canning.

Table 4.1. U.S. Per Capita Consumption of Fresh and Processing Carrots

Year	Fresh lbs.	Processing lbs.	Total lbs.
1970	6.0	3.6	9.6
1975	6.4	3.6	10.0
1980	6.2	3.4	9.6
1985	6.5	3.2	9.7
1990	8.0	3.3	11.3

Source: U.S. Economic Research Service.

The U.S. Census of Agriculture reported carrot production on 1,580 farms in 39 states in 1987; 87% of the acreage was irrigated. U.S. acreage has expanded to meet the increased per capita consumption for fresh carrots, with California representing an increasing share of the nation's acreage over time (Table 4.2).

Table 4.2. Harvested Carrot Acreage in the United States and California

Year	U.S. acres	California acres	California % of total
1970	77,570	24,100	31.1
1975	70,080	33,100	47.2
1980	81,800	36,600	44.7
1985	89,800	39,900	44.4
1986	86,600	40,500	46.8
1987	99,600	50,000	50.2
1988	97,550	51,100	52.4
1989	101,900	57,300	56.2
1990	94,400	56,100	59.4

Sources: U.S. Economic Research Service and California Crop and Livestock Reporting Service.

Table 4.3. U.S. Carrots to the Fresh and Processing Outlets

Year	Fresh 1000 cwt.	Processing 1000 cwt.
1970	10,952	7,207
1975	12,423	6,593
1980	13,704	7,183
1985	15,345	7,427
1990	20,405	8,832

Source: U.S. Economic Research Service.

Fresh market production has almost doubled over the last two decades, while carrots to processing have increased only slightly (Table 4.3). Fresh carrots sales brought U.S. growers $244 million in 1991, while carrots for processing earned about $29 million.

Table 4.4 shows where the fresh and processing carrots were grown in 1991. California produced 71% of the nation's fresh crop that year. Most of the rest came from Michigan and Florida. Washington state leads in the smaller processing market, followed by California. California's processing crop is only about 15% of the size of its fresh market production.

Imports/Exports

Imports supplement the U.S. carrot supply. Most (72.2% in 1990) come from Canada, and most of the rest (26.1%) is imported from Mexico (U.S.

Table 4.4. Location of the 1991 Harvest by State and Market

Market type	State	Production 1000 cwt.
Fresh market	California	13,680
	Michigan	1,279
	Florida	1,035
	Washington	760
	Texas	733
	Colorado	539
	Oregon	494
	Minnesota	161
	Arizona	160
	New York	156
	U.S. total	19,169
Processing	Washington	2,640
	California	2,000
	Texas	527
	Oregon	424
	Michigan	421
	Minnesota	388
	New York	360
	U.S. total	8,658

Source: U.S. National Agricultural Statistics Service.

Table 4.5. U.S. Fresh Carrot Exports and Imports, Selected Years

Year	Exports million lbs.	Imports million lbs.
1970	50,328	56,185
1975	92,972	60,797
1980	101,209	108,683
1985	134,352	147,789
1990	162,918	122,111

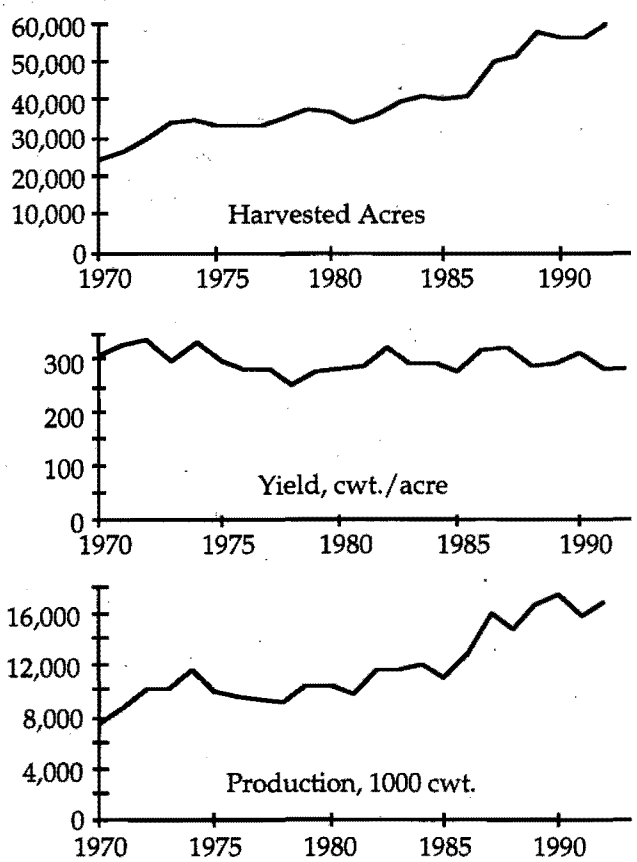
Source: U.S. Economic Research Service.

Table 4.6. Location of California Carrot Production, 1990

County	Harvested area acres	Production 1000 tons
Kern	29,552	841,000
Imperial	12,688	249,642
Monterey	3,180	76,800
San Luis Obispo	3,486	59,262
Santa Barbara	2,565	86,979
Riverside	2,271	23,709
Fresno	1,460	43,800
State total	56,261	1,381,288

Source: California Agricultural Statistics Service.

Figure 4. California Carrots, 1970-1992



Source: California Agricultural Statistics Service.

FATUS). Fresh market exports and imports are reported in Table 4.5. Both exports and imports have grown over time. Some years the United States is a net importer; other years, a net exporter (as in 1990).

Location of and Trends in California Production

Kern County is the state's leading carrot production area, harvesting 61% of the state's total crop in 1990. Kern County carrots go to the fresh market. The Monterey County crop was divided about 40% fresh, 60% processed. The other counties listed did not specify the market allocation of their crops. Although some other counties also grow carrots, the major ones are listed in Table 4.6.

Figure 4 shows the increasing trend in California's carrot acreage; see also Table 4.2. Acreage more than doubled over the two decades, from 24,100 acres in 1970 to 56,100 in 1990. Nearly all of the increased acreage has been devoted to production for the fresh market. Processed production declined slightly over the time period from about 2.5 million cwt. in 1970 to just over million cwt. in 1990. Carrot yields have been relatively steady over the time period, varying around a 21-year average of about 298 cwt./acre. (Data for Figure 4 are found in Appendix Table 4.)

5. CAULIFLOWER

Because much that is written about broccoli is also true of cauliflower and other cole crops, readers are referred again to Section 2. To give a perspective on the two crops, the broccoli harvest brought U.S. producers $253 million in 1991; the cauliflower crop, $185 million. In California these values were $226 million and $142 million, respectively (U.S. NASS). Like broccoli, cauliflower originated in the Mediterranean region.

The plant produces a mass of tightly compacted, fast-growing stems without chlorophyll; the harvested head is the tender tips of the stems (Brendler). Cauliflower is a cool season crop but is more temperature-sensitive than broccoli. The optimum temperature for the early-type (snowball) cauliflower to form curds is 63°F (Yamaguchi). Above 68°F the curd quality is poor, though some cultivars have been developed that will produce normal curds at higher temperatures. The plant will grow in the tropics where it remains only vegetative. Winter varieties require a period of cold temperature before heading.

While per capita consumption of broccoli more than quadrupled over the decades of the 1970s and 1980s, consumption of cauliflower almost tripled. Most of the increase has been in the fresh product (Table 5.1).

Table 5.1. U.S. Per Capita Use of Cauliflower

Year	Fresh lbs.	Processed lbs.	Total lbs.
1970	0.7	0.5	1.2
1975	0.9	0.6	1.5
1980	1.1	0.8	1.9
1985	1.8	0.9	2.7
1990	2.2	0.8	3.0

Source: U.S. Economic Research Service.

In response to increased demand for cauliflower, U.S. growers expanded their cauliflower area from 24,060 acres in 1970 to 65,800 acres in 1990 (U.S. ERS). Harvested acreage in 1991 was down to 63,500, due partly to losses in the desert valleys from the white fly. Of the 7.9 million cwt. harvested in 1990, 84% was marketed fresh; in 1991, 87% of the 7.1 million cwt. harvested was sold fresh.

The 1987 Census of Agriculture lists 1,962 U.S. farms growing cauliflower on 54,841 acres, 92% of which are irrigated. Over two-thirds of this reported acreage was in California. Arizona was second with 6,210 acres, Oregon third with 3,437 acres, followed by Washington with 2,176 acres and New York by 1,551. Many other states reported some acreage.

In 1991, over three-fourths of the nation's cauliflower crop was grown in California (Table 5.2). Unlike broccoli where other states entered in the mid-1980s to produce for the fresh market, most other states, with the exception of Arizona, grow for the processing outlet. Therefore, an even higher percentage of the fresh market harvest comes from California (U.S. ERS): In 1991, 81% of the total crop harvested for fresh use was from California (U.S. NASS).

Table 5.2. U.S. Cauliflower Acreage and Production, 1991

State	Harvested area acres	Production 1000 cwt.
California	50,000	5,500
Arizona	5,800	725
Oregon	3,860	386
New York	2,400	349
Michigan	1,100	72
Texas	900	45
U.S. total	64,060	7,077

Source: U.S. National Agricultural Statistics Service.

Imports/Exports

China and India are the world's largest producers of cauliflower. Of a world total of 5.4 million metric tons produced in 1990, China harvested 1.1 million MT and India, 0.7 million MT (U.N. FAO). Were these countries to begin exporting, they could overwhelm the world market with supply, but so far their production is used only domestically (Cook et al.). Other large producing countries include France with 690,000 MT in 1990, Italy with 410,000, the United Kingdom with 329,000 MT, Germany with 261,000 MT, Spain with 264,000 MT, and Poland with 230,000 MT These figures compare to 342,000 MT reported by the U.N. FAO for the United States in 1990; 35,000 MT for Canada and 13,000 MT for Mexico.

Increased demand for cauliflower in the United States has attracted imports from several countries. Total imported cauliflower increased from 62,000 lbs. in 1970 to over 84 million lbs. in 1990. Note that the United States exports more poundage of fresh cauliflower than is imported of both fresh and frozen (Table 5.3).

Table 5.3. U.S. Imports of Fresh and Frozen Cauliflower and U.S. Fresh Cauliflower Exports

Year	Imports	Exports	
	Fresh	Frozen	Fresh
	1000 lbs.	1000 lbs.	1000 lbs.
1970	62	—	—
1975	296	—	—
1980	7,292	9,721	33,575
1985	16,301	36,823	68,227
1990	22,077	62,172	132,243

Source: U.S. Economic Research Service.

Frozen imports increased from none in 1970 to over 62 million lbs. in 1990. This compares to a U.S. frozen pack in 1990 of 110 million lbs. and stocks of 76 million lbs. Most frozen imports come from Mexico. According to Runsten and Moulton, imports of frozen cauliflower were stimulated by U.S. investment in processing facilities in Mexico and Guatemala (see Section 2 for more details). With its relatively lower labor costs, Mexico is able to specialize in a hand-picked, hand-chopped frozen product. The U.S. places a 17.5% duty on processed cauliflower imports.

Canada is the leading exporter of fresh cauliflower to the United States representing from over half to nearly three-fourths of total fresh imports in the mid-1980s (Cook and Amon). Mexican fresh imports accounted for most of the rest, though other countries (Guatemala, Chile, Jamaica, Belgium, the United Kingdom, the Netherlands, France, and Greece) also began exporting fresh cauliflower in the mid-1980s. Imports of fresh cauliflower account for about 3% of the total U.S. supply (U.S. ERS).

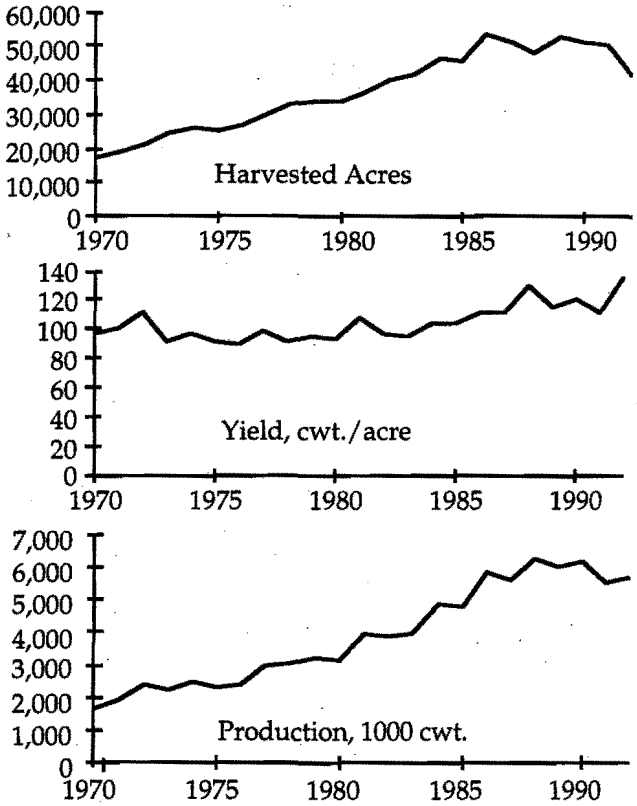
Canada is also the leading importer of cauliflower from the United States, purchasing 82.3% of the nation's cauliflower exports in 1990 (U.S. FATUS). Japan purchased most of the rest (14.5% of the total), with smaller amounts going to Mexico, the Caribbean, Western Europe, and other Asian countries.

California Production

The amounts of cauliflower to the fresh and processed outlets were approximately the same until the late 1970s when the quantity allocated to fresh began its ascent to its current position of approximately ten times more than that to processing: In 1991, 500,000 cwt. of cauliflower were processed; 5 million cwt. were sold fresh. See Figure 5. (Data for Figure 5 are found in Appendix Table 5.)

As with broccoli, field-packing equipment enabled many new growers to harvest and ship their own fresh product (Runsten and Moulton). As new growers entered and existing growers expanded, acreage increased steadily from 17,600 harvested acres in 1970, 33,900 in 1980, 51,300 in 1990. Over the two decades, yields have varied between 90 cwt./acre and 130 cwt., with no clear trend observed (Figure 5).

Figure 5. California Cauliflower, 1970-1992



Source: California Agricultural Statistics Service.

The Salinas Valley, with its 34,900 acres of cauliflower, accounted for over three-fourths of the state's acreage in 1990 (Cook et al.). This great coastal valley offers an agglomeration of services geared to the vegetable production that dominates there and is able to market an attractive product mix that includes fresh and processed cauliflower.

