

**Strawberries: An Economic Assessment of the Feasibility
of Providing Multiple-Peril Crop Insurance**

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Contributors: Diane Bertelsen (202) 219-0887
Joy Harwood (202) 501-8554
Fred Hoff (202) 219-1288
Hyunok Lee (916) 752-3508
Agnes Perez (202) 501-6779
Susan Pollack (202) 219-0002
Agapi Somwaru (202) 219-0812
Glenn Zepp, coordinator (202) 501-7703

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Executive Summary

The U.S. is the world's leading producer and consumer of strawberries. While strawberries are grown in nearly all states, California dominates commercial production. Florida and Oregon rank a distant second and third in the amount of strawberries they produce. U.S. production reached a record-high in 1993 and another large crop is anticipated in 1994, continuing the upward trend that has about tripled output since 1970.

Strawberry prices follow a very distinct seasonal pattern, declining from December through May as the volume of berries increases, first from Florida and then from California. Prices rise gradually from June through September as the volume from California declines, and then rise sharply during October and November as the California season winds down. The relatively flat prices apparent from May through September reflect the value of California strawberries for processing.

The 1987 Census reported 9,398 farms with sales of strawberries. The largest number of strawberry farms was reported in Pennsylvania and California. These two states accounted for 18 percent of all farms with strawberries in that year. Florida, the second-largest strawberry producing state, accounted for only 2 percent of total farms in 1987, and Oregon, which ranked third in production, accounted for 5 percent. Many minor producing states, such as Pennsylvania, account for a fairly large share of farms with strawberry sales, but a small share of total output. For most states, the number of farms reporting strawberry sales declined between 1987 and 1992.

About 80 percent of the U.S. strawberry acreage reported in the 1987 Census was irrigated. All of California's acreage was irrigated, and nearly all of Florida's acreage. The extent of irrigation use was much more variable across the minor producing states.

Cultural practices for strawberries vary widely from one part of the country to another. Strawberries are usually grown as an annual crop in areas with mild winter temperatures, such as California and Florida. They are generally grown as a perennial crop in other areas, although there appears to be considerable experimentation with cultivation of strawberries as an annual crop in a number of southern, eastern, and midwestern states. The cultural practices are quite different for the two cropping systems.

With the annual production system, strawberries are transplanted into the field during the summer or fall, and are harvested during the following winter, spring, or summer. The plants are destroyed after the first harvest season and a new planting is established for subsequent crops.

When strawberries are grown as a perennial, "mother" plants are transplanted during the spring. Their first year in the field is primarily a period of multiplication during which the mother plants produce "runners" from which "daughter" plants grow. The plants then go through winter dormancy, and the first harvest occurs during the spring a year after planting. Plantings can be renovated after harvest and produce again the following spring. Usually, a planting is maintained for two or more harvest seasons.

The most serious perils in strawberry production include excessive heat and moisture during the harvesting period. Excessive heat during harvest results in soft berries and lowers fruit quality. When accompanied by moist conditions, excessive heat fosters the development of gray rot and other diseases on the fruit. Gray rot is the most serious rot in strawberries.

Other causes of yield losses include late spring frost, excessive cold during the winter, drought, hail, and numerous insects and diseases. The importance of these various perils depends on the variety, climate, and time of the growing season.

Insurance issues addressed in this report include: annual crop vs. perennial crop issues; the potential for moral hazard and adverse selection; the setting of reference prices; the availability of individual yield data; and potential methods for estimating appraised production.

Our assessment is that strawberries are not a particularly good candidate for multiple-peril crop insurance in the major producing areas. The reason is that growers in California, Florida, and the Pacific Northwest (Oregon and Washington), who together produce 95 percent of reported U.S. output, are not likely to be very interested in such insurance. Growers in California, for example, face fewer serious production perils than growers in other parts of the country. Further, the perils that California growers do face (mainly early spring frost and early fall rains) usually disrupt harvesting for only part of the picking season and are not likely to cause yield losses as large as 25 percent of average yield. Although excessive cold is a production peril in Florida, the bulk of Florida strawberries are protected from serious yield losses because of the widespread use of overhead irrigation and row covers.

The small amount of ad hoc disaster assistance paid to growers in California and Florida provides further evidence that there may not be very much demand for crop insurance. There were no payments made to growers in California for yield losses to strawberries between 1988 and 1993 and only \$320,522 (0.1 percent of the value of strawberry sales) to growers in Florida.

The greatest interest in strawberry insurance is likely to be among growers in southern, eastern, and midwestern states such as Illinois, Indiana, Michigan, Minnesota, New York, Pennsylvania, Tennessee, and Wisconsin. Most of the strawberries in these states are grown as a perennial crop using the matted-row system. Frequently, growers have inadequate protection against late spring frosts, extreme drought, and excessive rainfall. In addition, conditions of extreme heat and excessive moisture, which can result in losses exceeding 25 percent of average yields, are more likely to occur during the critical harvest period in these states than in California and Florida.

Notwithstanding potential grower interest, sales of strawberry insurance in the South, East, and Midwest would be severely limited by the small amount of production in these areas. Growers in these states generally have small strawberry acreages. Frequently, strawberries are grown near population centers, and rely on direct-market sales.

Strawberries: An Economic Assessment of the Feasibility of Providing Multiple-Peril Crop Insurance

Introduction

Strawberries belong to the genus *Fragaria* of the rose family (Rosaceae). The plant is a low-growing herb and reproduces by sending out runners or stolons from which new plants grow. The berry is an enlarged, fleshy receptacle with numerous achenes (small one-seeded fruits) at the surface. The achenes are actually the true fruits, each bearing one seed inside a thin, dry ovary wall.

When both fresh and processing uses are considered, strawberries were the fourth most valuable fruit grown in the United States in 1993, following grapes, apples, and oranges (USDA, NASS). Most strawberries are consumed fresh. Considering only fresh-market sales, strawberries ranked second in value only to apples.

This report examines those aspects of the U.S. strawberry industry that relate to the demand for crop insurance and the feasibility of developing a strawberry crop insurance policy.

The Strawberry Market

The United States is the world's leading producer and consumer of strawberries (FAO). While strawberries are grown in most states, California dominates commercial production. Florida and Oregon rank a distant second and third in the amount of strawberries that they produce. U.S. production reached a record-high in 1993 and another large crop is anticipated in 1994, continuing the upward trend that has about tripled output since 1970. Plentiful supplies and low prices raised fresh strawberry consumption from generally less than 2 pounds per person in the 1970's to about 3.5 pounds in the 1990's.

Supply

USDA reported 1.424 billion pounds of strawberry production in 1993, up 8 percent from the prior year and 14 percent above the 5-year (1988-92) average.¹ The growth in U.S. strawberry production is due mainly to growth in the California industry, which nearly doubled its output between 1982 and 1993 (Table 1). Florida's production increased moderately during this period, while output in many other states remained relatively unchanged or declined.

California accounted for about 80 percent of all U.S. strawberry production over the 1990-92 period, compared to just under 60 percent in 1970-72. At the

Official production statistics do not count all U.S. strawberry output, because USDA reports strawberry production for only 13 states. Some production in other states, consequently, goes uncounted in the reported statistics.

Table 1--U. S. strawberry harvested acreage, yield per acre, and production, 13 states, 1982-93

		Item		1982	1983	1984	1985	1986	1987	1988
1989	1990	1991	1992	1993						
-----Acres-----										
Harvested acreage:										
Arkansas		300	300	300	300	300	220	250	250	230
230	230	230								
California		11,600	13,000	14,100	14,600	15,600	17,500	19,200	20,400	21,000
21,100	24,000	25,000								
Florida		5,000	5,400	5,100	5,300	4,900	4,900	5,000	5,300	5,300
5,500	4,700	5,100								
Louisiana		650	600	600	550	550	600	700	650	750
850	1,000	1,100								
Michigan		2,700	2,700	2,700	2,500	2,400	2,400	2,300	2,200	2,200
2,100	2,000	1,900								
New Jersey		1,000	1,000	1,000	1,100	900	800	700	600	500
500	500	500								
New York		2,800	3,000	3,000	3,300	3,300	2,800	2,500	2,400	2,700
3,400	3,600	3,800								
North Carolina		2,100	2,200	2,100	2,100	2,100	2,100	2,100	2,100	2,100
2,200	2,300	2,400								
Ohio		1,900	1,900	1,600	1,700	1,500	1,400	1,300	1,200	1,100
1,000	1,000	1,100								
Oregon		5,800	6,900	6,600	6,800	7,300	7,800	7,800	6,200	5,700
5,600	6,100	6,200								
Pennsylvania		1,800	1,800	1,700	1,700	1,800	1,900	1,900	1,800	1,700
1,600	1,500	1,500								
Washington		3,000	3,100	3,000	3,000	2,800	2,500	2,400	1,900	1,800
1,400	1,600	1,600								
Wisconsin		1,600	1,500	1,500	1,400	1,300	1,200	1,000	1,100	1,100
1,200	1,100	1,100								
U. S. Total		40,250	43,400	43,300	44,350	44,750	46,120	47,150	46,100	46,180
46,680	49,630	51,530								
-----1,000 pounds-----										
Yield per acre:										
Arkansas		6.7	5.0	5.7	5.7	6.0	5.0	4.6	3.5	2.4
3.5	2.4	3.0								
California		54.5	48.0	53.5	53.0	50.5	47.0	45.0	42.5	47.0
52.0	43.0	45.5								
Florida		19.5	19.0	17.0	20.0	18.5	22.5	25.0	26.0	22.0
24.0	30.0	27.0								
Louisiana		6.0	7.0	6.2	5.5	6.2	7.2	7.5	6.2	7.8
6.5	12.0	10.0								
Michigan		8.0	6.0	7.0	6.5	6.0	6.0	5.5	5.3	6.5
6.2	6.6	6.0								
New Jersey		4.9	5.0	5.0	5.5	4.2	5.3	4.6	3.0	4.2
3.8	5.0	3.5								
New York		4.5	4.5	5.1	5.1	5.5	5.7	4.8	5.6	6.3
5.6	3.0	6.0								
North Carolina		2.6	4.0	3.6	3.2	3.5	3.8	6.0	4.2	6.0
5.5	5.5	4.5								

Ohio	6.6	5.0	4.8	5.4	3.8	5.2	5.6	4.6	6.5
5.3 7.1	5.3								
Oregon	10.0	11.5	9.2	7.4	8.7	12.0	13.0	10.5	11.5
11.0 10.0	10.0								
Pennsylvania	4.2	4.0	3.0	3.0	3.4	3.8	4.3	4.7	4.3
3.8 3.9	3.6								
Washington	6.2	6.2	7.0	7.1	5.0	9.6	9.2	6.0	7.0
6.0 7.0	7.0								
Wisconsin	3.8	3.8	3.9	3.9	4.9	3.7	4.1	5.5	5.0
5.0 4.9	5.2								
U. S. Total	21.9	20.7	22.9	23.0	22.9	24.2	25.0	24.8	27.2
29.3 26.5	27.6								

-----Million pounds-----

Production:

Arkansas	2	2	2	2	2	1	1	1	1
1 1	1								
California	632	624	754	774	788	823	864	867	987
1,097 1,032	1,138								
Florida	98	103	87	106	91	110	125	138	117
132 141	138								
Louisiana	4	4	4	3	3	4	5	4	6
6 12	11								
Michigan	22	16	19	16	14	14	13	12	14
13 13	11								
New Jersey	5	5	5	6	4	4	3	2	2
2 3	2								
New York	13	14	15	17	18	16	12	13	17
19 11	23								
North Carolina	6	9	8	7	7	8	13	9	13
12 13	11								
Ohio	13	10	8	9	6	7	7	6	7
5 7	6								
Oregon	58	79	61	50	64	94	101	65	66
62 61	62								
Pennsylvania	8	7	5	5	6	7	8	9	7
6 6	5								
Washington	19	19	21	21	14	24	22	11	13
8 11	11								
Wisconsin	6	6	6	6	6	4	4	6	6
6 5	6								
U. S. Total	883	897	994	1,022	1,023	1,117	1,179	1,142	1,254
1,369 1,315	1,424								

Source: USDA, NASS.

same time, Florida's share of U.S. strawberry production rose from 4 to 10 percent, while Oregon's share fell from 14 percent to 5 percent.

The United States imported about 3 percent of its total fresh strawberry supply in 1993, mostly from Mexico (Table 2). About 9 percent of the U.S. frozen strawberry supply was imported in 1993, again mostly from Mexico (Table 3).²

Demand

Per capita use of fresh strawberries is increasing, while the use of frozen (processed) berries is relatively flat. Americans, today, eat about 3.5 pounds of strawberries each year in their fresh form and an additional 1.5 pounds in processed products (Tables 2 and 3).

The increase in consumption is likely due to the increased availability of strawberries. At one time a seasonal specialty item, strawberries are becoming a year-round product. Today, both restaurant salad bars and grocery store produce departments carry strawberries virtually year round. The increased availability is due to the development and adoption of varieties and production systems, primarily in California, that have extended the marketing season for fresh strawberries later into the summer and fall (see "California" section).

The United States exported 10 percent of both its fresh and processed strawberry production in 1993. Canada was the major foreign market, receiving 80 percent of U.S. fresh strawberry exports between 1989 and 1993. Japan and Mexico are other important destination for U.S. fresh strawberries.

Japan received about two-thirds of U.S. frozen strawberry exports over the last 5 years, while Canada was the destination for about 20 percent. Japan does not produce many frozen strawberries, so imports supply the food manufacturing sector with strawberries in that country.

Prices

There is considerable variability in fresh strawberry prices within the year, due mostly to seasonal changes in volume. Prices bottom out at about 40 cent a pound during May and June, when the coastal areas of California reach peak output. Prices usually crest at more than \$1.00 a pound during the fall, when California output declines to a minimum and Florida's production has not yet reached any substantial volume (Table 4).

Strawberry prices follow a very distinct seasonal pattern, declining from December through May as the volume of berries increases, first from Florida and then from California. Prices rise gradually from June through September

Most strawberries for processing are frozen before being processed into a final product. The quantity of frozen strawberries, consequently, is used as a proxy for the quantity of processed berries.

Table 2-- U.S. supply and utilization of fresh-market strawberries, 1970-93

Year	Utilized production	Imports	Total supply	Exports	-----Consumption-----	
					Total	Per capita
----- Million pounds -----					Pounds	
1970	316.4	51.1	368	11.8	356	1.73
1971	340.4	51.3	392	11.6	380	1.83
1972	321.1	43.2	364	14.5	350	1.67
1973	316.4	38.9	355	20.4	335	1.58
1974	368.0	43.7	412	21.0	391	1.83
1975	370.0	34.6	405	16.4	388	1.80
1976	360.1	21.6	382	20.6	361	1.66
1977	418.8	24.7	444	22.3	421	1.91
1978	477.9	33.7	512	39.2	472	2.12
1979	436.0	31.0	467	39.0	428	1.90
1980	482.1	12.7	495	47.1	448	1.97
1981	537.5	6.7	544	44.4	500	2.17
1982	589.6	4.5	594	44.0	550	2.37
1983	585.4	5.1	591	46.4	544	2.32
1984	748.2	8.8	757	56.3	701	2.96
1985	754.1	9.6	764	51.5	712	2.99
1986	734.8	13.0	748	51.5	696	2.89
1987	780.4	33.2	814	57.1	756	3.12
1988	855.5	39.4	895	78.0	817	3.33
1989	861.6	36.0	898	93.0	805	3.25
1990	864.2	32.2	896	85.7	811	3.24
1991	971.5	31.5	1,003	95.2	908	3.59
1992	980.3	23.8	1,004	102.3	902	3.53
1993	987.6	31.4	1,019	102.1	917	3.55

Source: USDA, ERS.

Table 3--U.S. supply and utilization of frozen strawberries, 1970-93

Year Total	Industry	Imports	Beginning	Total	Ending	Exports
	Consumption----- pack 1/ Per capita		stocks		stocks 2/	
----- Million pounds -----						
	Pounds					
1970	201.6	109.7	127.8	439.1	166.2	1.3
271.6	1.32					
1971	199.4	84.6	166.2	450.2	151.9	1.6
296.7	1.43					
1972	146.8	85.2	151.9	383.9	104.4	2.2
277.3	1.32					
1973	168.6	113.7	104.4	386.7	120.8	4.3
261.6	1.23					
1974	170.4	117.1	120.8	408.3	148.2	5.4
254.7	1.19					
1975	183.9	97.5	148.2	429.6	124.3	8.0
297.3	1.38					
1976	216.2	49.6	124.3	390.1	104.0	15.8
270.3	1.24					
1977	220.4	97.0	104.0	421.4	153.1	8.2
260.1	1.18					
1978	159.8	97.6	153.1	410.5	108.7	9.5
292.3	1.31					
1979	190.6	112.1	108.7	411.4	132.5	5.2
273.7	1.22					
1980	253.1	83.5	132.5	469.1	151.9	4.4
312.8	1.37					
1981	210.6	60.1	151.9	422.6	115.2	6.6
300.8	1.31					

1982	272.7	34.9	115.2	422.8	139.9	7.1
275.8	1.19					
1983	292.7	42.6	139.9	475.2	176.6	5.9
292.7	1.25					
1984	231.4	50.9	176.6	458.9	166.0	8.0
284.9	1.21					
1985	229.2	59.7	166.0	454.9	167.1	6.6
281.2	1.18					
1986	237.6	52.5	167.1	457.2	146.6	8.5
302.1	1.26					
1987	334.4	75.3	146.6	556.3	236.0	10.8
309.5	1.27					
1988	274.6	64.3	236.0	574.9	235.2	17.8
321.9	1.31					
1989	238.2	55.0	235.2	528.4	167.2	20.5
340.7	1.38					
1990	305.9	72.1	167.2	545.2	198.3	32.8
314.1	1.26					
1991	330.2	70.5	198.3	599.0	219.9	26.1
353.0	1.40					
1992	268.5	58.2	219.9	546.6	173.8	30.0
342.8	1.34					
1993	424.1	56.6	173.8	654.5	214.3	40.4
399.8	1.55					

1/ From The American Frozen Food Institute, "Pack Statistics".

2/ From National Agricultural Statistics Service, USDA "Cold Storage" reports, December 31 stocks.

Source: USDA, ERS

Table 4--Strawberries: U.S. f.o.b. prices, monthly averages, 1989-93

Month	1989	1990	1991	1992	1993
-----Cents per pound-----					
January	83.0	115.0	93.0	110.0	98.9
February	93.8	83.1	91.0	79.9	93.6
March	68.2	73.9	63.0	69.6	62.0
April	44.8	50.3	59.5	49.1	54.2
May	35.0	35.2	50.0	41.3	49.7
June	55.9	46.9	36.5	64.3	57.1
July	31.1	40.7	46.5	49.8	43.3
August	35.0	50.0	35.0	89.2	60.7
September	65.0	55.0	35.0	61.1	63.7
October	95.0	75.0	55.0	70.7	74.6
November	165.0	96.3	110.0	116.0	98.2
December	116.0	89.8	95.0	133.0	128.0

Source: USDA, NASS.

as the volume from California declines, and then rise sharply during October and November as the California season winds down. The relatively flat prices apparent from May through September reflect the value of California strawberries for processing. When there is a glut of fresh-market berries and net returns decline to the value of berries in processing, growers divert supplies from the fresh market to processing.

Prices for processing berries in California are substantially lower than in Oregon and Washington. Freezer berry prices averaged 23-26 cents a pound in California between 1988 and 1993, while in Oregon, prices ranged from 29 to 50 cents a pound. In California, most of the berries used for processing are ones intended for the fresh market, but that are instead diverted to processing. They do not generally have the deep red color and superior taste of berries from the Pacific Northwest.

In Oregon and Washington, strawberries are grown specifically for processing and contribute superior quality and flavor to processed products. Consequently, processors pay a premium price for processing berries grown in the Northwest which they blend with the cheaper berries from California.