Most of California's cauliflower is the snowball type, though the pearl type is also harvested between February and April (Brendler). Other varieties have been developed that are adapted to broader climatic conditions, allowing cauliflower to also be produced in the state's desert valleys and the San Joaquin Valley. In 1990, there were 9,500 acres of cauliflower in the desert valleys, 3,000 acres in the San Joaquin Valley, around 2,000 acres on the south coast (Santa Maria), and another 2,000 acres in other areas of the state (Cook et al.). Table 5.4 gives acreage and production by county.

Table 5.4. Location of California Cauliflower Production, 1990

Counties reporting	Harvested area acres	Production tons
Fresh Market		
Monterey	19,410	142,000
Santa Barbara	7,872	118,293
Imperial	8,683	45,561
Processing		
Monterey	2,930	12,600
Santa Barbara	1,724	6,896
Unspecified		
San Luis Obispo	1,854	14,345
Stanislaus	1,600	5,440
San Joaquin	1,400	5,990
Santa Cruz	1,064	7,341
San Diego	970	6,300
Ventura	886	5,484
Riverside	802	4,491
Orange	609	3,350

Source: California Agricultural Statistics Service.

6. CELERY

Celery, a member of the parsley family along with carrots (see Section 4), is an important crop in temperate regions of the world, especially Europe and North America (Yamaguchi). Wild celery is found in damp, marshy areas from the sub-Artic to the semi-tropics. The French first used *celeri* for medicinal purposes (as a sedative) in the 9th Century (Rose). Its medicinal use continued in Europe into the 16th Century. The flavor and aroma come from volatile oils in the stems, leaves, and, especially, the seeds. (Celery seed is still a popular herb.)

Celery was first used as a flavoring for food in the early 18th Century by the English for soups and stews (Sims et al.). Later, blancing and/or overwintering eliminated the strongest flavors, allowing celery to become a popular salad vegetable. To blanch, the stems are wrapped with paper or otherwise shielded from light several weeks before harvest. Blanching continued as a common practice well into the 20th Century.

Celery was first planted in the United States by Dutch farmers near Kalamazoo, Michigan, in the late 19th Century (Rose). Their delicate, blanched product was sold as a salad vegetable. In 1895, Florida farmers planted celery as an alternative crop to the citrus they had lost in a major freeze.

Celery is normally a biennial plant whose first year just yields leaves above the ground, like a carrot's (Yamaguchi). The second year the stem elongates after a cold period to produce a shrubby plant 3 or more feet high, bearing small, white flowers and a flat dry fruit.

In today's agriculture, celery is produced as an annual crop. The crop can be direct seeded or transplanted from greenhouse or outside beds. Celery has a tap root (like a carrot) that is removed from plants being transplanted (Sims et al.). It is a climatically sensitive plant: Exposure to low temperatures can cause it to "bolt" and yield unmarketable stems.

The crop is harvested when it has reached a marketable size but before the petioles become pithy. In the 1930s, topping the plants before harvest was found to greatly extend the product's storage life. If celery is stored at 32°F in high humidity with good air circulation, it will keep good quality for two to three months. However, in California, celery is seldom stored that long (Brendler).

Celery varieties are classed as green or golden. California grows only green varieties, nearly all of the Utah type well known for a compact, cylindrical shape (Brendler). One preferred type is the Crystal Jumbo with its compact, cylindrical head; attractive, well-overlapped petioles; good heart development; and dark green leaflets (Sims et al.).

U.S. per capita consumption of fresh celery has ranged from $6\frac{1}{2}$ lbs. to $7\frac{1}{2}$ lbs. over the past two decades, with no clear trend (Putnam and Allshouse). Following this relatively flat pattern of usage, U.S. celery acreage has remained rather constant between 1970 and 1991, varying between a low of 31,750 in 1975 and 37,660 in 1990 (U.S. ERS).

The 1987 U.S. Census of Agriculture reported that 377 farms grew celery on 36,478 acres, nearly all irrigated. California has nearly three times more acreage than the next state, Florida. Michigan and Texas also have substantial acreage. Acreage and production figures for these leading states are given in Table 6.1.

Table 6.1. U.S. Celery Acreage and Production, 1991

State	Harvested area acres	Production 1000 cwt.
California	21,700	14,489
Florida	7,500	2,813
Michigan	2,900	1,218
Texas	1,100	699
U.S. total	33,910	19,539

Source: U.S. National Agricultural Statistics Service.

Imports/Exports

Fresh celery exports have grown steadily over the last two decades (Table 6.2). The biggest customer by far is Canada which accounted for 87.2% of total celery exports, importing 88,119 metric tons in 1990 (U.S. FATUS). Significant quantities also went to Hong Kong (at 5,044 MT in 1990, Hong Kong was the second largest importer); Taiwan, 3,037 MT (the third largest); followed by Singapore's 1,480 MT.

Table 6.2. U.S. Celery Exports and Imports

Year	Exports 1000 lbs.	Imports 1000 lbs.
1970	92,763	1,702
1975	116,848	1,184
1980	196,474	4,863
1985	206,970	12,756
1990	222,736	40,655
1991	235,000	43,000

Source: U.S. Economic Research Service.

Table 6.3. Location of Seasonal Celery Production in California

Season	Planted	Harvested	Location
Winter	Aug.-Nov.	Nov.-Mar.	So. Coast (LA & Orange Cos., San Diego Co., and the Oxnard region in Ventura Co.)
Spring	Nov.-Mar.	April-July	LA & Orange Cos., Oxnard
Early Summer	Mar.-May	June-Aug.	Salinas-Watsonville (Monterey & Santa Cruz Cos.), Santa Maria-Oceano (Santa Barbara and San Luis Obispo Cos.) and, in the past, Santa Clara Co.
Late Fall	June-Aug.	Sept.-Jan.	Salinas-Watsonville, Santa Maria-Oceano, Santa Clara Co. and LA & Orange Cos.

Source: Sims et al.

Mexico imported 1,008 MT of U.S. celery; Western Europe, 1,519 MT; Japan, 619 MT. Imports have also increased over time, but exports remain many times greater as both have grown.

California Production

Celery is a year-round crop in California. Some of the crop is dehydrated and some is canned as an ingredient in various food products, but the most by far is marketed fresh. Harvest begins in early November in Ventura, Orange, and San Diego counties where it lasts until mid-July. San Luis Obispo and Santa Barbara counties start in May and harvest until mid-January. The Salinas Valley begins in mid-June and harvests until January 1st (Brendler). Sims et al. provide a planting/harvest schedule by production area (Table 6.3). Acreage and production by county is reported in Table 6.4.

Table 6.4. Location of California Celery Production, 1990

County	Harvested area acres	Production 1000 tons
Ventura	11,242	353.2
Monterey	7,290	240.1
Santa Barbara	3,092	89.0
San Luis Obispo	1,113	36.4
San Benito	664	19.5
Orange	594	18.8
Santa Cruz	219	6.8
Santa Clara	170	5.1
Riverside	110	3.0
San Diego	86	3.1
State total	24,580	775.0

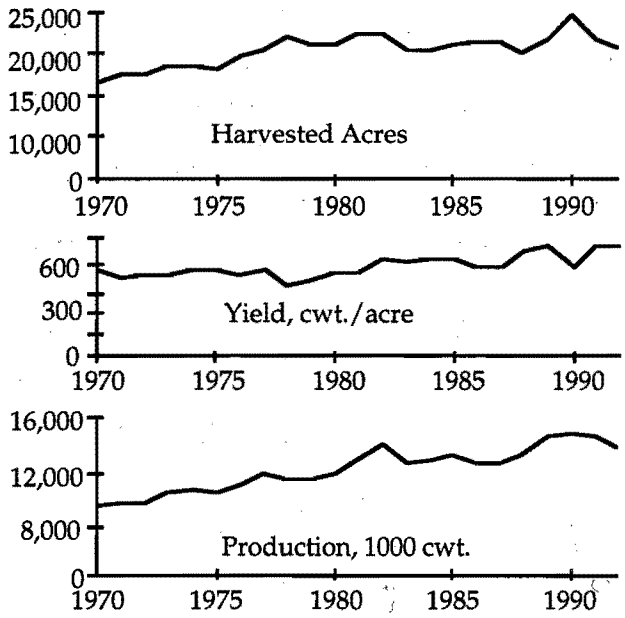
Source: California Agricultural Statistics Service.

Not only is the state's harvest extended throughout the year by regional variation, individual growers make their own harvest provide a continuous flow to market by the practice of planting a small amount each week (Brendler). Transplanting accounts for at least half of the pre-harvest labor needed; irrigation another third. There is about a ten-day period when the celery can be harvested—before pithiness, yellow leaves, and other defects occur.

Although a mechanical harvester exists, most California celery is harvested by hand. In the field, workers cut the stalks about 14½ inches long, remove the outer petioles, and sort by size into cartons weighing 60 lbs. Shorter stalks are sent to the packing shed where they are cut to 8 inches, grouped and wrapped, and marketed as celery hearts (Brendler).

Figure 6 diagrams the state's celery acreage, yield, and production. (Data for the graphs are found in Appendix Table 6.) The acreage trend is slightly upward over the last two decades, with a peak in 1990 at 24,800 acres. Yields have increased only slightly, varying around an average of 594 cwt. per acre, with more yields above that average in the 1980s, below it in the 1970s. Lower yields in 1990, perhaps on the new acreage, meant little change in the overall production figures that year, despite the increased acreage.

Figure 6. California Celery, 1970-1992



Source: California Agricultural Statistics Service.

7. CORN, SWEET

Corn is a member of the grass family, originating in tropical America (Yamaguchi). There is apparently no longer any wild corn in the area, only domesticated types. Corn has been an important food in Mexico and Central and South America since before the time of Christ. Cobs found in caves in southern Mexico have been dated at from 5,400 to 7,200 years ago.

The grains have sweet endosperm when immature that change to starch with increasing maturity (Yamaguchi). Although it is a warm season crop, requiring 70 to 110 frost free days (Yamaguchi), sweet corn is most successfully produced in relatively cooler regions. Because the rate that sugars condense into polysaccharides depends on the temperature, in warmer climates the corn matures so rapidly that it remains edible only a short time (Huelsen). Therefore , we find, for example, that the midwestern sweet corn production area lies along the northern border of the corn belt—in Minnesota, northern Illinois, and Wisconsin.

Most of the sweet corn produced in the United States is processed. In 1991, 1.9 million tons were canned and 1.5 million tons were frozen (U.S. ERS). This compares with 738,800 tons (14.8 million cwt.) sold on the fresh market that year. However, California is exclusively a fresh market producer.

The sweet corn canning industry began in Maine in the late 19th Century and spread to Maryland and other eastern states (Huelsen). At first the product was a cream style white corn. By the 1930s, the technology developed for and consumer preference shifted to canned whole kernel yellow corn.

After World War II, freezing technology already developed for fish in the Pacific Northwest was used on corn and other vegetables. With this change came a regional shift in production from the East to the Pacific Northwest. Today Minnesota and Wisconsin produce about one-half of the sweet corn for processing, most of which is canned (Love). Another third of the processing sweet corn is grown in Oregon, Washington, and Idaho, and is frozen.

Partly because of the popularity of microwave cooking, consumer preference has been shifting from the canned to the frozen product. Meanwhile, per capita fresh corn consumption has remained relatively stable (Table 7.1). Recently, consumers are enjoying new super-sweet varieties and an increasing availability of tender, white sweet corn.

Table 7.1. U.S. Per capita Use of Sweet Corn

Year	Fresh lbs.	Frozen lbs.	Canned lbs.	Total lbs.
1970	7.8	5.8	14.3	27.9
1975	7.8	6.3	12.0	26.1
1980	6.5	6.4	13.0	25.9
1985	6.4	7.9	11.9	26.2
1990	6.4	8.5	10.9	25.8

Source: U.S. Economic Research Service

Some sweet corn for the fresh market is grown in most states. Much of it is sold only locally. Of states reporting fresh sweet corn acreage in 1991, Florida's 46,300 acres represent over one-fourth of the U.S. total fresh sweet corn acreage. Florida produced 4.6 million cwt. or 31% of the nation's crop that year. California is second in production with 2.0 million cwt. in 1991 and third in acreage, following New York (Table 7.2).

Table 7.2. U.S. Sweet Corn Acreage and Production by Major States, 1991

State	Harvested area acres	Production 1000 cwt.
Florida	46,300	4,630
New York	26,500	1,988
California	18,500	2,035
Pennsylvania	15,700	659
Michigan	12,800	845
Ohio	9,900	743
New Jersey	9,000	756
Massachusetts	7,100	568
Illinois	5,900	537
North Carolina	4,900	294
Connecticut	3,700	241
Alabama	3,200	192
Colorado	3,100	496
Oregon	2,600	286
Washington	2,500	300
Virginia	2,100	126
Texas	1,600	80

Source: U.S. National Agricultural Statistics Service.

California Production

Almost half of the state's tonnage of sweet corn came from Riverside County, including the Coachella Valley, in 1990. That county had 40% of the acreage and captured almost a third of the value of the crop that year. Table 7.3 gives 1990 acreage and production by county.

Table 7.3. Location of California Sweet Corn Production, 1990

Counties reporting	Harvested area acres	Production 1000 cwt.
Riverside	5,668	34,942
Ventura	1,155	6,857
Contra Costa	1,260	5,090
Santa Clara	1,100	7,425
Kings	573	6,034
Orange	490	2,842
Los Angeles	415	3,233
Sacramento	400	1,600
San Diego	370	1,800
State total	14,130	71,522

Source: California Agricultural Statistics Service.

Recalling that sweet corn does best in cooler climates, we note that desert valley corn is shipped early in the year. Shipments from the desert valleys begin in late April, continuing through June (Federal-State Market News Service). Shipments from other regions continue the season into October. The Market News Service matrix of sweet corn shipment origins by various producing states to arrivals at 22 major cities shows that most California corn is marketed within the state; in Table 7.4, we reproduce the California column.

Table 7.4. Shipments of California Sweet Corn to 22 U.S. Cities, 1991

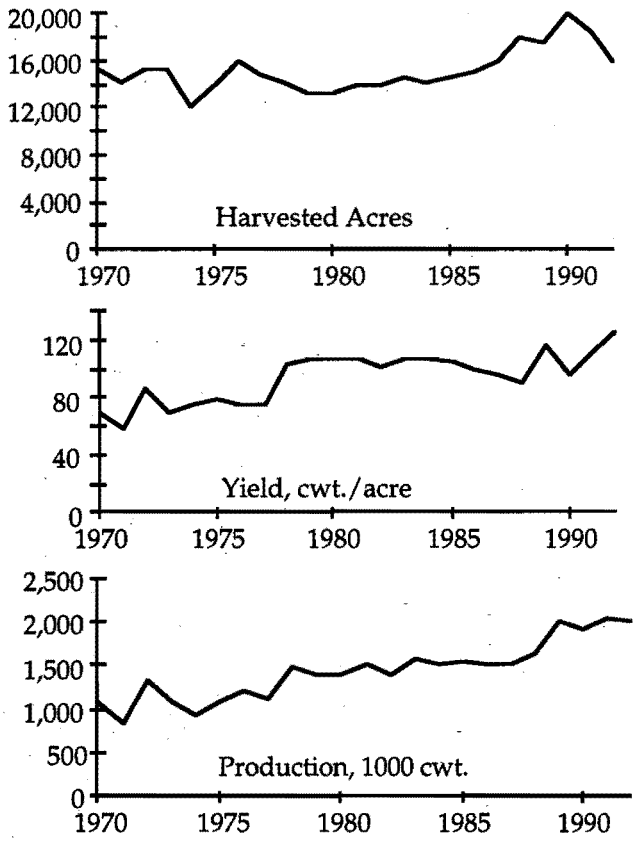
City	10,000 lbs.
Atlanta	4
Baltimore-Washington, DC	17
Boston	3
Buffalo	209
Chicago	52
Cincinnati	15
Columbia, SC	4
Dallas	22
Detroit	35
Los Angeles	5,124
Miami	10
New Orleans	12
New York-Newark	28
Philadelphia	—
Pittsburgh	—
San Francisco-Oakland	3,122
Seattle-Tacoma	834
St Louis	—
Total	9,491

Source: Federal-State Market News Service.

Looking again at where the state's corn is produced (Table 7.3), we see that except for these early shipments from the desert to U.S. markets, most of the corn is produced and sold to nearby urban areas. Ventura, Orange, San Bernadino, and Los Angeles counties market in the greater LA area; Contra Costa County sells to the San Francisco Bay Area; Santa Clara County to the San Jose area; and Sacramento County to the greater Sacramento area.

Figure 7 gives acreage, yield, and production trends for the state since 1970 (for data see Appendix Table 7). After an initial dip in acreage in the 1970s, acreage generally climbed from a low of 12,200 acres to a high of 20,000 in 1990. Acreage in 1991 dropped to 18,500. Yields took a sharp jump from 75 to 104 tons per acre in 1978, staying at about that level with some variation from year to year. The highest yield was in 1989 with 115 tons per acre. Production follows the increasing trends in acreage and production, approximately doubling over the two decades. Thus, production has kept up with California's population growth, while California's market share has grown from under 10% in the mid-1970s to almost 14% in 1990 (NASS).

Figure 7. California Sweet Corn, 1970-1992



Source: California Agricultural Statistics Service.

8. LETTUCE

Lettuce, known as green gold, is a crop grown mostly by risk-taking entrepreneurs (Friedland et al.). Consumer demand for lettuce is inelastic—that is, consumers tend to buy the same amount each week regardless of price, except when prices are very high. An inelastic demand also means that prices will vary widely with fluctuations in quantity supplied; yet, the quantity supplied is weather-dependent and ranges from shortages to price-depressing over-supply. Still, this very highly-perishable commodity that is 90-95% water is transported hundreds, even thousands of miles, delivered daily to markets all over the United States and abroad.

Lettuce has been used for food for many millennia, having been domesticated from wild lettuce, *L. serriola* (Yamaguchi), with the leafy types preceding the head types in development. Lettuce hybridizes very easily with the result that there are literally hundreds of varieties. Although lettuce is a cool season crop, there are varieties that can be grown in areas where the temperature reaches 118°F. or where the ground freezes and doesn't thaw until 10 am (Mayberry). The varieties have been usefully classified into five types (U.S. ARS):

Crisphead, such as iceberg lettuce, has a firm head about 6 or more inches in diameter. Its leaves are overlapping, smooth, and regular with prominent ribs.

Butterhead has soft, pliable leaves that overlap; its veins are finer and its ribs less prominent than crisphead.

Romaine or Cos has a loaf-shaped head composed of long, narrow leaves. There are two types, self-closing and loose-closing. It has dark green outside leaves and tender, light-colored inner leaves.

Looseleaf or *bunching lettuce* does not form a head, except for the central, very young leaves. Instead, the leaves are arranged loosely around the stem. Because of its exacting soil, water, and temperature requirements, it is the principal greenhouse variety.

Stem lettuce was developed by the Chinese and is used mainly in Chinese dishes. The edible part is the enlarged stem or seed stalk that is usually cooked.

Crisphead is the most important commercial type because it withstands handling and transport stress better than the other types. This attribute allows it to be produced far from final consumption locations. The three leafy types are much more difficult to handle and transport without damage, so traditionally they have mostly been grown near population centers for local consumption. However, with increasing consumer preference for the leafy types, used, for example, in tossed salads, and with improved handling and transportation technology, leafy types produced in the West are now also shipped long distances. U.S. per capita lettuce consumption has grown from 20.8 lbs./person in 1970 to 27.7 lbs. in 1989 (Putnam and Allshouse). This reflects, in part, an increased use by fast food restaurants and the popularity of salad bars.

U.S. acreage has remained relatively steady over time, but improved yields have brought production increases of over 60% over the last two decades (Table 8.1).

California leads other states in lettuce production, contributing 73% of the nation's lettuce in 1991 on 68% of the acreage. Arizona produced another 21% that year, with several other states also growing lettuce (Table 8.2). California ships year-round from its several production areas, while Arizona, especially the Yuma Valley, ships during the winter season, as does Florida. The other states grow mostly summer lettuce for local consumption.

Indiana and nearby states have specialized in greenhouse production (Ryder). Popular varieties grown are Grand Rapids (a leaf lettuce) and Bibb (a butterhead type). This lettuce is marketed in the winter months in competition with the western desert valleys, Texas, and Florida.

Summer and fall lettuce takes from 60 to 80 days from planting to harvest, while winter and spring lettuce takes from 90 to 145 days (Yamaguchi). Over half the weight of a head is gained during the two weeks before harvest.

Imports/Exports

Most countries in the world produce lettuce (Ryder). Northern European countries supply that region with summer lettuce, while Israel, Spain, Italy, and North Africa ship lettuce to northern European countries in the winter and spring. In the Western Hemisphere, besides U.S. production, lettuce is grown in southeast Canada in the summer, in Mexico in the spring and fall, and in several South American countries. Australia and Japan also produce lettuce, as does China, especially the stem type.

The United States exported 239,292 metric tons in 1990 (U.S. FATUS). Of this, 84.4% went to Canada and another 4.7% went to Mexico. Some lettuce was also exported to Western Europe (6,466

MT) and to Asia. Of the 18,509 MT sent to Asia in 1990, Hong Kong purchased 82.2%. In comparison with the amounts exported, lettuce imports are minor at 13,321 MT in 1990. Most of that (9,675 MT) came from Mexico, while 3,641 MT came from Canada. Mexico has not developed a significant lettuce export sector due to agronomic, climatic, postharvest technology, water quality, and other factors. Much of Mexico's small export volume is grown just across the border from Imperial County, under contract with U.S. firms.

California Production

Lettuce competes with processing tomatoes as California's leading vegetable crop (Mayberry). Unlike most vegetables, California harvests lettuce in approximately equal quantities each month in different areas of the state. The nation's "salad bowl" is located in the Salinas Valley, Monterey County. The Salinas-Watsonville harvest starts in early April and lasts until early November. The Imperial Valley, second in acreage and production, ships from early December until mid-March. Table 8.3 gives the location of production by type of lettuce.

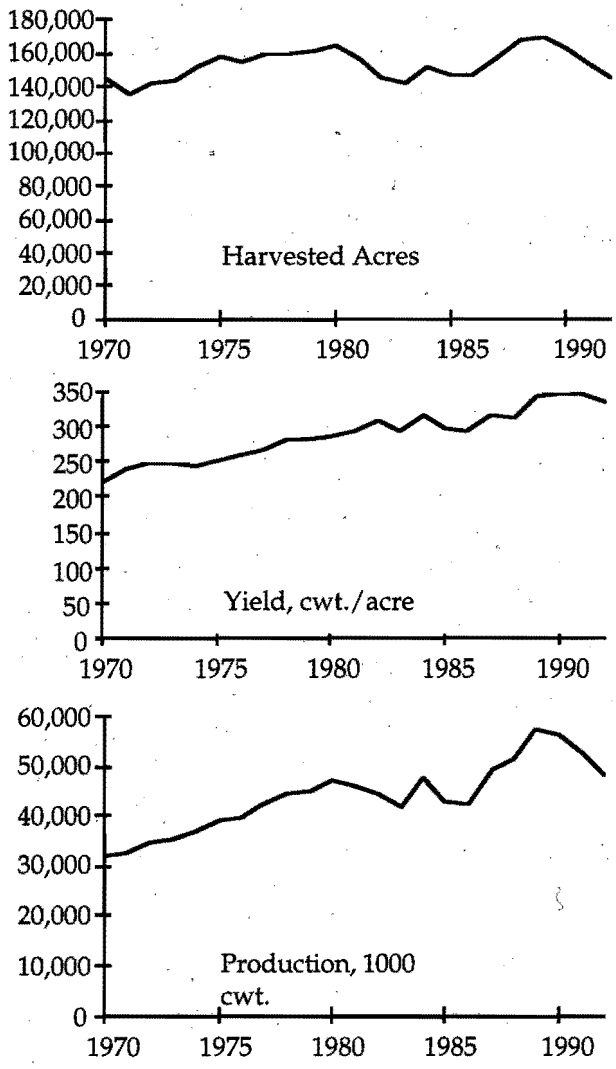
Unprocessed California iceberg lettuce shipments have experienced a major decline in market share relative to other types of lettuce, down from 80.2% of total lettuce shipments in 1986 to 58.6% in 1992 (Table 8.4). Romaine lettuce now represents 10.7% of lettuce shipments, other leaf lettuces account for 8.8%, and processed lettuce shipments now represent 21.9% of the total. The growth in the processed lettuce industry, including both iceberg and leaf lettuces, is the most significant trend in recent years.

Because of the range of temperatures during the Imperial Valley season, growers plant up to eight varieties at different times, while in the moderate Salinas Valley climate, only a few varieties are planted (Mayberry). Lettuce is precision planted using pelleted seed. Weeds are a serious problem, so both herbicides and hand hoeing (usually done while thinning) are used.

For ground-pack lettuce, a carton-making machine passes through the field surrounded by workers working in groups (Mayberry). A team of two cutters and one packer cuts and hand-places 24 heads in each box. Film-packed lettuce is trimmed in the field, placed on a conveyor belt moving up to workers aboard the machine where it is sealed in plastic film and conveyed on to be packed into boxes. Both kinds of packed lettuce are vacuum cooled to 34°F. A prototype mechanical harvester has been developed by the USDA and UC Davis but is not yet being used commercially.

Acreage and production trends are shown in Figure 8. (Data for the graphs are found in Appendix Table 8.) Acreage has remained rather stable, varying between 134,300 acres in 1971 and 168,400 in 1989. However yields have steadily increased, from 220 cwt./acre in 1970 to 345 cwt./acre in 1990. Consequently, production has increased over 75% during the two-decade period.

Figure 8. California Lettuce, 1970-1992



Source: California Agricultural Statistics Service.

9. MELONS

Muskmelons belong to the gourd family as do other vinecrops such as watermelons, cucumbers, squash, and pumpkins (Davis et al.). Besides the most important muskmelon, the cantaloupe, there are many other varieties, including honeydew, crenshaw, Santa Claus, casaba, Persian and other specialty melons. Their annual trailing vines grow 10 to 12 feet long. From these runners stem short branches that flower and produce the fruit. Each plant has a short thick tap root with lateral and fibrous roots. The flowers must be insect-pollinated with the domestic honey bee as the most effective agent.

Cantaloupes reach maturity faster than other muskmelons, about 90 days after planting (Tyler). When mature, the melon develops an abscission (the slip) where the fruit can be easily separated from the vine. Cantaloupes are commercially harvested when they are from three-fourths to fullslip.

The muskmelon probably originated in Africa, for wild varieties are still found there (Davis et al.). Today, cantaloupes are produced in many parts of the world. In 1990, a world crop of 9.5 million metric tons was harvested (U.N. FAO). Of this total, 32.8% was harvested in the Far East led by China's 2.5 million MT; 21.1%, in Europe led by Spain's 952,000 MT; 13.7%, in North and Central America led by the United States at 737,000 MT; and 13.2%, in the Middle East.

The U.S. National Agricultural Statistics Service no longer publishes cantaloupe acreage and production data, but from the U.S. Census of Agriculture we note that U.S. cantaloupe acreage increased from 113,981 harvested acres in 1982 (97,713 irrigated acres) to 129,810 in 1987 (115,597 irrigated acres). Most of the increase was in California where an 81% share of the U.S. muskmelon crop was harvested in 1990 (Cook et al.).

The U.S. ERS does report cantaloupe data that include domestic and imported shipments. Netting out import shipments that are reported separately, gives an approximation of the trend in U.S. cantaloupe production figures: 1.0 million lbs. in 1980, 1.5 million lbs. in 1985, down to 705,745 lbs. in 1990, partly due to reduced yields from the white fly infestation in the desert production areas.

U.S. production figures are available for honeydew melons and are reported in Table 9.1. Associated with greater production is increased per capita consumption of honeydew melons (Table 9.2). Presumably, along with increases in most fresh vegetables, per capita cantaloupe consumption also increased over the two decades.

Meanwhile, watermelon consumption has not grown. Allred quotes *The Packer's* "Fresh Trends 1988 Survey" that noted a reduced use of watermelon.[1] She explains that U.S. consumers prefer more convenient produce with consistently high quality. In response, the industry is gradually developing smaller melons (for smaller-sized U.S. households) and seedless hybrids (for convenience appeal).

Table 9.1. U.S. Honeydew Melon Production

Year	1000 cwt.
1970	1,931
1975	2,395
1980	3,180
1985	4,758
1990	4,520

Source: U.S. Economic Research Service

Table 9.2. U.S. Per Capita Consumption of Honeydew Melons

Year	lbs.
1970	1.0
1975	1.1
1980	1.4
1985	2.1
1990	2.0

Source: U.S. Economic Research Service.