Industry Characteristics

Aspects of the strawberry industry which have significance in assessing the demand for crop insurance include:

- ! Widespread use of irrigation in the major strawberry producing states that reduces the risk of drought;
- ! A relatively high degree of specialization in strawberries on California and Florida farms, which limits income diversification among enterprises;
- ! In other states, a greater degree of income diversification among strawberries and other farm enterprises, as well as substantial off-farm employment.

The primary sources of available information on farms producing strawberries are the 1987 and 1992 Censuses of Agriculture, and USDA's 1992 Vegetable Chemical Use Survey.³

Farms with Strawberries

The 1987 Census reported 9,398 farms with sales of strawberries. The largest number of strawberry farms was reported in Pennsylvania (882) and California (831), the first-ranked producing state. Together, these two states accounted

Results for the 1992 Census of Agriculture were not available for all states at the time this report was prepared. States for which data were not available include California, Louisiana, Minnesota, and North Carolina.

for 18 percent of all farms with strawberries in that year (Appendix table 1). Florida, the second-largest strawberry producing state, accounted for only 2 percent of total farms in 1987, and Oregon, which ranked third in production, accounted for 5 percent. Many minor producing states, such as Pennsylvania, account for a fairly large share of farms with strawberry sales, but a small share of total output.

For most states, the number of farms reporting strawberry sales declined between 1987 and 1992. For example, the number of farms in Pennsylvania with strawberry sales declined from 882 to 813 over that period, while the number of Oregon farms declined from 487 to 391. Of those states with data currently available, the only increases in farm numbers were registered in Florida and Wisconsin.

About 80 percent of the U.S. strawberry acreage reported in the 1987 Census was irrigated. All of California's acreage was irrigated, and nearly all of Florida's acreage. The extent of irrigation use was much more variable across more minor producing states.

About 65 percent of farms with strawberry sales had total crop sales of less than \$25,000 in 1987 (Appendix table 2). Farms in California, Florida, and Oregon, however, had a more evenly dispersed distribution among the various sales categories than in other states. In California and Oregon, about a third of the farms that produced strawberries had sales of \$100,000 or more and another third had sales of less than \$25,000. Florida had the greatest percentage of large farms, with half having sales of \$100,000 or more.

Farms growing strawberries are overwhelmingly individual- or family-owned operations. Eighty-three percent were individual- or family-owned in 1987 (Appendix table 3). Partnerships were the next largest ownership category, accounting for 10 percent of all farms with strawberries.

Farming was reported as the operator's main occupation for 63 percent of strawberry-producing farms (Appendix table 4). However, 39 percent of the operators reported working 100 days or more off the farm. In Illinois and Indiana, about one-half the farms had operators who worked 100 days or more off the farm. Most of these farms reported sales of less than \$25,000.

Income Diversification on Farms with Strawberries

Farms in Florida and California tend to be more specialized in strawberries than in other states. In these two states, strawberries account for a larger share of total farm sales than in other states (Table 5). In most other states for which data are available, strawberries rank after vegetables and melons as a source of income.

USDA's Vegetable Chemical Use Survey, reflecting 1992 data, also offers an indicator of diversification. The survey results indicate that New York and New Jersey strawberries accounted for less than 10 percent of the vegetable acreage on sample farms in those states (Table 6). In contrast, strawberries

Table 5-- Market value of sales on farms producing strawberries, selected states, 1987

State	All Products	All Crops	Vegetables & melons	Strawberries	Strawberries, % of all products
	-----1,000 dollars-----				Percent
Arkansas	3,785	1,852	977	528	14
California	433,785	432,258	350,973	407,251	94
Florida	63,238	61,544	27,127	67,062	106 ¹
Michigan	45,117	43,330	18,352	6,785	15
New Jersey	14,184	13,935	3,407	2,856	20
New York	52,847	47,177	17,849	9,104	17
North Carolina	18,426	14,693	2,655	3,992	22
Ohio	31,360	26,936	10,582	4,453	14
Oregon	80,849	79,357	40,929	31,520	39
Pennsylvania	64,451	41,614	17,932	5,947	9
Washington	30,387	28,847	16,076	8,180	27
Wisconsin	14,260	11,397	3,544	2,508	18
12 states	852,689	802,940	510,403	550,186	65

¹ The NASS estimate of strawberry sales for Florida exceeds the Census estimate of all product sales. There is no apparent reason for this discrepancy.

Sources: All data are from the 1987 Census of Agriculture, except for strawberry sales, which are from USDA, NASS, *Vegetables*.

Table 6--Enterprise diversification on farms growing strawberries, 1992

State	Farms sampled	Farms growing both strawberries and other vegetables	Strawberries, percent of total vegetable acreage
	---Number---	---Percent---	---Percent---
California	69	45	62
Florida	44	86	45
Michigan	58	27	12
New Jersey	85	23	7
New York	78	27	9
North Carolina	54	64	58
Oregon	66	49	24
Washington	41	79	32
Wisconsin	54	87	33

Source: USDA, *Vegetable Chemical Use Survey*, 1992.

accounted for 62 percent of total vegetable acreage on California farms that responded to the survey.

Among the farms that responded to the Chemical Use Survey as growing other vegetables, a large percentage produced vegetables that are already eligible for crop insurance. However, crop insurance may not be offered for all of these vegetables in all states or in all areas of a given state (Table 7).

Cultivation and Management Practices

Cultural practices for strawberries vary from one part of the country to another because management systems are adapted to the unique climate in each area. Commercially, strawberries are usually grown as an annual crop in areas with mild winter temperatures, such as California and Florida. They are generally grown as a perennial crop in other areas, although there appears to be considerable experimentation with cultivation of strawberries as an annual crop in a number of southern, eastern, and midwestern states.⁴ The cultural practices are quite different for the two cropping systems.

With the annual production system, strawberries are transplanted into the field during the summer or fall, and are harvested during the following winter, spring, or summer. The plants are destroyed after the first harvest season and a new planting is established for subsequent crops.

When strawberries are grown as a perennial, "mother" plants are transplanted into the field during the spring. Their first year in the field is primarily a period of vegetative growth and multiplication during which the mother plants reproduce asexually by sending out "stolons" or "runners" from which "daughter" plants grow. The plants then go through a period of winter dormancy and the first harvest occurs during the spring a year after planting. Plantings can be renovated following harvest and produce again the following spring. Usually, a planting is maintained for two or more harvest seasons.

Climate

Strawberries are grown in a wide range of climates. Different strawberry varieties can produce successfully from southern Florida to as far north as Maine and Minnesota. Strawberries are subject to cold damage, however, as unprotected crowns (the plant's compressed stem, from which all primary roots, leaves, flowers, and runners arise) may be killed at temperatures of 10° F or less (Galletta and Himelrick). Spring frosts also can damage strawberries, killing unprotected fruit buds and destroying immature and unharvested fruit.

High temperatures during the fruiting period tend to drive plants toward their asexual growth cycles, and significantly reduce later fruit production. In addition, temperatures above 85° F can prevent flower bud formation.

In North Carolina, as much as a third of the acreage may be grown as an annual crop.

Table 7--Selected specialty crops on farms producing strawberries, 1992

State	Farms sampled	Farms growing				
		Onions	---Sweet Corn---		----Tomatoes----	
			Fresh	Processed	Fresh	Processed
	Number	-----Percent-----				
California	69	12	23	16	26	0
Florida	44	0	14	20	18	0
Michigan	58	7	52	33	48	0
New Jersey	85	0	54	51	72	0
New York	78	9	74	37	69	0
North Carolina	54	0	43	11	25	0
Oregon	66	12	29	17	0	0
Washington	41	0	24	22	0	0
Wisconsin	54	9	35	9	0	0

Source: USDA, *Vegetable Chemical Use Survey*, 1992.

Soil Requirements

Although strawberries can be grown successfully on a wide range of soil types, the best growth and yield is attained on deep, fertile, well-drained, slightly acid (pH range of 5.0-7.0,) sandy loam soils. Sandy loams are ideal for strawberries because they respond better to soil fumigation, compact less under the stress of frequent harvesting and irrigation, accumulate less salt over the life of the planting, and exhibit fewer minor element problems compared with other soil types (Welch, et al.). Soils high in salts should be avoided because strawberries are one of the most salt-sensitive crops.

A soil depth of 12 to 36 inches or more is preferred because of better root penetration than on shallower soils. Strawberries will not grow well on soils shallower than 8 inches (Galletta and Himelrick). Strawberries need an abundant supply of moisture, but the plants may be weakened or killed by root diseases in excessively wet or waterlogged fields.

Sites

Fields with a gentle slope and higher elevation than surrounding areas are the best sites for growing strawberries because they provide better water drainage and air movement than flat areas at lower elevations. Cold air settles to low areas, increasing the risk of spring frost damage to blossoms and unharvested fruit. Strawberries grown on southern slopes may ripen sooner in the spring than those produced on northern slopes because the soils on southern slopes usually warm sooner. Yields, however, may be larger from plantings with a northern slope because such sites generally remain cool for a longer period and provide more uniform moisture.

Low fields of any soil type should be avoided when selecting a site because they have a greater chance of losses from frost, accumulating water, and disease organisms than sloping fields at higher elevations. Areas that are surrounded by trees or buildings also may not be suitable for strawberries because they may have poor air movement. Diseases may be more serious in such places because of increased dampness.

Varieties

Strawberries are generally categorized as short-day, everbearing, and day-neutral varieties. These categories are based on the effects of daylight length on flower bud development.

Short-day, or June-bearing, strawberries form fruit buds when day length is less than 12 daylight hours. These varieties produce one fruit crop per season. The plant's response to day length does not influence when the plant blooms, but only when the flower buds form. Flower bud formation on June-bearing varieties occurs during the short days of late September through early November, and may continue during warm days in early March.

Everbearing or long-day plants, in contrast, form flower buds when days exceed 12 hours of light. They produce two main crops per season, but yields are

less than a single crop from a June-bearing variety. Everbearing varieties usually are not grown on a commercial scale because of poor productivity and berry quality.

Day-neutral varieties form flower buds regardless of the length of the daily light period. They produce fruit from spring through fall. Table 8 lists some of the recommended varieties for several of the major strawberry growing areas.

Planting

Strawberry plants may be transplanted by hand or by mechanical transplanters. A skilled crew can machine set 3 to 5 acres a day. The usual planting and harvesting dates for strawberries are summarized in Table 9.

The recommended time for planting in northern climates (the Northeast and Midwest) is during April, or as soon as the soil is dry enough to work (Goulart, Tomkins, et al.). Planting after June 1 is not recommended because the plants do not have time to become established and send out runners bearing daughter plants before cold weather. In addition, plants may die due to the lack of an established root system during dry, hot summers if planting occurs after June 1.

Two planting systems, summer and winter, are used in California's commercial strawberry production. In the summer planting system, strawberries are planted during mid- to late-summer, using transplants dug the previous winter and held in cold storage at 28° F. Transplants used for summer planting are grown in nurseries located in low-elevation areas (such as in the Sacramento and San Joaquin Valleys). They are dug while dormant between late December and early February and placed in cold storage for 6-8 months before being transplanted.

Summer plantings are common in the San Joaquin Valley and, to a lesser extent, in the central coastal area. The summer planting system tends to provide higher yields than the winter planting system described in the following paragraphs. However, fruit production is generally earlier in the season under the winter planting system.

With the winter planting system in California, transplanting takes place from mid-October to early November, using current-season plants shortly after they are dug from high-elevation nurseries located in the intermountain valleys of northern California. The plants are placed in cold storage for 1 to 3 weeks before being transplanted for the winter growing season.

Winter planting may be considered a "forcing" system because plants flower and fruit without going through a complete chilling period. When incomplete winter chilling is followed by cool summer growing temperatures, as in the central coast of California, a prolonged fruiting period results. The success of winter planting, however, depends upon active plant growth during winter, which is directly related to mild temperatures.

Table 8--Recommended strawberry varieties in selected production States

State	Variety	Characteristics/Limitations
California	Chandler	Short-day, winter-planted in southern California, summer and winter-planted in central California, nursery plants that were insufficiently chilled usually have low vigor and produce small, soft fruits with reduced shelf life, more than two weeks of cold storage as well as very hot temperatures during fruiting season stimulates excessive growth but with substantially reduced yields.
	Pajaro	Short-day, summer-planted, low yields if winter-planted, insufficient chilling renders the plant weak and produces small, soft fruits with reduced shelf life, susceptible to damage from rain, very hot temperatures during fruiting season stimulates asexual growth and significantly reduces later fruit production.
	Douglas	Short-day, fall-planted, very early production if winter-planted, produce soft fruits under warm weather conditions, occasionally produce albino fruits (coloring problem) given a heavy fruit load and poor conditions for photosynthesis.
	Selva	Day-neutral, winter- and summer-planted in central coastal counties, low tolerance to two-spotted red spider mite especially when chilling treatments were not done properly to stimulate vigor.
	Oso Grande	Short-day, winter-planted preferred, suited to warmer climates, potential defects are albino and split fruit.
Oregon	Totem	June bearer, mid-season, suited to northwest climate.
	Sumas	June bearer, early- to mid-season.
	Hood	June bearer, early- to mid-season, resistant to powdery mildew, foliage diseases, red stele but susceptible to virus.
	Ranier	June bearer, late-season, fruit ripens late and difficult to cap.
	Shuksan	June bearer, mid-season.
	Selva	Day-neutral.
	Tristar	Day-neutral.
Florida	Selva	Day-neutral, peak production in November-December, susceptible to anthracnose.
	Oso Grande	Late season, suited to warmer climates, peak production in March-April.
	Sweet Charlie	Early season, developed for Florida conditions (hot, humid southern climates), best yields in January-February.
	Douglas	Very susceptible to anthracnose.
	Pajaro	Susceptible to water damage and very susceptible to anthracnose.

Table 8--Recommended strawberry varieties in selected production States, continued

Pennsylvania	Earliglow	June bearer, early season, only partially resistant to powdery mildew.
	Honeoye	June bearer, early mid-season, susceptible to red stele and verticillium wilt, soft fruits in hot weather.
	Raritan	June bearer, mid-season, susceptible to verticillium wilt, red stele, and leaf diseases.
	Guardian	June bearer, mid-season, Susceptible to powdery mildew and Sinbar injury, tends to get a "long neck", which breaks down and serves as an entry for slugs and sap beetles.
	Red Chief	June bearer, mid-season, excellent disease resistant but partially resistant only to Verticillium wilt.
New York	Earliglow	Recommended early season, resistant to red stele and verticillium wilt root rots.
	Honeoye	Tends to have mid-early maturity, most consistent high-yielding cultivar for the northern States, very good winter hardiness.
	Raritan	Early-mid season, yields less consistent than for Honeoye.
	Red Chief	Mid-season, resistant to red stele.
	Guardian	Mid-season, resistant to red stele and verticillium wilt, has only moderate plant vigor and moderate runner production, moderately susceptible to leaf spot.
	Midway	Resistant to some races of red stele, susceptible to leaf spot, leaf scorch, and verticillium wilt, not as resistant to drought.
	Fletcher	Late-maturing, average in overall performance.
Tennessee	Earliglow	June-bearer, early season, susceptible to anthracnose and to some extent to powdery mildew, fruit seems to resist decay during wet weather.
	Cardinal	June-bearer, mid-season, susceptible to red stele, verticillium wilt, and anthracnose, resistance to powdery mildew is unknown, requires heavy renovation.
	Red Chief	June-bearer, mid-season, susceptible to anthracnose, Performs better in higher elevations because foliage has tendency to roll at lower elevations.
	Allstar	June-bearer, mid-season, susceptible to anthracnose, may require heavy renovation.

Table 8--Recommended strawberry varieties in selected production States, continued

Midwest	Midway	June bearer, produce runners freely, resistant to some races of red stele, susceptible to leaf spots, leaf scorch, and verticillium wilt, not as resistant to drought as some varieties,
	Red chief	June bearer
	Earliglow	June bearer
	Surecrop	June bearer, resistant to several races of red stele, to verticillium wilt, leaf spots, leaf scorch, and drought.
	Tribute	Day-neutral, resistant to red stele and powdery mildew, tolerant to leaf diseases, and partially resistant to verticillium wilt.
	Tristar	Day-neutral, resistant to verticillium wilt, red stele, and powdery mildew, and tolerant to leaf diseases.

Sources: Chandler et. al.; Goulart; Hochmuth; Poling; Rutledge and Johnson; Seelig; Strik; Tomkins et. al.; Welch, et al.; Welch, et al.

Table 9--Usual planting and harvesting dates for strawberries

State	Planting date	-----Usual harvest date-----			
		Begin	Most active	End	
<u>Fall/</u>	:				
<u>Winter--</u>	:				
	:				
California	:	See Table in "California" section.			
	:				
Florida	:	Oct. 1-Nov. 15	Dec. 15	Feb. 1-Mar. 31	May 15
	:				
<u>Spring/</u>	:				
<u>Summer--</u>	:				
	:				
Arkansas	:	Feb. 1-Mar. 31	May 1	May 5-May 31	Jun. 10
	:				
California	:	See Table in "California" section.			
	:				
Louisiana	:	Oct. 15-Dec. 31	Mar. 25	Apr. 1-May 10	May 20
	:				
Michigan	:	Apr. 1-May 15	Jun. 1	Jun. 10-Jul. 5	Jul. 25
	:				
New Jersey	:	Mar. 15-May 5	May 20	Jun. 1-Jun. 25	Jun. 30
	:				
New York	:	Apr. 15-May 31	Jun. 1	Jun. 10-Jun 25	Jul. 10
	:				
N. Carolina	:	Oct. 1-Mar. 31	Apr. 10	Apr. 20-May 20	Jun. 10
	:				
Ohio	:	Mar. 15-May 15	May 1	Jun. 1-Jun. 20	Jul. 5
	:				
Oregon	:	Apr. 15-May 31	May 15	Jun 5-Jul. 25	Jul. 30
	:				
Pennsylv- ania	:	Apr. 1-May 30	May 25	Jun. 1.-Jun. 30	Jul. 10
	:				
Washington	:	Apr. 10-May 15	Jun. 10	Jun. 25-Jul. 5	Jul. 20
	:				
Wisconsin	:	Apr. 15-May 15	Jun. 10	Jun. 15-Jul. 15	Jul. 31
	:				

Source: USDA, Statistical Reporting Service.

Note: Dates reported in this table may differ slightly from those reported in the "State Analyses" section. Dates in that section largely reflect personal communication with extension specialists and may be more location-specific than the dates in this table.

In California, winter planting is confined to coastal and semi-coastal sites that have relatively warm winters. It is the dominant system in southern California, where early fruit production is of primary economic importance. An added advantage of winter planting is that the land is tied up for a shorter period of time between planting and the onset of harvesting than is the case for the summer planting system.

Fall planting is the prevalent system in Florida. Recommended planting dates range from September 20-November 10 for north Florida to October 1-December 1 for south Florida (Hochmuth).

Strawberries may be planted during the fall, winter, or spring in the mid-South, depending on elevation and the severity of the winter. At low elevations in North Carolina, for example, plants may be set during late fall, winter, and early spring (Shoemaker). At elevations in the mountains, however, spring planting is best. The Agricultural Extension Service recommends spring planting (March and April) in Tennessee (Rutledge and Johnson).

Plasticulture

The annual cropping system of planting on raised beds covered with plastic is referred to in the horticultural industry as "plasticulture" (Poling). Plasticulture is widely used in growing strawberries in California, Florida, North Carolina, and to a smaller extent, in other southern, eastern, and midwestern states. Under this system, the strawberries are planted in the fall and harvested the following spring. The system consists of transplanting freshly dug (green) or container grown (plug) plants at 6- to 9-inch spacings, usually in double rows, on raised beds covered with black plastic (Poling).

A drip irrigation system is usually installed beneath the plastic cover and may be used jointly with a sprinkler (overhead) irrigation system. The drip irrigation system allows producers to "fertigate"--that is, to apply plant nutrients with irrigation water. The overhead irrigation system provides frost protection. Plants and plastic are removed after spring harvest and the process begins again.

There are several advantages associated with plasticulture. This cultivation method produces uniform plant stands that are generally unaffected by summer diseases, drought, or weed competition. It results in earlier and easier harvests, and larger berry sizes. In addition, plasticulture results in a shorter turnaround time (seven months) from planting to harvest.