U.S. cantaloupe production is concentrated in California, but many other states also harvest these melons. Table 9.3 reports the 1987 harvested cantaloupe acreage for the three leading states. In addition, Indiana had almost 3,000 acres, while Colorado, Georgia, Illinois, Maryland, Minnesota, New Jersey, North Carolina, Ohio, and Pennsylvania all harvested over 1,000 acres each. In contrast, the same three leading states accounted for over 97% of the harvested honeydew acreage (Table 9.3).

Table 9.3. Harvested U.S. Cantaloupe and Honeydew Acreage, 1987

State	Cataloupe acres	Honeydew acres
California	63,361	18,023
Texas	28,801	4,238
Arizona	12,436	2,708
U.S. total	129,810	25,699

Source: U.S. Bureau of the Census.

Imports/Exports

Mexico is the dominant foreign source of cantaloupe, supplying 65 percent of U.S. imports in 1990, despite a very high seasonal tariff (Cook et al.). Mexican imports mostly complement U.S. production, with peak shipments between December and April when domestic shipments are unavailable. However, Mexican shipments also overlap U.S. production in May-June and October-November when they compete with the California-Arizona desert valleys and with Texas. It is during this overlap that the higher tariff is applied: A 35% ad valorem tariff is added between September 16 and December 31 and between May 16 and July 31. The tariff falls to 20% between August 1 and September 15 and is removed completely between January 1 and May 15.[2] Of course, these tariffs will eventually be phased out when the North American Free Trade Agreement is ratified.

The United States imports several times more cantaloupe than it exports, and imports have grown severalfold over the last two decades (Table 9.4). Between 1980 and 1990, U.S. cantaloupe imports from Mexico doubled from 82,892 U.S. tons to 161,423 tons, but the Mexican share of total imports has declined as those from Central America (Honduras, Costa Rica, and Guatemala) increased (Cook et al.). The Central American countries enjoy duty-free shipments by being a part of the Caribbean Basin Initiative. U.S. cantaloupe exports also increased significantly over the last two decades.

Table 9.4. U.S. Cantaloupe Exports and Imports

Year	Exports 1000 lbs.	Imports 1000 lbs.
1970	52,339	148,803
1975	44,630	138,916
1980	62,725	169,917
1985	100,350	245,955
1990	89,097	530,255

Source: U.S. Economic Research Service.

California Production

About 65% of the California cantaloupe crop is composed of summer melons from the San Joaquin Valley—Fresno, Merced, Kern, Stanislaus, and Kings counties (Table 9.5). Planting in the valley is from March through mid-July; the crop is harvested from late June through early October (Tyler). The remainder of the state's cantaloupes comes from the desert valleys in Riverside and Imperial counties. Spring melons are planted in February and harvested from late May to July (Tyler). There is also a smaller fall crop from the Imperial and Palo Verde valleys planted in July and August and harvested in October and November. It is mainly these fall and spring crops that are in competition on U.S. markets with Mexican imports (Cook et al.).

Table 9.5. Location of California Cantaloupe and Honeydew Melon Production, 1990

County	Harvested area acres	Production tons
Cantaloupe melons		
Fresno	36,900	301,000
Imperial	35,152	145,428
Merced	7,260	55,530
Riverside	3,931	30,347
Kern	3,433	31,800
Stanislaus	1,890	15,600
Kings	1,485	15,563
State total	90,171	645,507
Honeydew melons		
Yolo	5,300	46,640
Stanislaus	4,020	31,000
Sutter	3,142	29,849
Imperial	2,985	13,063
Fresno	2,920	34,200
Riverside	957	8,024
State total	21,192	162,776

Source: California Agricultural Statistics Service.

Table 9.5 also gives 1990 acreage and production by county for honeydew melons. The Sacramento Valley produces almost half the honeydews. Much of this acreage is in the Sacramento River bypass areas in Yolo and Sutter counties that are often flooded in the winter. The rest of the honeydews are produced in the San Joaquin and desert valleys.

Figure 9 shows trends in production, yields, and acreage for (a) cantaloupes and (b) honeydew melons. (Data for these graphs are found in Appendix tables 9a and 9b.) The state's cantaloupe acreage increased from 58,100 acres harvested in 1970 to 90,200 acres in 1990. No estimates were published in 1991, but in 1992, 86,000 acres were harvested at an average yield of 140 cwt./acre and a total production of 12.0 million cwt. Production followed this upward trend, offset some years by varying yields. Overall, production nearly doubled over the two decades.

Figure 9b shows that honeydew acreage more than doubled from the early 1970s to the late 1980s, dropping some after a peak of 21,300 acres in 1988 and 1989. Production increased along with the acreage,

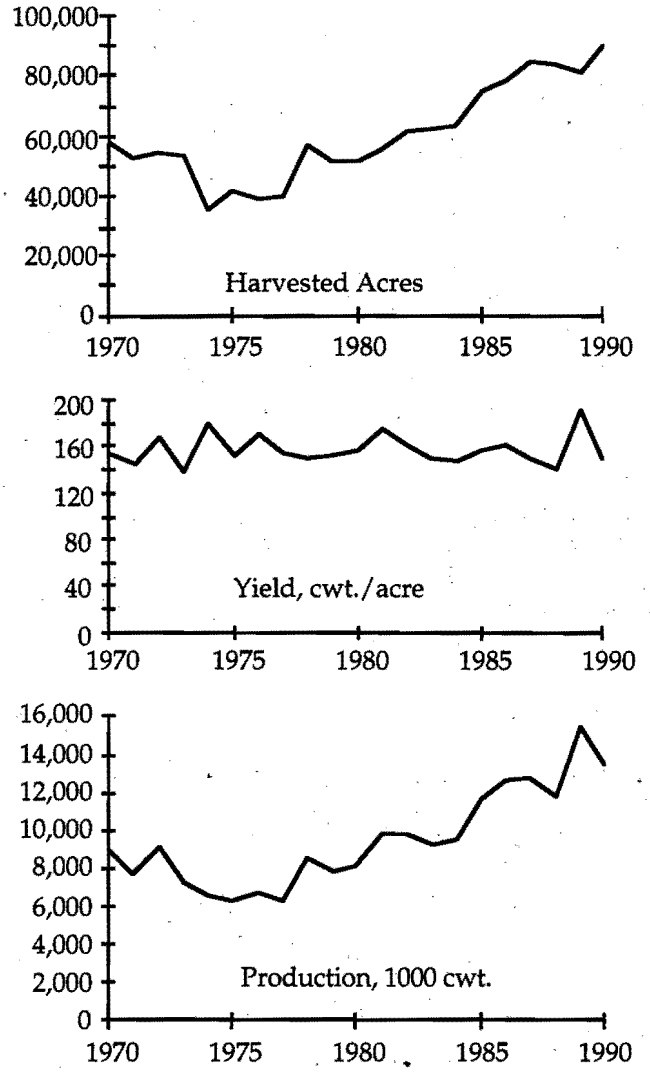
but dropped from 4.0 million cwt. in 1989 to just under 3 million in 1992 as acreage decreased and yields fell due to the white fly problem in desert areas.

Table 9.6 reports statewide acreage and production figures for several other California-grown muskmelons. Casaba/Santa Claus melons together showed a substantial increase in acreage and production, while Crenshaw melons declined and Persian melons remained stable at about 500 acres.

Table 9.6. Harvested Acreage and Production for Other California Muskmelons

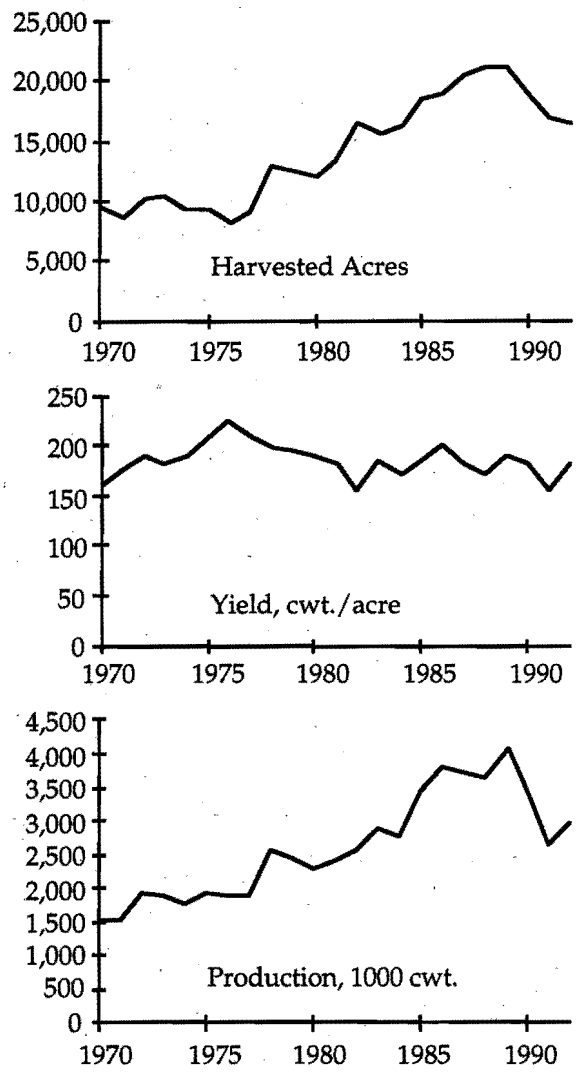
	Casaba/Santa Claus		Crenshaw		Persian	
	acres	1000 cwt.	acres	1000 cwt.	acres	1000 cwt.
1970	700	96	1,500	248	500	65
1975	1,000	110	1,100	132	500	50
1980	1,400	238	1,000	140	400	72
1985	1,700	289	1,400	224	550	110
1989	2,500	463	1,000	180	500	83

Figure 9a. California Cantaloupe Melons, 1970-1990



Source: California Agricultural Statistics Service.

Figure 9b. California Honeydew Melons, 1970-1992



Source: California Agricultural Statistics Service.

10. MUSHROOMS

The United States is the largest mushroom producing country, supplying 21% of the world's total in 1990 (Hamm). Other major mushroom producers include China (with 19%), France (12%), the United Kingdom (9%), and the Netherlands (9%).

Pennsylvania is the leading state with 47% of the nation's production in 1990, followed by California with 17% (Table 10.1). Florida entered the market three years ago, passing Michigan, and now accounts for about 4% of the U.S. total.

Table 10.1. U.S. Mushroom Production, 1990/91

State	1000 lbs.
Pennsylvania	351,204
California	130,867
Florida	30,677
Michigan	25,451
US total	749,488

Source: Hamm, from the U.S. National Agricultural Statistics Service.

California production is oriented toward the fresh market, but production for processing has increased over the past decade (Table 10.2). Fresh output nearly doubled over the decade, while mushrooms for processing increased by 22%.

Along with this production expansion is a sharp increase in per capita mushroom use. Table 10.3 shows a manyfold increase in fresh consumption since 1970; a two-thirds increase since 1980. Processed consumption has also increased, but more gradually.

Table 10.3. U.S. Per capitaUse of Mushrooms

Year	Fresh lbs.	Processed lbs.
1970	0.3	1.0
1975	0.7	1.2
1980	1.2	1.5
1985	1.8	1.8
1990	2.0	1.8

Source: Hamm.

Mushrooms are grown indoors in beds or trays; beds are the older and more labor-intensive method (Hamm). The number of U.S. growers is down to 238 in 1991 from 440 in 1983, but total production (fresh and processed) has increased 160% since 1980, due mostly to increased yields. A grower can multiply output by adding trays over the same area of ground. Besides stacking trays, yields have also improved through increased spawning rates and shortened production cycles (Hamm). A nutrient-rich top dressing (such as peat moss) is mixed into the spawn run, as well as other nutrient supplements, that shortens the time until the first picking. One production cycle is usually three pickings, before yields decline.

Disposal of water from the compost is a problem, as is the compost itself (Hamm). Growers are now required to reclaim all drainage water on site. Compost may be sold to nurseries, but must be spread first to leach out excess nitrogen. In some areas, the disposal process causes conflicts with nearby residents because of the odor.

By far the main variety of mushroom produced is the agaricus (white button), but specialty mushrooms have also increased in importance (Hamm). While specialty mushrooms represent less than 1% of the U.S. mushroom output, they represent over 3% of the value because of a per-pound price four or five times greater. In 1990, 4 million pounds of Shiitake were sold at an average price of $4.17/lb. and 1.5 million pounds of Oyster mushrooms, at $2.67/lb. This compares to an average agaricus price of 98¢/lb.

Because Shiitake can be grown commercially outdoors on oak logs, entry costs are low and the crop is well suited to small operations, including hobby farmers (Hamm). Industry experts claim that there are as many as 1,500 growers of Shiitake, compared to only 237 commercial Shiitake operations reported by USDA (those with 200 or more logs).

Table 10.2. Mushrooms to Fresh and Processing Outlets

	Pennsylvania and other eastern states		California and other western states		Total U.S.	
Year	fresh	processing	fresh	processing	fresh	processing
	1000 lbs.		1000 lbs.		1000 lbs.	
1980/81	129,877	163,466	110,536	6,742	275,052	194,524
1985/86	221,785	116,919	156,431	17,093	427,204	160,752
1990/91	266,060	177,985	188,307	29,064	512,258	237,230

Source: Hamm, from the U.S. National Agricultural Statistics Service.

Imports/Exports

Chief suppliers of U.S. imported mushrooms are the People's Republic of China, Taiwan, Indonesia, and Hong Kong (Hamm). In the mid-1980s, the United States was a net importer of mushrooms for processing: In 1985, 274 million pounds of processed mushrooms were imported, while 161 million pounds of U.S. mushrooms were processed here. In 1989, the FDA banned imports from China because of a contamination problem, so total imports were temporarily reduced. By 1990, 237 million pounds of U.S.-produced mushrooms went to processing, and 205 million pounds were imported. Imports from Indonesia have rapidly increased as U.S. food companies, such as Green Giant, purchase mushrooms for processing there. Hong Kong is another major supplier, bringing in brined mushrooms from China to be processed and exported.

The United States is a net exporter of fresh mushrooms, with Canada buying 80% of all fresh mushroom exports in 1991 (Hamm). Japan, the European Community, and Mexico also import U.S. mushrooms, with Japan and the EC being particularly interested in the high-value specialty mushrooms.

California Production

California mushroom production is concentrated in two adjacent counties -- Monterey and Santa Clara (Table 10.4).

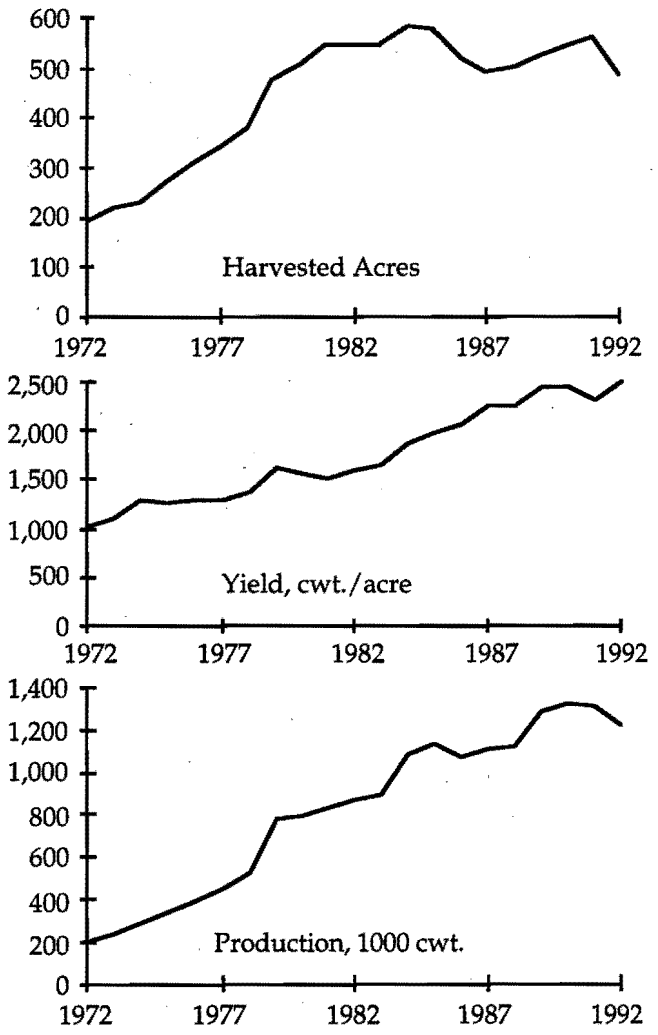
Table 10.4. California Mushroom Production and Value, by Leading Counties, 1990

County	Production tons	Value million $
Monterey	23,206	42.7
Santa Clara	12,576	24.1
San Diego	4,000	10.1
State total	39,782	121.0

Source: California Agricultural Statistics Service.

Figure 10 gives acreage, yield, and production trends for California mushrooms. (Data for the graphs are found in Appendix Table 10.) While the area in mushroom production is only a few hundred acres, it has nearly tripled since the early 1970s. Meanwhile, production increased sixfold, largely because of increased yields.

Figure 10. California Mushrooms, 1972-1992



Source: California Agricultural Statistics Service.

11. ONIONS

Onions, members of the lily family, may well be the oldest-known vegetable, probably originating in the Iran-West Pakistan area (Jones and Mann). Some 300 species are widely scattered around the temperate regions of the Northern Hemisphere. Egyptians used onions for food, medicine, and mummification in the 4th and 3rd centuries BC. The Israelites on their way to Canaan in about 1500 BC complained that they missed the onions and leeks of Egypt (Jones and Mann). Onions were enjoyed in the cuisine of India in 600 BC and in Greece and Rome in 400-300 BC (Yamaguchi).

Onions are grown as an annual plant, except for seed production that requires vernalization. They have shallow adventitious roots and a short stem that increases in diameter as it grows, maturing to the shape of an inverted cone, topped by hollow green leaves (Yamaguchi). Onions are a temperature-sensitive crop, requiring cool temperatures during early stages of growth before bulbing, then warmer temperatures to induce bulbing. However, if it is too warm, bulbing is inhibited; if it is too cold (<50°F.) bolting (flowering) will occur.

There are a number of ways of classifying onions. Because bulbing is dependent on a suitable day-length, one classification scheme is by the photoperiod required (Greene): short-day (12-13 hours), intermediate-day (13½-14 hrs.), and long-day (14½-15 hrs.) cultivars. Short-day onions are mild flavored, but have a short storage life; intermediate-day onions have a mild to medium pungency and a longer storage life; long-day onions are more pungent and have a long storage life. Onions are also classed by their maturity or harvest date: spring, summer nonstorage, and summer storage.

Onions are also classed by their type (Paterson). Globe onions are round or oval, medium sized (2 to 3 inches), firm to touch, and mostly yellow-skinned, though there are red- and white-skinned types. Spanish onions are mild and sweet-flavored, but with poor storage characteristics; most have yellow skin, but some are white. Grano and granex onions are yellow, mild, medium-to-large onions. Processing onions (dehydrators) are usually white cultivars with high solids and strong pungency (Jones and Mann). Among specialty onions are Bermudas, soft-fleshed, sweet, flat bulbed onions covered with shiny skin (USDA) and the Walla Walla, a yellow globe unique to the valley by that name in Washington with an ability to overwinter and produce a heavy, very sweet onion (Hinman et al.). Other well known sweet onions whose production is expanding include the Vidalia, grown in Georgia; Texas Sweets; and the Imperial Valley Sweet. Green bunched onions, popular as a salad ingredient, are harvested before the plants mature.

U.S. per capita onion consumption has increased substantially, complementarily with increased use of other vegetables and because of onion use in fast food restaurants and in ethnic cuisines. Between 1970 and 1990, onion use increased from 12.4 lbs./person to 18.1 lbs (Greene). In response to increased demand, U.S. growers expanded acreage and production (Table 11.1).

Table 11.1 U.S. Harvested Onion Acreage and Production

Year	Harvested area fresh market acres	Production fresh and processing million lbs.
1970	101,000	3,072.3
1975	103,080	3,183.4
1980	113,160	3,358.1
1985	122,760	4,505.9
1990	138,340	5,278.1

Source: U.S. Economic Research Service.

Onions are grown in all 50 states but commercial production is limited to a few, with concentration of production gradually shifting more to the western states.

Early crop areas generally harvest by hand because spring onions have relatively soft flesh. The eastern Oregon-southern Idaho area produces about one-third of the U.S. storage onions; New York, another fourth. Colorado leads in the pearl type onion, most of which are frozen. There are two federal onion marketing orders—one in Texas, the other in eastern Oregon-Idaho—that specify grade and size regulations and sponsor research and promotion. Table 11.2 gives more detail about location of production by type of onion.

Imports/Exports

Trade in onions is small but important (Paterson), with exports generally from 3 to 4 million cwt. (Table 11.3). Canada is the leading customer, buying U.S. onions every month. Japan is the second largest importer, buying mainly storage onions from the eastern Oregon-Idaho district. Western Europe imports storage onions in the late fall and spring onions from the Texas new crop.

Table 11.2. Location of Harvest by Type of Onion, 1991

State	Harvested area acres	Production 1000 cwt.
Spring		
Texas	11,800	2,832
California	8,000	3,160
Georgia	6,000	660
Arizona	900	441
U.S. total	26,700	7,093
Summer nonstorage		
New Mexico	7,400	2,960
Texas	4,000	960
Washington	900	297
U.S. total	12,300	4,217
Summer storage		
Colorado	12,700	4,953
New York	11,700	3,510
Oregon	14,000	7,588
Idaho	7,700	4,543
Michigan	7,300	2,044
Washington	7,200	3,096
Utah	1,900	874
Minnesota	980	294
Ohio	490	169
U.S. total	65,570	27,631
Summer, mostly processing		
California	30,000	11,250

Source: U.S. National Agricultural Statistics Service.

Imports amount to from 2 to 4 million cwt. (Table 11.3), accounting for 3 to 6% of the U.S. supply, depending on the year. About 90% of U.S. imports are from Mexico; these onions are mostly late winter whites. Pickled onions are imported from the Netherlands, Japan, and Italy (Jones and Mann).

Table 11.3. U.S. Onion Exports and Imports

Year	Exports million lbs.	Imports million lbs.
1970	147.2	83.4
1975	152.5	91.0
1980	296.6	143.1
1985	195.1	281.8
1990	347.1	381.8

Source: U.S. Economic Research Service.

California Production

California ranks first in dry (cured) onion production (Johnson), producing both for the fresh and processing markets. About 60% of the state's crop is dehydrated, and California accounts for all of the nation's dehydrated onions. California's fresh crop (spring onions) is shipped directly to market, rather than being stored.

Onions are produced throughout the state from Tulelake in the north to the Imperial Valley near the Mexican border. Fresno County leads with nearly 20,000 acres in 1990 (Table 11.4). Included in Table 11.4 are California's several thousand acres of green bunching onions marketed throughout the year from Monterey and other production areas. However, considerable green onion production has shifted across the California and Arizona borders into Mexico, due to the hand labor required to bunch green onions. California also produces onion seed on several hundred acres in the San Joaquin and Imperial valleys and in the Salinas-Gilroy-Hollister area (not included in Table 11.4).

Table 11.4 Location of California Onion Production, 1990

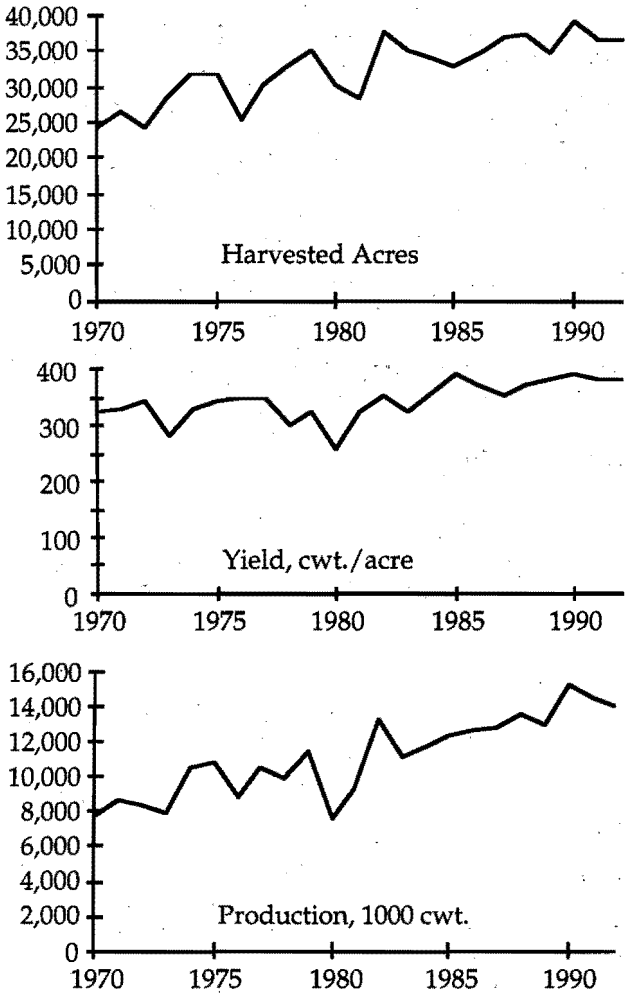
County	Harvested area acres	Production 1000 tons
Fresno	19,950	379.4
Imperial	10,125	207.2
Kern	7,114	156.5
Los Angeles	1,550	38.8
San Joaquin	1,530	31.8
Modoc	1,361	29.9
Riverside	942	20.8
San Benito	907	20.3
Stanislaus	800	16.6
Siskiyou	462	10.2
Monterey	383	5.9
Santa Clara	350	4.6
State total	46,914	922.8

Source: California Agricultural Statistics Service.

The first onions of the year come from Imperial County starting in late April continuing through early June (Johnson). The Fresno and Bakersfield areas begin harvesting in early June; Fresno lasts about six weeks, while Bakersfield continues until September. The Stockton area harvest runs from mid-June through July. The latest production areas are in southern California and harvest in September and October. Spring plantings of dehydrator onions in Monterey, San Benito, Siskiyou, and Modoc counties are harvested in the fall.

California fresh onions are harvested by hand. When the onions are mature, their tops collapse. The bulbs are undercut by machine, then pulled by hand; tops and roots are trimmed. The onions are placed in burlap sacks to cure for four to ten days (Johnson). Curing dries the tissues and seals out organisms that could cause decay (Paterson). In

Figure 11. California Onions, 1970-1992



Source: California Agricultural Statistics Service.

other U.S. production areas curing is done in windrows, in slotted crates, or with forced-air heat (Yamaguchi).

California dehydrator onions are harvested by machine. The tops are cut off, and the bulbs are left to cure in the ground for several days (Johnson). Then the bulbs are undercut, lifted out, and picked up by machine. Defective bulbs and clods are sorted out by hand, and the onions are transported in bulk to the processor.

At the processing plant the onions are graded by size, flame-peeled to remove the outer peels, washed and brushed, inspected, trimmed of tops and roots, and sliced (Jones and Mann). They are placed uniformly on wooden trays or stainless steel belts and dried for three or more hours in three stages—at 165°F., at 145°F., and from 130° to 140°F. After another 12 hours in bins through which warm air is passed, the onions finish with a moisture content of less than 4%.

Figure 11 shows the aggregate onion acreage, yields, and production for the state between 1970 and 1990. (Data for Figure 11 are found in Appendix Table 11.) Production has increased over 85% since 1970 on 13,800 additional acres. Between 1970 and 1991, 1,600 acres were added in spring onions, while there were 12,200 more acres in summer dehydrators. Three-fourths or more of the acreage and production is in summer dehydrators (Table 11.5).

Table 11.5. Percentage of California Onion Acreage in Spring and in Summer (Dehydrator) Onions

Year	Spring %	Summer %
1970	24.3	75.7
1975	14.7	85.3
1980	21.9	78.1
1985	28.6	75.4
1990	23.5	74.2

California Crop and Livestock Reporting Service.

12. STRAWBERRIES

Strawberries are sold either fresh or for processing; processed forms include frozen, canned, used in jams, jellies, ice cream, yogurt, fruit juice blends, and occasionally wine. They are one of the most capital- and labor-intensive crops (Palerm). Perishability and vulnerability to disease, weather, and market conditions make strawberries a very risky crop to grow and sell, yet they hold promise for very rewarding returns.

The versatility of the genetic makeup of the strawberry plant allows it to be adapted to a variety of environmental conditions and produced worldwide (Brun et al.). The various cultivars differ markedly in their response to, for example, day length and temperature, and thus are developed specifically for certain regions. Cultivars adapted to California would perform poorly in the Pacific Northwest, for example.

According to the 1987 Census of Agriculture, 9,398 U.S. farms grew strawberries in 1987, harvesting 959 million pounds on 53,085 acres (42,584 of these were irrigated). In 1991, California produced over 80% of the total U.S. strawberry crop (up from a more usual three-fourths of the total), followed by Florida's winter crop that accounted for 9.4% (Table 12.1).