A disadvantage of the system is that it requires a higher initial cost. Further, fruit can only be harvested one season before the planting is renewed.

Training Systems

When a system other than plasticulture is used, there are several methods of "training" daughter (runner) plants. Most commercial strawberry operations in

the East and Midwest use June-bearing strawberry plants grown in a **matted-row system**. In this system, plants are initially spaced 18-24 inches apart in the row, and the runner plants are kept within a 12-inch width in each row by cultivation or hand placing. The distance between row centers is 36 to 44 inches.

In some areas, a **ribbon-row system** has also been successful. Under this system, plants are spaced 3-6 inches apart on 10-12 inch raised beds. Runners are removed throughout the first season, directing the plants' energy into crown enlargement and branching, which in turn allows more sites for flower bud initiation on each plant. If properly managed, this system results in a higher yield potential than the matted-row system.

Cultivation

Cultivation is needed for both weed control and for bed maintenance in matted-row plantings. Cultivation keeps new plants within the desired row.

Mulching

In northern climates, strawberries require mulching for protection from temperature fluctuation and soil heaving during the winter. Heaving, caused by alternate freezing and thawing, damages strawberry roots and can weaken or kill the plants. A mulch, about 4 inches thick, of clean small-grain straw, salt marsh hay, pine needles, or other materials is applied during December and removed in the spring after danger of freezing is past. The mulch is left in the rows as a bed on which the berries can ripen. It keeps the berries cleaner than if they touch the ground and protects them from waterborne fungal spores, such as *Phytophthora*. In some northern areas (Minnesota and Michigan, for example), the snow cover serves as a mulch, and is sufficient to provide the protection needed by strawberry plants.

Clear polyethylene bed mulch is used in most plantings in California to prevent contact with soil, and for enhancing growth during the winter months in the warm coastal zones. Black polyethylene mulch is used in certain other areas as an aid in weed control, to prevent fruit rot, and to conserve soil moisture.

Fertilization

Most state extension services recommend applying lime and minerals according to soil test results prior to planting. In most areas, nitrogen is the principal nutrient needed by strawberries after they are planted.

Irrigation

The frequency and amount of irrigation needed for strawberries depends on local weather conditions and soil characteristics. In California, the estimated average seasonal water requirement for strawberries ranges from 26 to 36 inches.

Sprinkler irrigation is often used for frost protection during the early spring, but drip irrigation is the preferred method for applying irrigation water. The drip method allows various field activities to continue, such as spraying and harvesting, regardless of irrigation schedules. In addition, the drip method makes more efficient use of irrigation water than other methods and results in less fruit loss due to rot than the sprinkler method.

Renewing Plantings

When growing June-bearing strawberries as a perennial crop, plantings must be renovated in order to achieve maximum yields in future seasons. Renovation reduces plant crowding and invigorates the remaining plants. The renovation process begins immediately after harvest and consists of applying herbicides for weed control, mowing off the old strawberry plants sufficiently high so as not to damage the crowns, cultivating to narrow the rows, and fertilizing.

Renovation is not recommended for day-neutral plants. For day-neutral varieties, the best practice is to harvest for only two years, followed by a new planting.

Harvesting, Packing, and Shipping Fresh Strawberries

All strawberries are hand picked to minimize bruising and decay. Fresh-market strawberries must be picked 2 or 3 times a week (depending on the temperature) to avoid over-ripening. Over-ripe berries become too soft to stand up to the rigors of fresh-market handling. Over-ripening also fosters the development of various rot organisms. Strawberries for processing can be harvested less frequently than most fresh-market berries, perhaps as infrequently as one picking a week.

Fresh strawberries for the commercial market are packed in the field. Pickers place the berries directly into retail-size (one pint) baskets. Baskets are packed 12 to a tray. From the field, strawberries are hauled to a cooling plant where field heat is removed. Typically, the cooling plant is operated by a strawberry handler who also provides selling and shipping services. In some cases, the grower is also the handler.

Marketing

Nearly all of the strawberries in California and Florida are produced with the intent of selling for the fresh market. In California, growers have the option of selling their berries to the fresh market or to a processor. If the fresh market becomes glutted and fresh-market returns fall below the returns to processing, growers can divert production from fresh use to processing. About one-third of California's 1993 output, for example, was sold for processing uses (USDA, NASS). USDA does not report processing use in Florida, but some of Florida's output reportedly goes to processing (Crocker).

There are few processors in the East and Midwest, and growers in those locations have less opportunity to divert berries from the fresh market to processing uses. A relatively large share of the berries in these states, however, are sold through direct market outlets (such as pick-your-own operations, roadside stands, and farmers' markets), where prices may not be affected by gluts and shortages in the national market. Our contacts estimated that 50 percent or more of the strawberry production in most southern, eastern, and midwestern states was marketed through pick-your-own or other direct marketing outlets.

Processing sales dominate the marketing of strawberries in Oregon and Washington. Ninety and eighty percent, respectively, of the production in Oregon and Washington was sold for processing in 1993. Although the berries grown in Oregon and Washington possess superior color and taste qualities, the berries tend to be too soft to hold up to the rigors of fresh-market handling. Most fresh-market sales in Oregon and Washington are through pick-your-own or other local outlets.

Costs of Production

Cost of production information provides an indication of the magnitude of losses associated with an insurable event occurring at different stages in the growing cycle. Cost of production data for strawberries also illustrate that the value of berries in the field is much less than their value at the first delivery point, a situation which in some circumstances may create the potential for moral hazard.

Variable harvesting costs generally represent a large share of the total costs of strawberry production (Table 10). In the case of fresh strawberries in California, variable harvesting and marketing expenses account for an estimated 63 percent of total costs. Variable harvesting expenses for fresh-market strawberries range from 46-78 percent of total costs; for processing strawberries, from 40-61 percent. Detailed cost of production data appear in Appendix table 6.

Production Perils

The most serious perils in strawberry production are excessive moisture and excessive heat during the harvesting period. Other causes of yield losses include late spring frost, excessive cold during the winter, drought, hail, and numerous insects and diseases. The importance of these various perils depends on the variety, climate, and time of the growing season. A more detailed discussion of perils in various locations is provided in the "State Analyses" section.

Excessive Rain

Excessive rain during the strawberry bloom and fruiting season favors the development of gray mold or Botrytis fruit rot (see later discussion).

Table 10--Strawberries: Variable harvesting costs, selected states ¹

State	Yield	Variable harvest cost	Total cost	Variable harvest percent of total
	Pounds	-----\$/acre-----		Percent
<u>Fresh market:</u>				
California (Fresh)	48,000	12,232	19,353	63
Florida	24,000	6,740	14,111	48
Michigan	9,600	2,658	5,465	49
Louisiana	1,000	2,069	4,456	46
Virginia	12,400	3,642	6,360 ²	57
Ohio	7,000	3,050	6,437 ²	47
Pennsylvania	10,000	4,800	6,745 ²	71
Tennessee	15,744	3,730	4,803 ²	78
<u>Processing:</u>				
California	45,000	3,875	7,861	49
Oregon	10,000	1,932	3,171	61
Washington	10,000	2,015	5,088 ²	40

¹ Costs may not be comparable among states because budgets may be for different seasons and may not include the same cost items.

² Exceeds total costs shown in Appendix table 6 because amortized establishment costs were added to production-year expenses.

Sources: University of Tennessee; Goulart; Louisiana State University; Nott et al.; O'Dell et al.; Ohio State University; Oregon State University; Ilic; Smith and Taylor; University of California Cooperative Extension Service.

Flooding of berries in low-lying areas also is particularly serious because the flood waters carry mold spores from the soil to the fruit. Excessive rain during the harvest period also can prevent the grower from picking berries on a timely basis. There is a relatively short window between when berries are ready to be harvested and when they become over-ripe.

Excessive Heat

Excessive heat during the harvest period results in soft berries and lowers fruit quality. Excessive heat also results in berries ripening rapidly--sometimes too quickly for timely harvesting. Excessive heat, accompanied by moist conditions, during the harvest period is particularly serious for strawberries because it fosters the development of gray rot and other diseases on the fruit. Gray rot is the most serious fruit rot in strawberries.

Excessive heat following planting of bare-rooted plants stresses the newly-set plants and increases the chances of the plants dying.

Excessive heat during the summer can retard runner development, limiting plant populations below planned levels and reducing subsequent harvests. Overhead irrigation can help combat this problem by keeping the plants cool during periods of extremely high temperatures.

Frost

Strawberry flower buds and fruit are susceptible to frost injury at any time after the blossoms appear on the buds. Yields can be substantially reduced by frost during this period. Frost-damaged flowers turn black and die, and no berries develop. Because they develop blossoms sooner in the spring, early cultivars are more susceptible to frost damage than later-bearing varieties. It is important to protect the first flowers (King blossoms) that open because they represent the largest fruit and up to 30 percent of the crop by volume.

Applying water to the plants with overhead irrigation during periods of below-freezing temperatures is the most effective method of frost protection. The temperature of the buds, blossoms, and berries remain at or near the freezing point, which is several degrees above the critical damaging temperature of about 30° F, as long as a layer of freezing water covers the plants. Row covers are also used in some areas.

Usually, frost damage is limited to a percentage of the normal yield because not all of the blossoms or berries develop at the same time. Frost is less of a threat to yields in areas where harvesting extends over several months (such as in Florida and California) because a small percentage of the total yield is susceptible to damage at any point in time.

Winterkill

Unprotected strawberry crowns can be damaged by temperatures of 10° F or lower. Also, alternate freezing and thawing during the winter and early

spring can break off roots due to soil heaving, weakening or killing the strawberry plant.

Covering the plants with a layer of straw, marsh hay, pine needles, or other protective material during the coldest parts of the winter reduces soil temperature variations and minimizes heaving and root damage.

Drought

Drought during the spring reduces berry size and diminishes yields. Drought during the summer frequently reduces the number of new plants established by runnering, particularly if dry conditions accompany periods of extreme heat. Drought is not generally a serious problem when growers supplement rainfall with irrigation.

Hail

Hail can cause yield losses if it occurs during the time when berries are on the plants. Hail bruises the strawberries, creating an entry way for disease organisms and decay. Hail damage is an infrequently-mentioned peril for strawberries.

Insects

Spider mites

Spider mites attack strawberry plants in almost every growing region. The mites feed on the plants, reducing their vigor, which leads to lower yields and smaller fruit sizes. Strawberry plants are fairly tolerant of spider mites at low population levels. The population level of mites that is acceptable before noticeable yield loss occurs varies depending on the cultivar, growing region, and time of season. The Selva variety, for example, is particularly susceptible. The best defense against spider mites is resistant varieties and vigorous plants that can withstand some level of mite infestation.

Lygus bugs

Lygus bug infestations lead to severe distortion of the fruit, known as "catfacing," that renders the fruit unmarketable. Lygus bugs are most destructive in the early summer, and cause damage similar to that of frost injury in winter plantings. Lygus bugs overwinter on such cover crops as alfalfa and vetch. If these crops are grown near strawberries, they should be mowed at two week intervals to keep lygus bugs from migrating out of the cover crop and into the strawberries.

Cyclamen mites

Cyclamen mites are prevalent in the central California coastal area. They become most damaging during the summer, when high temperatures encourage activity. Their impact has been greatly reduced, however, with the shift to

annual plantings. When the mite is present, it feeds on the plant, causing the leaves and flowers to wither and die. Control is achieved with a combination of predatory insects and pesticides.

Strawberry bud weevil

The strawberry bud weevil, also known as the "strawberry clipper," or simply the "clipper," is one of the most destructive strawberry pests in the eastern United States. In the spring, the female lays an egg in the strawberry bud and then clips it off so that it hangs by a thread or falls to the ground. Injury is most likely to occur when strawberries are grown near wooded areas where the adult weevils hibernate over the winter. If their population reaches a critical economic level, weevils can be controlled with pesticide sprays.

Thrips

Thrips are tiny insects that feed on flower parts, making numerous, very shallow punctures from which they suck juices. Injured blossoms drop off or the young berries may remain hard, turn brown, and fail to grow. Damage is more prevalent during dry seasons.

Thrips seldom become so abundant that control is required. A heavy infestation is necessary to reduce the set of fruit. In the event of a severe infestation, an insecticide application may be necessary for control.

Tarnished plant bug

The tarnished plant bug may cause considerable loss by puncturing the young strawberries before the receptacle expands. Berries that are injured remain small with a woody texture and fail to mature. They become knobbed with seeds grouped apically and are unsalable. This injury is known as "button berry." Insecticide sprays just before bloom provide control for this pest.

Strawberry root weevils

Root weevils include several species whose adults and larvae look similar and their damage to strawberries is similar. Adults feed on leaves, but the larvae are responsible for the more serious damage. They feed on roots and crowns, which weakens, stunts, and finally kills the plants. Damage is often contained within small areas of the planting because of their limited mobility.

Other insects

Insects of lesser importance include field crickets, flea beetles, root worms, grasshoppers, ants, root aphids, white grubs, slugs, snails, and cutworms.

Nematodes

The two types of nematodes of chief importance to strawberry production are the foliar nematode and the root-knot nematode. Both pests are tiny round worms that live in the soil, water, and/or plant tissue. Soil fumigation and crop rotation aid in reducing nematode populations.

Diseases

Diseases in strawberry plants can be classified into three groups: fruit diseases that affect the berry itself (gray mold, rhizopus rot, powdery mildew, and anthracnose); foliar diseases that infest the leaves of the plants (leaf spot and powdery mildew); and root and crown diseases (anthracnose). Disease pathogens survive mainly in or on the soil and are spread by wind and splashing water. They can also be spread by infected transplants and certain insects. Soil fumigation and drip irrigation are the two main defenses against diseases.

Gray mold

Gray mold (*Botrytis blight*), also called *Botrytis fruit rot*, is a fungal disease affecting petals, flower stalks, fruit caps, and the fruit of strawberries. It usually starts as a blossom blight and invades the developing fruits, causing them to rot. Gray mold is characterized by pale or brown patches in its early stages, which progress to velvety gray spots, eventually causing the fruit to mummify (dry up). Gray mold is particularly destructive in that it spreads easily to healthy plants and can lead to significant yield reductions. Decay in infected berries after harvest can cause buyers to reject an entire shipment.

During wet seasons, gray mold causes more fruit and flower injury than any other disease. Temperatures between 70° F and 80° F and free moisture on the foliage from rain, dew, fog, or irrigation are ideal conditions for disease development. The disease is most severe during prolonged rainy and cloudy periods just before or during harvest.

The most commonly-affected berries are those that touch the soil or another decayed berry. Mulching helps eliminate the berry-to-soil contact. Moisture is necessary for the spores to germinate, so practices that help reduce humidity and increase air movement, such as plant cultivation and wider spacing of rows and plants, help control gray mold. The fungus thrives on debris, so sanitation is essential for control. Dead plants and fallen leaves should be removed and burned or buried.

Rhizopus rot

Unlike gray mold, rhizopus rot occurs mainly after harvest. Infected fruit will soften rapidly and collapse. Rhizopus rot is a soil-borne pathogen. Prevention measures are similar to those of gray mold in that mulch and drip irrigation help prevent infection. Careful handling during the harvest and postharvest period is crucial. Fungicidal treatments are not effective.

Leather rot

Leather rot of strawberries, a fungal disease, is associated with poorly-drained areas where there is or has been free-standing water, or on berries in direct contact with the soil. It is of little economic importance in many areas of the United States. However, excessive rainfall during May, June, and July can lead to severe losses in fruit yield and quality. Commercial growers in Ohio have reported up to 50 percent yield losses (Ohio State University).

Leather rot primarily attacks the fruit but may also infect blossoms. It causes green berries to turn brown and die. Infected ripe fruit are soft to the touch and develop a bitter taste.

The disease is spread by splashing or wind-blown water from rain or overhead irrigation. Controls consist of following production practices to minimize the likelihood of severe infections and the use of a fungicide spray program tailored to leather rot if the disease organism is likely to be a problem.

Powdery mildew

Powdery mildew can affect the entire strawberry plant and is a serious problem in the damp coastal areas of California. Infected fruit will remain hard, fail to ripen, and purple blotches may appear. Powdery mildew can be identified by an upward curling of the leaves, and in later stages, a white, powdery fungus may appear underneath the leaves. Powdery mildew can be managed through application of appropriate fungicides in the early stages of the disease. Removing damaged leaves from transplants during harvest and packing helps minimize the introduction of the disease.

Verticillium wilt

Verticillium wilt is a fungus that infects about 300 different host plants, including strawberries. Once it becomes established in the soil it may remain alive for 25 years or longer. If the disease is serious, large numbers of plants may wilt and die rapidly. When the disease is not serious, an occasional plant or several plants scattered over the entire planting may wilt and die.

Control consists of planting resistant varieties. If planting susceptible varieties, the incidence of the disease can be minimized by not planting in soil where susceptible crops, such as tomatoes, peppers, potatoes, eggplant, melons, okra, mint, brambles, stone fruits, Chrysanthemums, roses, or related susceptible crops, have been grown for the past five years. Verticillium-susceptible varieties may be grown in infected fields if soil fumigation is done as a preplant treatment.

Leaf spots

A wide array of leaf spots can infect strawberries. They may or may not cause severe problems, depending on the cultivar. Susceptible cultivars may be weakened and partly defoliated in years particularly favorable for disease

development. Usually, disease development is favored by rain and warm, humid weather.

Sanitation and the use of resistant cultivars are preventative measures. Applying protective fungicides at blossom time and before fruiting also help provide control of leaf spot diseases.

Anthracnose

Anthracnose can affect berries, leaves, petioles, stolons, and roots of the strawberry plant. Symptoms include brown lesions on the upper leaf surface, lesions on the petioles and stolons, or rotting of the crown. When the crown becomes infected the whole plant may wilt and die. Fungicide sprays may help in controlling petiole, stolon, and fruit infection.

Red stele

Red stele is a fungal disease infecting the roots of susceptible strawberry plants, destroying the water- and food-conducting tissues and resulting in wilting and eventual death of the plants. The disease is most destructive in the northern parts of the United States, on heavy clay soils that are saturated with water during cool weather when the fungus is most active. The fungus can survive in soil for up to 13 years or longer once it becomes established.

Infected plants are weakened and produce few runners. With the onset of the first hot, dry summer weather, diseased plants wilt and die.

Currently, the only practical method of controlling red stele is to grow certified, disease-free varieties. Soil fumigation may be helpful in cases where resistant varieties are not available. Planting on soils that have never been infected with red stele also reduces infections.

Black root rot

Black root rot is the general name for several root disorders which infect strawberries throughout the United States. It may be caused by stress to the plants due to soil fungi, nematodes, winter injury, fertilizer burn, herbicide damage, drought, and excess salt, water, or alkalinity. Infected plants are less vigorous than normal plants and produce fewer runners. Severely affected plants may die.

Physiological Disorders

Salt toxicity

The strawberry plant is very salt-sensitive, and high salt levels in the soil will cause stunting, marginal leaf scorch, loss of feeder roots, and severe yield losses. Salt toxicity is a problem faced by California growers, but one which they can manage with irrigation. If high levels of salt are detected in the field, irrigation can be increased to flush the salts out of the soil.

Weeds

If present, weeds are a serious problem because of competition with the strawberry plants for water, light, and plant nutrients. In addition, weeds exacerbate problems with plant diseases, particularly gray mold, by obstructing air flow and keeping the soil surrounding the strawberry plants more moist than would occur otherwise.

A major step in weed management consists of control before the strawberries are planted. Growing a crop in the field during the "off-season" that competes with weeds reduces the weed's ability to reproduce, and thus reduces the potential for weed problems after the strawberries are planted. Soil fumigation before planting kills most weed seeds in strawberries grown with plastic mulch, and hand hoeing is used to control weeds that do emerge. Usually, weeds growing in the alleys between the rows are controlled with herbicide sprays or manual cultivation.