Table 12.1. Harvested U.S. Strawberry Acreage and Production, 1991

State	Harvested area acres	Production 1000 cwt.
California	21,100	10,972
Florida	5,500	1,320
Oregon	5,600	616
New York	3,400	190
US total	46,680	13,689

Source: U.S. National Agricultural Statistics Service.

U.S. strawberry production doubled from 1980 to 1991, with a large jump in production of 146 million pounds between 1990 and 1991 (Table 12.2). California usually represents about three-fourths or more of the nation's increasing total supply. Because of California's high yields, this share is harvested on less than half total U.S. acreage (Table 12.2).

The increased production observed during the last decade was in response to greater U.S. consumer demand, particularly for fresh strawberries. Per capita strawberry consumption figures are shown in Table 12.3—consumption of fresh berries almost doubled between 1970 and 1989, while consumption of frozen berries increased very little. Although this varies from year to year, about 70% of the U.S. total is sold fresh; the rest is processed. The proportion to fresh is somewhat higher in California (Table 12.4).

Table 12.2. U.S. and California Strawberry Production, 1980-1991

Year	United States 1000 cwt.	California 1000 cwt.
1980	7,017	5,170
1981	7,397	5,396
1982	8,779	6,272
1983	8,917	6,240
1984	9,900	7,544
1985	10,188	7,738
1986	10,193	7,878
1987	11,157	8,232
1988	11,791	8,640
1989	11,420	8,670
1990	12,543	9,870
1991	13,689	10,972

Source: U.S. National Agricultural Statistics Service.

The increased production observed during the last decade was in response to greater U.S. consumer demand, particularly for fresh strawberries. Per capita strawberry consumption figures are shown in Table 12.3—consumption of fresh berries almost doubled between 1970 and 1989, while consumption of frozen berries increased very little. Although this varies from year to year, about 70% of the U.S. total is sold fresh; the rest is processed. The proportion to fresh is somewhat higher in California (Table 12.4).

Table 12.3. U.S. Per Capita Strawberry Consumption, 1970-1989

Year	Fresh lbs.	Frozen lbs.	Total lbs.
1970	1.6	1.2	2.8
1975	1.7	1.4	3.1
1980	1.8	1.4	3.2
1985	2.8	1.2	4.0
1986	2.8	1.3	4.1
1987	3.0	1.3	4.3
1988	2.9	1.3	4.2
1989	3.1	1.5	4.6

Source: Putnam and Allshouse.

Table 12.4. Utilization of the Strawberry Crop, California and the United States

year	California fresh 1000 cwt.	California processed 1000 cwt.	United States fresh 1000 cwt.	United States processed 1000 cwt.
1980	35,610	16,090	48,210	21,960
1985	58,040	19,340	75,410	26,470
1990	67,050	31,650	86,420	39,010
1991	79,590	33,300	100,220	39,840

Source: U.S. National Agricultural Statistics Service.

Imports/Exports

In 1988, the United States imported 39.4 million pounds of fresh and 72.1 million pounds of frozen strawberries, 19.6 million pounds of strawberry jam, and 3.3 million pounds of otherwise prepared strawberries (U.S. FATUS). In 1990, of the 104.3 million pounds of fresh and frozen berries imported, 88.7 million (85%) came from Mexico; most of the rest came from Central America (7.0 million pounds) and Canada (0.9 million pounds). Of all the fresh strawberries consumed in the United States in 1990, 3.1% came from Mexico, and of the frozen berries used, 16.1% came from Mexico (Cook et al.).

The vast majority of imported strawberries are from Mexico. The Mexican strawberry freezer industry started in 1948 and expanded rapidly through the mid-1970s, helped by low field and plant wages, subsidized sugar prices, a stable peso relative to the dollar, and the Klondyke berry, popular with processors (Runsten). However, by the late 1970s, Mexico became a less certain supplier due to the oil boom and an overvalued peso, increased sugar prices, better demand and prices for fresh berries in Mexico, flat U.S. demand for processed berries, disease problems, lack of research and/or successful technology transfer, disorganization in the industry, and competition from California's high-yielding, high-tech produced, low-cost processed berries. Mexico's share of the U.S. strawberry market declined over the last decade.

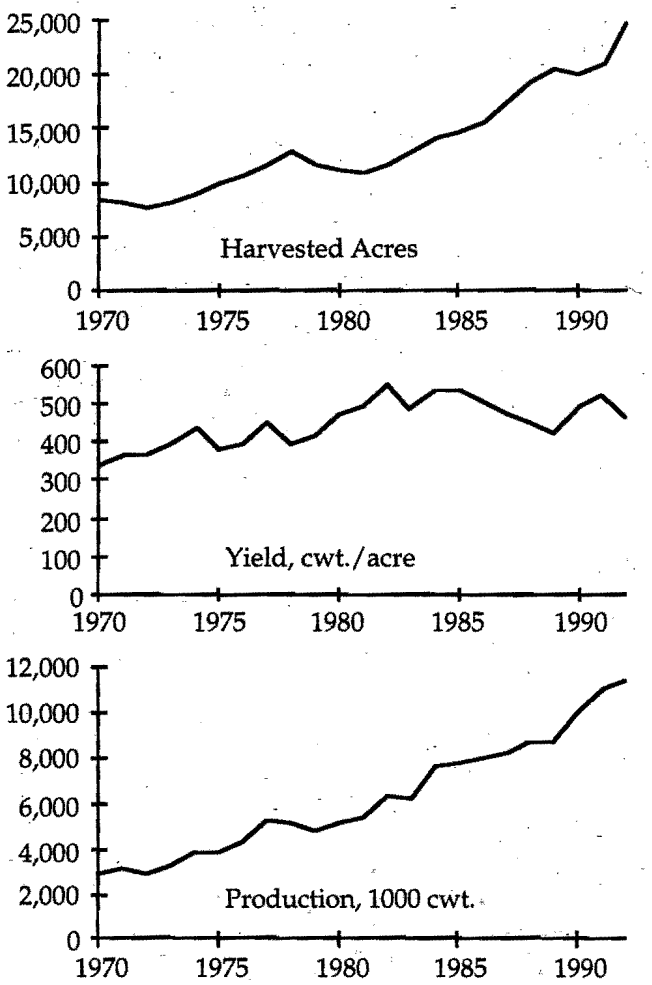
In 1988, the United States exported 30.7 million pounds of fresh and 17.8 million pounds of frozen strawberries (U.S. FATUS). The two main buyers of U.S. strawberries are Canada and Japan.

California Production

Increased production in California is largely accounted for by expanded acreage (see Figure 12 and Appendix Table 12). California strawberry acreage increased rather steadily from a low of 7,800 acres in 1972, rising to a peak of 12,900 in 1978, dropping some in the late 1970s, before steadily expanding to over 20,000 acres by 1990. California growers planted in response to increasingly favorable returns; per-acre returns jumped from around $12,000 in the mid-1970s to almost $25,000 in the late 1980s (Mamer and Wilkie).

California strawberry yields are more then twice those in Florida and over four times those of Oregon. This is due to differences in cultivars grown, a much longer harvest season in California (in some places almost year-round), and California's practice of replacing plants every year (annual production). Florida harvests only a winter crop, while Oregon's season lasts only about three weeks in June. California's research thrust has been to develop large-berried, higher-yielding varieties, suited for annual production. In contrast, Oregon treats the crop as a four-year perennial, replanting only about one-fourth of its acreage each year.

Figure 12. California Strawberries, 1970-1992



Source: California Agricultural Statistics Service.

Runsten describes several other important advantages that California has in strawberry production: (1) an industry structure that is highly organized in cooperatives and grower-shipper corporations; (2) a marketing order (implemented by the California Strawberry Advisory Board) that has supported marketing research and promotion and production research and development with an emphasis on breeding disease-resistant plants with large berries and very high yields; (3) capital-intensive, high-tech production and marketing methods; and (4) both fresh and processed market outlets. This final point bears more discussion.

California's cultivars have been developed specifically for the higher-price fresh market. A major success has been the state's ability to market these cultivars first to fresh, then to processing. As the harvest season progresses from south to north along the California coast and it becomes too hot for fresh berries, the late berries go to processing after growers have already sold most of their crop in the lucrative fresh market (Runsten). Sales to processing, therefore, merely have to cover variable costs (especially, harvesting and transportation). Thus, the portion of California's crop that is sold for processing is subsidized by the relatively high-priced fresh market. Table 12.5 compares California's fresh and processed strawberry prices. High-yielding, disease-resistant varieties have propelled the California industry to dominate fresh sales, with extra profits added as late-season berries go to processing.

Location of Production

The fresh crop is harvested first along the south coast, beginning with San Diego County's 800 plus acres, moving north as the season progresses into Orange, Los Angeles, Ventura, Santa Barbara, and San Luis Obispo counties. Along the south coast, Santa Barbara and Ventura counties have the most acreage, 4,530 and 4,200 acres in 1990, respectively (CASS). As discussed above, the last berries harvested go to the processing market. For example, in 1990, San Diego County sent 17,956 tons to the fresh market, followed by 6,155 tons to processing. Replanting occurs at the beginning of the calendar year and the cycle begins again.

As the season progresses, the Central Coast fresh harvest begins, with Monterey County's 5,830 and Santa Cruz County's 2,771 harvested acres (in 1990). Monterey County sent 147 thousand tons to the fresh market before harvesting 36.4 thousand for processing.

Nurseries producing strawberry plants are located at low elevations in Shasta, Tehama, and Stanislaus counties and at high elevation (3,000 feet) in Shasta County (Bringhurst).

13. TOMATOES, FRESH

Florida and California are the leading states in fresh tomato production (Table 13.1). Together they account for 65% of the acreage and 75% of the production. Florida, California, and Mexican imports supply the U.S. market year-round with fresh tomatoes. Florida production brought growers $597 million in 1991, representing 54.7% of the value of the U.S. crop; California tomatoes brought $228 million for 20.9% of the value. Production in other states is mainly sold in local and regional markets in the summer when it competes with California tomatoes.

Table 13.1. U.S. Fresh Tomatoes, Acreage Harvested and Production by State, 1991

State	Harvested area acres	Production 1000 cwt.
Florida	46,200	16,170
California	38,000	9,120
New Jersey	4,800	480
Tennessee	4,700	846
Pennsylvania	4,300	344
South Carolina	3,700	1,110
Virginia	3,500	1,435
Texas	3,300	83
Ohio	3,200	640
Alabama	2,800	420
Maryland	2,700	420
Michican	2,700	297
New York	2,700	378
Georgia	2,600	793
North Carolina	1,600	272
Indiana	1,400	203
Arizona	800	224
Massachusetts	430	90
Hawaii	200	57
U.S. total	129,630	33,408

Source: U.S. National Agricultural Statistics Service.

U.S. harvested tomato acreage has varied a few thousand acres since the 1970s with no clear trend. The high of the 21 year period between 1970 and 1990 was in 1970 when 147,100 acres were harvested; the low was in 1982 when only 119,690 acres were harvested (U.S. ERS). Most years more acreage is planted than is harvested. For example, in 1991, 133,390 were planted, but only 129,630 harvested. Despite the rather stable U.S. acreage, production shows a strong upward trend as yields have improved (Table 13.2).

Along with overall increased vegetable consumption, the U.S. per capita use of fresh tomatoes increased during the 1980s, facilitated by increased production plus imports (Table 13.3).

Table 13.2. U.S. Fresh Tomato Acreage Harvested and Production

Year	Harvested area acres	Production 1000 cwt.
1970	147,100	18,234
1975	124,680	21,114
1980	126,250	25,393
1985	123,760	29,740
1990	134,290	33,564

Source: U.S. Economic Research Service.

Table 13.3. U.S. Per Capita Use of Fresh Tomatoes

Year	lbs.
1970	12.1
1975	12.0
1980	12.8
1985	14.9
1990	15.4

Source: U.S. Economic Research Service

There are two distinct growing methods used for fresh tomatoes (Sims): vine ripes and mature greens. Vine ripes are grown on stakes or trellises, picked at the pink fruit stage in several picks. They are usually staked in mulch and watered by drip irrigation systems. Mature greens are grown as bush types that are picked once or twice. They are less labor-intensive to produce and handle and have come to be preferred on the U.S. market mostly because of their greater ease of handling and transporting, and their greater shelf life (Cook et al).

Florida Production

Florida produces a winter tomato in several production regions—the west central (the Ruskin area), the southwest (the Immokalee area), and the Dade area, southwest of Miami (Cook et al.). In a typical year, harvest begins in the Ruskin and Immokalee areas in mid- to late October, peaking in late November and December. Some harvesting in the Immokalee area continues while the Dade area moves into full production and accounts for most of the harvest between January and March. In April the Dade falls off while the Ruskin and Immokalee areas start harvesting their spring crops that lead to a second Florida peak in April through May.

Florida grows mostly mature greens, but in many places uses the staked production method.

Imports/Exports

The nation's largest horticultural import is fresh tomatoes, representing 17% of the physical volume and 26% of the value in 1990 (Cook et al.). Most tomato imports are from Mexico: In 1990, 97.5% of fresh tomato imports were from Mexico. The rest came from Canada, the Caribbean (the Dominican Republic), the Netherlands, and Israel (U.S. FATUS). Tomatoes are usually Mexico's second most valuable agricultural export, following coffee. (In 1990, tomatoes captured first place in terms of value because of high prices associated with the Florida freeze.)

The bulk of tomato imports comes from Sinaloa, a narrow state on the Pacific Coast some 650 miles south of the Arizona border (Cook et al.). Compared to many other Mexican states, Sinaloa is relatively well endowed with water for irrigating and infrastructure for handling and transporting tomatoes that move mostly through Nogales, Arizona. Tomato acreage has expanded there from 36,500 acres in 1980/81 to 55,027 acres in 1990/91.

An increasing proportion (up to half or more) of the Sinaloa harvest is now being sold on the Mexican market, sometimes at better prices than exports to the United States would bring (Cook et al.). Roma tomatoes, historically preferred by Mexicans and of increasing interest to U.S. consumers, are representing a greater share of the harvest in Sinaloa. In 1990, 23% of tomato exports from Sinaloa were Romas (Cook et al.).

Baja California has produced fresh tomatoes for many years, but not much production was exported until the 1980s (Cook et al.). Production is concentrated in a cool, coastal region, the San Quintin Valley, about 150 miles south of San Diego. The impetus for increased production and exports came from joint ventures between San Diego grower/handlers and Baja growers. San Diego producers, pressured by urbanization, were seeking alternative production areas with lower land, water, and labor costs. San Diego vine-ripe, staked production technology was transferred to the region where yields increased and acreage expanded from 9,949 acres in 1980 to 11,053 in 1990. However, salt water intrusion into ground water aquifers threatens the future viability of the industry there. Labor availability is also becoming a problem because of the area's distance from population centers and the increased permanent immigration of Mexican farmworkers to the United States in the wake of the 1986 Immigration Reform and Control Act.

While the United States has imported huge volumes of tomatoes for a long time, fresh tomato exports have grown rapidly (Table 13.4). Canada has traditionally been and still is the biggest importer of U.S. tomatoes, purchasing 94% of U.S. exports in 1990 (U.S. FATUS), but recently exports to Mexico have increased substantially. While representing only 3.6% of U.S. exports in 1990, Mexican imports are relatively more important to California producers because of a complementarity with Mexican tomato production seasons. In fact, the California Tomato Board held a California tomato promotion campaign in Mexico in 1992 (Cook et al.).

Table 13.4. U.S. Fresh Tomato Exports and Imports

Year	Exports 1000 lbs.	Imports 1000 lbs.
1970	89,171	646,724
1975	202,573	567,146
1980	275,272	651,736
1985	271,504	850,986
1990	315,035	795,857

Source: U.S. Economic Research Service.

California Production

Tomato production is widely distributed in the state from the north of the San Joaquin Valley to the Mexican border, allowing fresh shipments from May into December (Cook and Amon). There are four major production regions: the Imperial Valley, the San Joaquin Valley, the South Coast (San Diego, Orange, and Ventura counties), and the Central Coast (mainly Monterey County). Table 13.5 gives 1990 acreage and production by county. Harvest seasons by production region are reported in Table 13.6.

When the Imperial Valley initiates the shipping season in May and June, Florida is the main competition and Mexican shipments are negligible (Cook et al.). The Imperial Valley's acreage is rather stable: 1,200 acres in 1980; 1,196 in 1990.

Most of the state's growth in acreage has been in the San Joaquin Valley, while south coast acreage, especially San Diego County, has decreased. Valley acreage increased from 14,460 acres in 1980 to 26,369 in 1990 (Cook et al.); San Diego County acreage is down from almost 8,000 acres in 1980. Note however that San Diego yields are the highest in the state—over 34 tons/acre, compared to about 14 tons/acre in the San Joaquin Valley. The shift in acreage from the coast to the valley has meant that an increasing proportion of the state's tomato crop is mature greens, while the

Table 13.5. Location of California Fresh Tomato Production, 1990

County	Harvested area acres	Production 1000 tons
Merced	7,440	82.7
Fresno	6,000	113.0
San Joaquin	6,000	73.8
Montery	4,970	73.4
Stanislaus	4,490	67.4
San Diego	3,310	113.7
Kings	1,200	24.0
Imperial	1,196	16.0
Orange	937	28.9
Tulare	639	10.7
State total	38,838	617.0

Source: California Agricultural Statistics Service.

Table 13.6. California Production Regions and Harvest Seasons

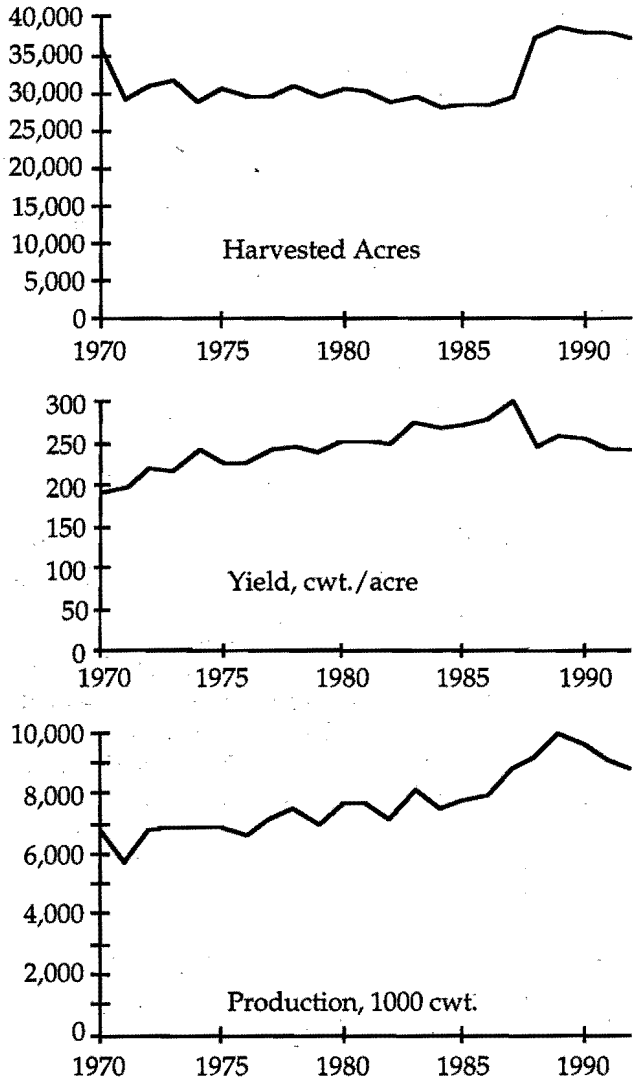
Region	Harvest season
Imperial Valley	May 25-July 1
Cutler-Orosi[a]	June 15-August 5
Merced	June 24-August 15
Northern San Joaquin Valley	July 15-Nov. 15
Gonzales-King City[b]	August 1-Oct. 5
Southern California	May 20-Dec. 30

[a]Fresno, Kings, Tulare, and Kern counties.
[b]Monterey County.
Source: Sims.

San Diego and South Coast vine ripes have a decreasing share of the total.

Figure 13 and Appendix Table 13 show the state's tomato acreage, average yields, and production over the last two decades. The overall acreage average does not show the shifts that have occurred. Most of the large jump in acreage in 1988 occurred in the San Joaquin Valley where 4,800 acres were added. The average yield over the 22 years was about 245 cwt. (12.2 tons) with gradual improvement over the time period. As valley bush type tomatoes replace the extremely high-yielding coastal staked tomatoes, the state's average yield is affected. For example, yields declined after 1988 when the new valley acreage was added. The production trend is steadily upward. Improved yields account for most of the increase in production until after the mid-1980s when acreage expansion more than offset the decreased yields.

Figure 13. California Fresh Tomatoes, 1970-1992



Source: California Agricultural Statistics Service.

14. TOMATOES, PROCESSING

Processing tomatoes are used to produce canned cut up or whole tomatoes, puree, sauce, paste, juice, catsup, chili sauce, and other products. U.S. production of tomatoes for processed products has quadrupled since World War II. In 1948, 2.7 million tons were harvested; by 1990, the total was 10.3 million tons (U.S. ERS).

This greatly expanded output is in response to a strong increase in per capita consumption (Brandt et al.). With changing consumer preferences, lifestyles, and especially away-from-home dining, U.S. per capita consumption of tomato products grew from 43.7 lb./person in 1960 to 62.6 lbs. in 1975 (Brandt et al.). (Since then, per capita consumption has been rather steady around 60 lbs./person, according to Putnam and Allshouse.) Much of the increased consumption took place with the more concentrated of the products, e.g., paste, catsup, in conjunction with their use in fast-food restaurants and pizza parlors.

Three regions of the United States have traditionally produced processing tomatoes—the East (New Jersey, Delaware, Maryland, Pennsylvania, Virginia, and New York), the Midwest (Illinois, Indiana, Ohio, and southern Minnesota), and California. Over time production has shifted away from the East and the Midwest. California that accounted for 36% of the total in 1950, was up to 75% by 1975 (Brandt et al.), and to 91% by 1991 (U.S. NASS). In 1950-52, California produced 1.7 million tons; in 1975, 6.0 million tons (Brandt et al.), and in 1991, 10.9 million tons.

California Production

Processing tomatoes are produced in the state from the Mexican border up to within 100 miles of the Oregon border (Brandt et al.). Harvest begins in the Imperial and Palo Verde desert valleys in mid-June and continues northward through the San Joaquin and Sacramento valleys to Butte County; the harvest ends in the southern coastal counties in November (Sims). Five counties, Fresno, Yolo, San Joaquin, Colusa, and Solano account for over three-fourths of the state's production (Table 14.1).

California's success over other regions of the country can be attributed to several factors, including climate, soils, water availability, an excellent highway system, and research and development. It was research that produced the mechanical harvester and bred the mechanically-harvestable tomato. The time-table went like this (Brandt et al.):

Table 14.1. Location of California Processing Tomato Production, 1990

County	Harvested area acres	Production 1000 tons
Fresno	104,000	3,692,000
Yolo	59,500	1,713,000
San Joaquin	28,200	871,000
Colusa	22,400	683,200
Solano	19,547	615,731
Sutter	16,200	439,992
Stanislaus	13,500	365,000
Imperial	10,400	334,900
Merced	8,500	240,000
Sacramento	7,300	219,000
Kern	5,200	170,000
Contra Costa	4,800	130,000
San Benito	3,597	128,413
Kings	3,300	90,090
Monterey	2,800	90,000
Santa Clara	1,900	60,800
Riverside	857	28,281
Santa Barbara	545	13,598
Orange	345	7,400
State total	312,891	9,892,405

Source: California Agricultural Statistics Service.

1961—The first commercial use of the mechanical harvester, developed at UCDavis. That year about 1% of the crop was harvested mechanically. At the same time university research had bred varieties that could be harvested mechanically. The tomatoes had to be firm enough to withstand mechanical handling, they had to ripen at the same time on the plants to allow once-through harvesting, and they had to have good processing qualities such as solids content, peelability, and flavor.

1962—Bin containers holding 1,000 pounds of raw product made to handle mechanically harvested tomatoes. Lug boxes had been used for the hand-picked harvest.

1964—The end of the Bracero program (Public Law 78). Just when labor shortages threatened, the mechanical harvester and the new varieties stood ready to be adopted.

Early 1960s—Deliveries from the State Water Project opened up thousands of new acres on the San Joaquin Valley's Westside. Much of this ground was put into processing tomatoes.

1970—Bulk-type gondolas introduced, holding 25-30 tons of raw product.

1973—Asceptic bulk storage and transport. This allowed the raw product to be processed in bulk during the height of the harvesting season and stored for reprocessing into final products later in the year. This greatly extended the time that the processing facilities could operate.

1975—The first commercial use of the electronic tomato sorter. This was a second stage of the major mechanical innovation. A color sensitive electronic eye rejects green tomatoes and dirt and accepts ripe red ones.

Major structural changes in the industry accompanied these developments. We already mentioned the regional shifts in production that took place in the United States. The threat of adverse weather in other states at harvest almost precluded their adopting the harvester. Tomato farming in California became a much more capital-intensive operation, for along with harvesters was needed a package of other equipment such as direct seeders, power tillers, bulk bin carriers, thinning machines. With such an increased fixed investment, California farmers became tomato specialists. Production became concentrated among fewer farmers on larger acreages. While many farmers also grew other crops on their farms (sugar beets, wheat, cotton, alfalfa), their main cash crop was tomatoes. In contrast, farmers in other parts of the country treat tomatoes as a secondary cash crop.

Imports/Exports

The long-run competitiveness of California's important tomato processing industry no longer depends on its position relative to other regions in the United States. Now competition is intense in the international marketplace (Runsten and Moulton). California's advantage over other countries has mainly been in improvements in production technology, while Europeans have been more innovative in processing technology. Within the European Community, tomato products enjoy subsidies improving their competitve stance on the world market.

The large size of the U.S. market and increased consumer demand for tomato products encouraged import competition, but tomato product exports are also important. Table 14.2 summarizes exports and imports for selected years. While the total column is a bit like adding apples and oranges, particularly considering the weights of canned tomatoes and juice relative to the concentrated products, comparing the two columns gives some idea when the United States was a net importer of tomato products and when a net exporter. In physical quantity, exports have increased steadily since the mid-1980s, helped partly by a weakening dollar. Still, imports exceed the quantity exported these years.

Table 14.2. U.S. Processed Tomato Exports and Imports (1000 lbs.)

Imports	Paste	Sauce	Canned tomatoes	Total
1970	91,382	—	128,534	219,916
1975	26,881	—	68,914	95,796
1980	25,466	1,651	39,881	66,998
1985	111,400	33,586	220,028	365,014
1986	130,625	31,590	197,559	359,774
1987	101,274	17,201	178,587	297,062
1988	107,655	10,761	175,528	293,944
1989	228,400	24,221	111,590	364,211
1990	136,913	19,072	137,292	293,277
1991	104,840	23,680	114,840	243,360

Exports	Paste, puree	Sauce	Juice	Catsup/chili	Other	Total
1970	9,994	4,501	13,427	6,967	19,146	54,035
1975	22,176	6,142	32,828	15,014	25,259	101,419
1980	29,077	6,421	32,512	23,852	34,952	126,814
1985	17,089	4,723	11,984	18,082	15,939	67,817
1986	18,045	6,187	15,000	18,902	13,902	72,036
1987	22,946	6,479	13,272	23,450	8,040	74,187
1988	31,370	16,662	18,869	26,447	11,842	105,190
1989	41,535	58,781	12,818	25,782	9,124	148,040
1990	91,712	53,883	16,524	35,197	14,189	211,505
1991	98,700	63,400	6,300	35,200	17,600	221,200

Source: U.S. Economic Research Service.

Most canned tomato imports come from Italy, the leading tomato processor in Europe and the world's largest exporter of tomato products (Runsten and Moulton). Israel and Spain also export canned tomatoes. Imported tomato paste comes mainly from Portugal and, increasingly, from Mexico.

In the mid-1980s, Kirby Moulton and Leon Garoyan of the University of California Cooperative Extension studied the processing tomato industry in a number of countries, including Portugal, Israel, Taiwan, Turkey, Mexico, and Italy. Their work is summarized in Runsten and Moulton who report that much of the increased competition from imports and on the world market can be traced to technology transfer. One important vehicle has been rapid diffusion through multinational companies, e.g., Heinz in Portugal, Coca Cola in Turkey, Del Monte in Greece, and Japanese companies in Taiwan.

Throughout the world, California-developed varieties are being grown. Ironically, the firm tomato developed for the harvester does especially well in developing countries with weak infrastructure, such as rough roads or inadequate facilities that mean long waits before handling. And even though most tomatoes abroad are hand harvested, the new varieties have halved the number of passes needed through a field. Also, varieties developed for the arid San Joaquin Valley Westside do very well in places such as Israel and Turkey.