State Analyses

California

California accounted for about 80 percent of total U.S. strawberry production in 1993, with approximately 70 percent going to the fresh market. Strawberry acreage in California has more than doubled since 1980, from 11,600 acres to 25,000 acres. The farm value of the California crop was \$544 million in 1993. The Census of Agriculture reported 831 farms in California with strawberries in 1987, all of which were irrigated.

Monterey County is the biggest production area in California, accounting for 34 percent of the state's output in 1992 (Appendix table 5). The remainder of California's output is located primarily in Ventura (20 percent), Santa Cruz (14 percent), Santa Barbara (13 percent), and Orange (9 percent) counties.

Because of the ideal climates for strawberry production (low humidity and temperatures between 55° F to 75° F), most of California's strawberries are grown in its coastal valleys, with only a small amount in the inland areas. Strawberries can be harvested practically year round (from mid-December to mid-November) in one area or another of the state.

Cultural practices

Most California strawberries are grown as an annual crop, in which the plants are harvested for one season and then destroyed. A small portion of California's strawberries are held over for second-year production. Second-year berries, grown mostly in the Watsonville and Santa Maria areas and used primarily for processing, account for about 10 percent of the state's strawberry output. Second-year berry production requires that the winter temperatures be cold enough to provide a substantial chilling period (Welch, et al.). Although second-year production requires less capital investment

than annual cropping, yields tend to be lower and the berries smaller and softer.

Two planting systems, summer planting and winter planting, predominate in California with winter planting being the more common. Winter planting requires active plant growth during winter, which limits the practice to the coastal and southern areas of the state that have relatively warm winters. It is the dominant system of southern California, where early fruit production is of primary economic importance. Typical planting and harvesting dates for the various regions of the state are shown in Tables 11 and 12.

Varieties

The most popular strawberry cultivar in California at the present time is Chandler, accounting for 40 percent of total acreage in 1994 (Tables 13 and 14). It is followed by Selva (30 percent of total acreage), the variety most prevalent in the central coast region. Other notable varieties are Pajaro, Oso Grande, Seascape, Muir, and Irvine. Pajaro, once a major variety, is being replaced with Selva or Seascape. Chandler dominates in the southern regions (Oxnard, San Diego, and Orange counties) and Selva in the north (Table 14).

Harvesting

Harvesting extends from early January in the south to October in the central counties, or even into November during years with warm, dry autumns (Table 12). Production peaks during mid-April in southern California and during May in central California.

Strawberries for the fresh market are hand-picked every two to four days during the harvest season. The berries may be picked at different stages of ripeness depending on the variety and market destination. Fruit that will be transported long distances is picked at a substantially less ripe stage than that for nearby markets. Firmness of the fruit also affects the stage of ripeness at which the berries are picked. Berries of the Selva variety, for example, should be picked fully colored because of their very firm texture. Berries destined for the processing market are harvested when they are fully ripe, and are generally picked only once a week (Faxon).

Front-wheeled portable tray carts are used in picking. For fresh-market berries, picking-carts hold trays containing 12 1-pint baskets that are pushed through the field by pickers as they harvest the berries. The fruit is picked directly into pint baskets holding slightly less than 1 pound of fruit each. Weight per pint basket varies with the variety and fruit size. Berries for processing are placed directly into plastic trays without baskets. Fresh-market berries are sold in 12-pint trays (weighing 11-12 pounds), and processing berries are sold in 17-pound trays.

Careful post-harvest handling is extremely important for strawberries as they are easily damaged. Fresh-market berries should be cooled within two hours of

Table 11--Strawberry planting dates and varieties for California

Location	Cultivar	Planting Date
<u>Summer plantings:</u>		
Central Valley	Chandler, Pajaro, Oso Grande	July 20 to Aug. 5
Central Coast	Pajaro, Chandler Muir, Selva	Aug. 15 to Sept. 5 Sept. 25 to Oct.10
Santa Clara Valley	Pajaro, Chandler	July 25 to Aug.8
Southern California	Oso Grande, Chandler	Aug. 20 to Sept. 5
<u>Winter plantings:</u>		
Central Coast	Oso Grande, Chandler, Muir, Selva	Oct. 15 to Nov. 26
Southern California	Oso Grande, Chandler	Oct. 20 to Nov. 1

Regions: Central Valley (Fresno, Modesto); Central Coast (Salinas, Watsonville, Santa Maria); Santa Clara Valley (San Jose, Gilroy); Southern California (Ventura, Orange, Los Angeles, San Diego).

Source: Welch, et al., 1989; *Strawberry Review*, various issues.

Table 12--Strawberry harvest dates in California

Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Southern California												
Winter	*	+	++	++	++	+						
Summer			+	+++	+++	++	+					
Fresno (San Joaquin Valley)												
Summer				+	++	+						
Central coast												
Summer				+	+++	+++	++	++	+	+		
2nd year				+	++	+++	++	+	+	*		
Winter (short-day)					+	++	++	+	+	*		
Winter (day-neutral)				+	++	++	+	+	+	+	+	*

- * Very low
- + Light production
- ++ Moderate production
- +++ Heavy production

Source: Welch, et al., 1989.

Table 13--Strawberry varieties produced in California as
a percent of total plantings

Variety	1990	1991	1992	1993	1994
Chandler	47%	45%	44%	46%	40%
Selva	19%	25%	24%	27%	30%
Pajaro	15%	11%	11%	6%	4%
Oso Grande	3%	5%	6%	4%	5%
Seascape	0%	0%	3%	5%	7%
other	16%	14%	13%	12%	16%

Source: California Strawberry Commission.

Table 14--Percent of acreage held by various strawberry varieties in California, by region, 1994

Variety	Region				
	Oxnard	San Diego	Orange	Santa Maria	Watsonville
Chandler	83%	89%	92%	51%	--
Selva	--	--	--	19%	56%
Pajaro	--	--	--	--	8%
Oso Grande	4%	10%	5%	15%	--
Seascape	--	1%	--	--	14%
other	13%	0%	3%	15%	22%

Source: California Strawberry Commission.

picking at 33° F. Careful attention must be paid to avoid having any decay present, as it can swiftly spread to an entire shipment.

Marketing practices

Strawberries in California are marketed through two principal channels: marketing companies (shippers or grower-shippers) and marketing cooperatives. There are about 20-30 shippers in the coastal area, with the top-5 shippers having about a 40-percent market share (Moriyama).

There are a multitude of grower-shipper arrangements for financing and marketing strawberries in California (Carreiro). Sometimes a single shipper will have different arrangements for different growers, depending on the needs and preferences of each. Some shippers supply plants and provide production credit in exchange for the right to market a grower's strawberries. In such situations, the shipper may carry part of the financial risk associated with yield losses. Shipper-financed production is a common practice among those growers who have limited capital resources to finance the high establishment costs associated with producing strawberries (Mountjoy). In some cases, the grower finances the entire growing operation and the shipper provides cooling and marketing services for a fee. In such situations, the grower bears the financial burden of a yield loss.

One major marketing cooperative in California is "Naturipe Berry Growers." Naturipe markets both fresh and processed strawberries. Their processing facilities are located in Anaheim, Oxnard, and Watsonville. Growers pay a management and sales staff to arrange for all marketing.

Handlers typically perform cooling and marketing services for a set fee. The grower receives the market price net of marketing costs. There is, therefore, usually about a three-week lag from the time growers harvest until they know the sales price (Riggs).

Production perils

California growers received no disaster assistance payments for strawberries between 1988 and 1993, suggesting that production perils are not a major issue in growing strawberries. Although frost and excessive rain can cause yield losses in California, they do not appear to be serious production perils. The harvest season is relatively long for California strawberries and losses to part of the crop due to frost may not reduce the season average yield enough to qualify growers for disaster assistance.

Producer organizations

The California Strawberry Commission operates a state marketing order that supports marketing promotion and research activities for the California strawberry industry. These activities are funded with money collected from handlers on the basis of marketed strawberry volume.

The Processing Strawberry Advisory Board of California serves as an inspection/grading service for processing berries in the state. The Board is financed by assessments on processors based on the quantity of berries processed (Faxon).

Availability of data

The California Strawberry Commission conducts an industry-wide survey in California each year to determine overall acreage, varieties planted by district, and planting dates. Survey results are reported in the Commission's newsletter, Strawberry Review. Although not reported for individual growers, the Commission collects data on acreage and production which could provide a historical yield series for individual growers (Roach).

The County Agricultural Commissioners in California maintain a complete list of current strawberry growers in each county. The California Department of Food and Agriculture requires that growers obtain permits through the County Agricultural Commissioners' offices to apply chemicals to crops. The Agricultural Commissioner maintains acreage records on all those growers who have obtained a permit to spray agricultural chemicals (Roach).

Processed strawberries

California growers can sell strawberries for either fresh or processing uses. While berries have a higher value in the fresh market, the quality requirements are higher than those for the processing market. Strawberries that do not meet the highest fresh-market quality standards because of small size, softness of the fruit, or for other reasons, are diverted to processing. Growers also may divert strawberries from fresh to processing uses when there is a glut of berries in the fresh market.

Processing usually accounts for 20-30 percent of total production in California (Table 15). About 50 percent of the production from the southern regions (Orange County and Santa Maria and Oxnard districts) sell for processing, while about 20 percent of the output from the central coastal area is processed (Faxon). Summer temperatures in the southern districts are warmer, resulting in a shorter growing period with higher-quality berries than in the central coast. Growers in the southern districts divert their strawberries to the processing market when central coast production reaches its peak levels (Faxon). Most of the second-year berries (production from plants held for a second harvest season) from the Watsonville area of the central coast district go for processing

Fresh berries are sold at about \$.50-\$.60 per pound and processed berries are sold at \$.20-\$.30 per pound. The market prices for freezer berries usually provide the floor price for the fresh market. Because of the higher returns from fresh berries, California growers can often recover much of their overhead costs in the fresh market before selling later-harvested berries for processing at lower prices (Runsten).

Table 15--Fresh and processing utilization for
California strawberries, 1980-93

Year	Fresh	Frozen
-----Percent of total-----		
1980	68.7	31.3
1981	72.8	27.2
1982	63.8	36.2
1983	64.9	35.1
1984	77.6	22.4
1985	74.8	25.2
1986	73.3	26.7
1987	68.4	31.6
1988	76.3	23.7
1989	75.7	24.3
1990	67.8	32.3
1991	70.0	30.0
1992	74.0	26.0
1993	67.8	32.2

Source: Faxon.