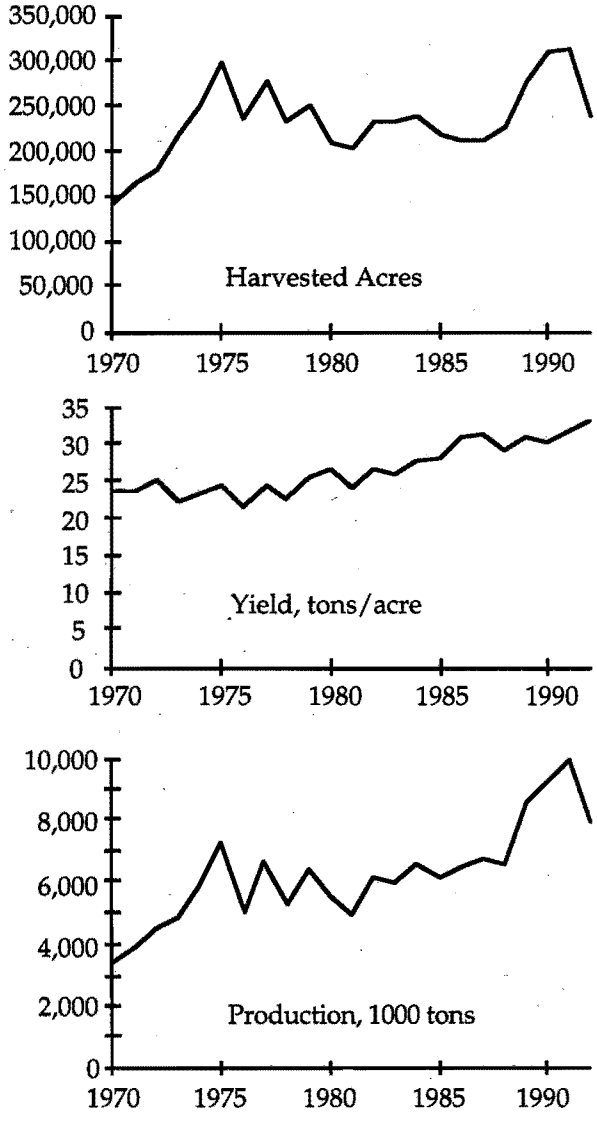
Some tomato-growing developing countries are strictly export oriented—that is, they grow mainly for export, using little product domestically. An important strategy for these countries is to service foreign debt by exporting value-added farm products, such as tomato paste. Tunisia, Thailand, and some Latin American countries have entered the processed tomato products industry (Runsten and Moulton).

Trends in Acreage, Yields, and Production in California

However, so far California is competing well with its processed tomato industry, and growers are responding by adding acreage (Figure 14; also, Appendix Table 14). Since 1988, harvested acreage increased from 226,100 to 310,000 acres in 1990. The San Joaquin Valley accounted for 47,600 acres of the increase; the Sacramento Valley, 28,050 acres. There was also a steep climb in acreage through the early 1970s from 141,300 harvested acres in 1970 to 299,200 in 1975. The San Joaquin Valley accounted for 80,590 acres of the increase, while the Sacramento Valley added 69,550 acres. Through the mid-1970s to the late 1980s, acreage was more stable.

Yield increases have slowed since the 1960s when the most dramatic technological changes were being adopted. The average yield over the 22 years is 26.3 tons/acre, with a slight upward trend of just over $\frac{1}{3}$ ton/year. The production trend follows the acreage trend, inflated slightly by improved yields.

Figure 14. California Processing Tomatoes, 1970-1992



Source: California Agricultural Statistics Service.

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APPENDIX

Statistical data for commodities included in this report.

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

1. Asparagus

	acres	cwt./acre	1000 cwt.
1970	42,900	31	1,330
1971	43,000	32	1,376
1972	45,700	34	1,554
1973	45,000	28	1,260
1974	44,100	29	1,279
1975	38,200	28	1,070
1976	33,900	37	1,254
1977	30,300	37	1,121
1978	28,000	28	784
1979	26,400	35	924
1980	27,900	28	781
1981	27,300	30	819
1982	29,600	27	799
1983	31,800	20	636
1984	34,200	25	855
1985	35,200	28	986
1986	37,800	29	1,096
1987	39,700	30	1,191
1988	40,100	29	1,163
1989	37,500	29	1,088
1990	35,900	29	1,041
1991	33,500	28	938
1992	34,000	29	986

2. Broccoli

Year	acres	cwt./acre	1000 cwt.
1970	34,100	82	2,786
1971	36,100	78	2,807
1972	40,800	79	3,240
1973	49,000	65	3,200
1974	45,600	81	3,693
1975	46,400	80	3,723
1976	50,400	82	4,133
1977	67,800	81	5,487
1978	64,400	80	5,158
1979	68,000	90	6,095
1980	72,600	88	6,424
1981	71,400	96	6,888
1982	81,800	97	7,940
1983	82,000	92	7,552
1984	95,700	99	9,440
1985	97,700	98	9,575
1986	106,400	98	10,427
1987	107,600	96	10,330
1988	101,100	115	11,626
1989	101,600	120	12,192
1990	97,500	115	11,213
1991	100,000	105	10,500
1992	104,000	105	10,920

3. Raspberries, 1978-1990

	acres	cwt./acre	1000 cwt.
1978	110	91	10
1979	110	91	10
1980	110	82	9
1981	140	64	9
1982	190	68	13
1983	260	69	18
1984	350	74	26
1985	500	84	42
1986	600	100	60
1987	1,000	82	82
1988	1,500	111	167
1989	1,400	104	145
1990	1,700	104	177

4. Carrots, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	24,100	307	7,408
1971	26,300	329	8,641
1972	30,000	336	10,073
1973	33,700	295	9,941
1974	34,300	335	11,506
1975	33,100	299	9,886
1976	33,000	281	9,287
1977	33,000	280	9,234
1978	35,400	255	9,016
1979	37,000	278	10,290
1980	36,600	284	10,385
1981	33,900	287	9,735
1982	35,900	319	11,446
1983	39,400	292	11,490
1984	41,300	291	12,011
1985	39,900	275	10,959
1986	40,500	315	12,758
1987	50,000	320	16,000
1988	51,100	285	14,564
1989	57,300	290	16,617
1990	56,100	310	17,391
1991	56,000	280	15,680
1992	60,000	280	16,800

5. Cauliflower, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	17,600	96	1,694
1971	18,800	100	1,880
1972	21,600	110	2,374
1973	24,600	91	2,235
1974	25,800	96	2,466
1975	25,000	91	2,286
1976	26,500	90	2,397
1977	30,000	98	2,944
1978	33,400	92	3,071
1979	33,700	95	3,187
1980	33,900	93	3,168
1981	36,300	109	3,940
1982	40,000	97	3,875
1983	41,900	95	3,965
1984	46,200	105	4,851
1985	45,600	105	4,788
1986	53,000	110	5,830
1987	51,100	110	5,621
1988	48,000	130	6,240
1989	52,500	115	6,038
1990	51,300	120	6,156
1991	50,000	110	5,500
1992	42,000	135	5,670

6. Celery, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	16,500	582	9,597
1971	17,500	556	9,736
1972	17,400	568	9,886
1973	18,600	569	10,576
1974	18,600	580	10,783
1975	18,150	581	10,542
1976	19,800	561	11,110
1977	20,400	580	11,828
1978	22,000	524	11,524
1979	21,100	544	11,488
1980	20,950	570	11,938
1981	22,500	578	13,004
1982	22,300	624	13,917
1983	20,400	617	12,580
1984	20,600	627	12,912
1985	21,200	624	13,223
1986	21,400	593	12,683
1987	21,300	595	12,671
1988	20,300	654	13,277
1989	21,800	670	14,612
1990	24,800	597	14,812
1991	21,700	668	14,489
1992	20,700	670	13,875

7. Sweet Corn, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	15,400	69	1,063
1971	14,300	58	835
1972	15,400	87	1,336
1973	15,200	70	1,065
1974	12,200	76	922
1975	13,900	78	1,087
1976	15,900	75	1,193
1977	14,800	75	1,105
1978	14,100	104	1,464
1979	13,100	107	1,384
1980	13,150	107	1,400
1981	13,900	108	1,501
1982	13,800	102	1,406
1983	14,600	108	1,576
1984	14,200	107	1,521
1985	14,700	105	1,544
1986	15,000	100	1,500
1987	16,000	95	1,520
1988	18,000	90	1,620
1989	17,500	115	2,013
1990	20,000	95	1,900
1991	18,500	110	2,035
1992	16,000	125	2,000

8. Lettuce, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	144,900	220	31,810
1971	134,300	241	32,300
1972	140,700	248	34,867
1973	143,400	246	35,310
1974	150,700	242	36,443
1975	156,500	250	39,139
1976	155,100	256	39,640
1977	159,700	263	42,026
1978	159,400	278	44,349
1979	160,500	278	44,673
1980	163,600	287	46,934
1981	156,300	294	46,027
1982	144,900	306	44,342
1983	142,200	293	41,689
1984	150,900	313	47,273
1985	145,500	295	42,923
1986	145,500	290	42,195
1987	157,100	315	49,487
1988	166,700	310	51,667
1989	168,400	340	57,256
1990	162,200	345	55,959
1991	152,000	345	52,440
1992	144,000	335	48,240

9. Cantaloupe Melons, 1970-1990

	acres	cwt./acre	1000 cwt.
1970	58,100	153	8914
1971	52,700	145	7659
1972	53,900	168	9037
1973	53,200	137	7308
1974	36,200	180	6501
1975	41,700	151	6306
1976	39,000	170	6626
1977	40,400	154	6236
1978	56,700	150	8484
1979	52,100	151	7865
1980	51,900	156	8084
1981	55,600	175	9730
1982	61,500	160	9840
1983	62,200	150	9330
1984	64,000	148	9483
1985	75,100	155	11641
1986	79,100	160	12656
1987	85,100	150	12765
1988	84,000	140	11760
1989	80,800	190	15352
1990	90,200	150	13530

10. Honeydew Melons, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	9,600	160	1,536
1971	8,700	175	1,523
1972	10,200	190	1,938
1973	10,300	182	1,878
1974	9,300	190	1,767
1975	9,300	208	1,931
1976	8,350	224	1,868
1977	9,110	208	1,896
1978	12,900	197	2,544
1979	12,500	193	2,413
1980	11,900	191	2,268
1981	13,300	180	2,394
1982	16,500	155	2,558
1983	15,500	185	2,868
1984	16,300	170	2,771
1985	18,500	185	3,423
1986	19,000	200	3,800
1987	20,600	180	3,708
1988	21,300	170	3,621
1989	21,300	190	4,047
1990	19,000	180	3,420
1991	17,000	155	2,635
1992	16,500	180	2,970

11. Mushrooms, 1972-1992

	acres	cwt./acre	1000 cwt.
1972	190	1,026	195
1973	220	1,114	245
1974	230	1,274	293
1975	270	1,256	339
1976	306	1,279	391
1977	342	1,292	442
1978	377	1,382	521
1979	478	1,628	778
1980	506	1,573	796
1981	550	1,516	834
1982	547	1,600	875
1983	546	1,637	894
1984	581	1,867	1,085
1985	578	1,965	1,136
1986	518	2,063	1,069
1987	495	2,242	1,110
1988	501	2,248	1,126
1989	529	2,440	1,291
1990	545	2,440	1,330
1991	567	2,307	1,309
1992	488	250	1,219

12. Onions, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	24,200	321	7,762
1971	26,500	326	8,650
1972	24,400	342	8,333
1973	28,200	280	7,896
1974	31,800	327	10,389
1975	31,600	341	10,767
1976	25,400	349	8,867
1977	30,200	345	10,420
1978	32,800	300	9,840
1979	35,300	323	11,408
1980	30,100	255	7,683
1981	28,300	325	9,185
1982	37,600	351	13,200
1983	35,000	324	11,125
1984	33,700	355	11,714
1985	32,800	389	12,263
1986	34,700	370	12,639
1987	37,200	351	12,683
1988	37,300	371	13,547
1989	34,700	381	13,005
1990	39,000	389	15,160
1991	36,600	379	14,410
1992	36,500	381	13,913

13. Strawberries, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	8,500	340	2,890
1971	8,300	365	3,030
1972	7,800	365	2,847
1973	8,100	395	3,200
1974	8,900	430	3,827
1975	10,000	380	3,800
1976	10,800	390	4,212
1977	11,600	450	5,220
1978	12,900	390	5,031
1979	11,500	410	4,715
1980	11,000	470	5,170
1981	10,900	495	5,396
1982	11,600	545	6,322
1983	13,000	480	6,242
1984	14,100	535	7,544
1985	14,600	530	7,738
1986	15,600	505	7,878
1987	17,500	470	8,225
1988	19,200	450	8,640
1989	20,400	425	8,670
1990	20,000	495	9,900
1991	21,100	520	10,972
1992	24,500	460	11,270

14. Fresh Tomatoes, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	35,700	190	6,777
1971	29,100	197	5,725
1972	30,800	220	6,786
1973	31,500	218	6,864
1974	28,700	242	6,932
1975	30,400	226	6,862
1976	29,400	227	6,661
1977	29,600	243	7,192
1978	30,800	245	7,535
1979	29,300	239	7,011
1980	30,500	253	7,703
1981	30,100	254	7,650
1982	28,700	249	7,154
1983	29,300	277	8,114
1984	27,900	267	7,452
1985	28,600	272	7,783
1986	28,600	278	7,938
1987	29,500	300	8,850
1988	37,500	245	9,188
1989	38,400	260	9,984
1990	38,000	255	9,690
1991	38,000	240	9,120
1992	37,000	240	8,880

15. Processing Tomatoes, 1970-1992

	acres	cwt./acre	1000 cwt.
1970	141,300	23.80	3,362,950
1971	163,700	23.70	3,879,700
1972	178,900	25.30	4,526,150
1973	218,000	22.30	4,861,400
1974	249,900	23.40	5,847,650
1975	299,200	24.30	7,270,550
1976	233,800	21.67	5,066,450
1977	276,400	24.13	6,669,550
1978	231,900	22.81	5,289,650
1979	250,000	25.40	6,350,000
1980	208,300	26.60	5,540,780
1981	204,300	24.00	4,903,200
1982	232,000	26.50	6,148,000
1983	233,500	25.58	5,972,930
1984	239,700	27.50	6,591,750
1985	217,000	28.12	6,102,040
1986	210,400	30.80	6,480,320
1987	214,000	31.32	6,702,480
1988	226,100	28.96	6,547,860
1989	276,500	31.05	8,585,330
1990	310,000	30.02	9,306,200
1991	312,000	31.71	9,893,520
1992	240,000	33.1	7,932,000