Demand for crop insurance

There is not likely to be very much demand for crop insurance for strawberries in California because growers face relatively few production risks. The major risk mentioned by our contacts was late spring frost. These contacts were quick to point out, however, that frost usually destroys only a small percentage of the crop because of the extended harvesting season in California.

Disaster assistance data further substantiate the conclusion that there would not be very much interest in strawberry insurance in California. There were no payments for yield losses for strawberries in California between 1988 and 1993.

Florida

Florida ranks second to California in strawberry production, accounting for about 10 percent of U.S. output in recent years. Most of Florida's production is sold in the fresh market. Processing accounts for a minimal amount of Florida's strawberries, although Paradise Growers, Inc. opened a plant in 1992 (Crocker).

About 90 percent of Florida's strawberry acreage is near Plant City in Hillsborough County, which is in west central Florida. Strawberries are also grown in the adjacent counties of Pasco, Polk, and Manatee, as well as in Collier, Palm Beach, and Dade counties in south Florida, and Bradford County in the north.

There are currently about 250 growers who plant and harvest about 5,000 acres of strawberries in Florida (Crocker, 1992 Census). Some operations are very large, producing 70 to 100 acres of strawberries and marketing their own brands. Smaller operations are more likely to double-crop vegetables using the same plastic mulch and drip irrigation system set up for strawberries. A number of smaller growers sell through pick-your-own operations.

Nearly all Florida strawberry acreage is irrigated. Overhead irrigation is used to prevent freeze damage. Recent water management restrictions have encouraged growers who use overhead irrigation to provide water for plant growth to switch to drip irrigation. Growers often use overhead sprinklers for frost protection, and drip irrigation for moisture.

Florida growers usually receive a higher average price for their berries than California growers because they sell early in the season, before large-volume shipments from California reduce prices.

Cultural practices

Florida producers use an annual cropping system for growing strawberries. The strawberries are planted on raised beds in October, through slits cut in black plastic mulch. Growers fumigate with methyl bromide and chloropicrin before planting to control weeds and soil-borne insects and diseases.

The first berries may be ready for harvest in late November, but large-volume shipments begin in December and last into early April. Although some pick-your-own operations in north Florida may operate into early May, warm weather usually causes commercial output to cease earlier.

Strawberries are picked once or twice a week from December through March, depending on the weather and prices. If prices are low, harvesting for the fresh market may be curtailed. Growers may open their fields to pick-your-own operations or sell to a processor later in the season as quality declines and prices fall. Most growers use a broker to sell their berries, which are packaged and hauled to market by truck.

Two of the most popular strawberry varieties grown in Florida, Oso Grande and Selva, were developed at the University of California. Selva is a day-neutral variety released in California in 1983, and introduced in Florida in 1987. Oso Grande is a short-day variety, released in California in 1987. A third variety, Sweet Charlie, was recently released by the University of Florida. Acreages of Oso Grande and Sweet Charlie are rising, while Selva is declining.

Florida's strawberry season begins in late November with Selva, the earliest-bearing variety. Harvest of Oso Grande begins in late December and peaks in March. Selva accounted for 29 percent of Florida's 1993/94 strawberry area, down from 47 percent in 1992/93. Oso Grande accounted for 53 percent of 1993/94 acreage in Florida, up from 31 percent the year before.

Sweet Charlie is an early-fruiting strawberry variety developed for Florida growing conditions. An important feature of the Sweet Charlie variety is its resistance to anthracnose, a fungus disease that thrives in the hot and humid southern climate. Sweet Charlie accounted for 16 percent of Florida's acreage in 1993/94. Sweet Charlie fills a seasonal gap for Florida growers by ripening after Selva and before Oso Grande.

Production perils

The major production perils for Florida strawberries are: (1) winter freezes, (2) excessive rain, (3) plant loss from weakened nursery stock, and (4) fast warmup in the spring (Crocker). Although winter freezes occur in Florida with some degree of regularity, freeze protection devices such as overhead sprinklers and row covers (air-, water-, and light-pervious blankets) are used on 90 to 95 percent of the acreage to protect plants and berries (Hinton). However, excessive use of overhead sprinklers causes reduced fruit quality and encourages various types of rots. Excessively wet soil also reduces the effectiveness of soil fumigation to control nematodes. Using row covers for cold protection eliminates the excess moisture problem.

Low temperatures, excessive rain at planting time, or any other event that delays crop development, whether or not it reduces early-season yield, is a serious production peril in Florida. The profitability of strawberries in Florida is dependent on having a volume of berries early in the season when prices are highest. Early-season yield losses can represent

disproportionately large revenue losses for Florida growers because that is when Florida is the principal shipper and prices are the highest.

A warm spring can end the season early because berry quality declines and they are more susceptible to various types of rots. Yield losses at the end of the season usually represent a smaller economic loss than a comparable loss early in the season.

Florida received relatively high disaster payments in 1993, resulting from a cold winter that delayed fruit development, and an early warm-up in March that caused fruit quality to decline (Crocker). In addition, severe weather over much of the East Coast reduced consumer demand for strawberries, resulting in low prices. The low prices may have contributed to growers' decisions to end the season early.

Industry organizations

The Florida Strawberry Growers Association promotes Florida-grown strawberries and handles public relations for the industry. The Association does not market produce for members.

Demand for insurance

One source indicated that there would not likely be very much interest among Florida growers in crop insurance for strawberries because of "bad experiences" they had in obtaining disaster assistance following crop losses due to freezes in the 1980's (Hinton). In addition, an estimated 90 to 95 percent of the crop in Florida is now protected against freezes, a major peril, with overhead irrigation or row covers.

Another source indicated that he thought Florida growers would probably like to insure against losses attributable to restricted chemical use, such as the loss of methyl bromide as a fumigant (Crocker).

Illinois

Strawberries are grown throughout Illinois, with 571 harvested acres reported in 1992, down from 914 acres in 1987 (1987 and 1992 Censuses). The number of farms producing strawberries, at 239 in 1992, also declined over that period, down from 291 in 1987.

Commercial strawberry enterprises in Illinois range in size from one-quarter to one-half acre for small-scale growers to about 40 to 50 acres for the largest growers. Picking begins about May 15 in southern Illinois and ends about June 30 in the northern part of the state. At any given location, the harvest period may last 6-8 weeks. Popular varieties currently include Kent, Jewell, and Allstar.

Virtually all of Illinois' strawberries are sold in local markets within a 20-mile radius of where they are grown. Between 30-40 percent are sold through

pick-your-own operations. The remainder is sold through roadside stands or to local supermarkets.

Strawberries in Illinois are typically grown as a perennial crop. They are transplanted in the field during early spring and multiply during the summer, forming matted rows by fall. The first berry crop is harvested the following spring. Most growers maintain their plantings for two harvest seasons.

Approximately twenty-five to fifty percent of those growers with less than 3 acres irrigate, while about 75 percent of those with more than 3 acres irrigate (Otterbacher). Growers who irrigated generally use an overhead system, which provides frost protection during the spring, as well as protection against drought.

Nearly all of the crop is protected during the winter with a straw mulch. A few growers are using a fiber mulch in place of straw.

Major production perils include late spring frosts and weeds (particularly during the establishment period). Weeds are typically controlled with herbicides, although organic growers and those who are not careful concerning weed control may face yield losses. Other perils include diseases, although most can be controlled through the use of resistant cultivars or fungicides.

Hot, dry weather is also a peril. Even with irrigation, hot, dry summers retard runner development and can reduce the next year's crop. Causes of yield losses listed on disaster assistance applications included drought in 1988, late spring frost and excessively wet conditions in 1990, freeze followed by drought in 1992, and flooding in 1993 (Warner).

Growers would likely be quite interested in crop insurance for strawberries. One source indicated that this would likely be the case for growers with several acres, who could better justify the premium cost (Otterbacher).

Indiana

Strawberry production in Indiana is scattered throughout the state, although the greatest concentration is in the northwest corner, near Chicago, and in the Indianapolis area. About 75-85 percent of Indiana's strawberries are marketed through pick-your-own operations (Bordelon). The remainder is sold through road-side stands or local supermarkets. Some pick-your-own growers advertise heavily and use strawberries as a "loss leader" early in the season, hoping to attract a clientele that returns to pick other crops that are more profitable later in the summer.

The Census of Agriculture reported 718 acres planted to strawberries in Indiana in 1992. The typical strawberry enterprise averages about 5 acres. Earlyglow is the most common variety. Harvesting begins in the southern part of the state about May 15, and in the northern part, during the first week of June. Plants bear for 6-8 weeks at any given location.

Strawberries are generally grown as a perennial crop in Indiana, bearing for 2-3 years. However, some growers have been successful with maintaining plantings for 15-20 years. Spring planting on raised beds is the typical practice in Indiana. Some growers are also moving to plasticulture, although fewer than 5 percent of the growers use this method.

About two-thirds of Indiana's strawberry acreage was irrigated in 1992 (1992 Census). Some growers use both sprinkler irrigation (for frost protection) and drip irrigation (for watering during dry periods).

Virtually all of the strawberries in Indiana are mulched to protect against cold injury during the winter. Most growers use wheat straw or chopped corn fodder. In the spring, the mulch covering is raked off the plants. The remaining mulch helps protect the berries from exposure to the soil and helps control weeds. The mulch is plowed under during renovation and a new mulch is applied in the fall.

The most serious production peril is frost damage to the strawberry blossoms. Chilling injury can also damage small berries. Frost damage is less of a problem for those growers with sprinkler irrigation systems.

Hot weather is a peril in that plants go dormant and do not produce runners at high temperatures. Overhead irrigation can help combat this problem by keeping the plants cool during periods of extremely high temperatures. Drought is not generally a serious problem because of the widespread use of irrigation. However, it may become a problem in extreme years when water sources--particularly ponds--dry up.

Reasons cited by ASCS for disaster assistance payments in Indiana included late frost, excessive rain, and drought (Wittbrock). The most important diseases include fruit and root rots, although they can generally be controlled unless the weather is very wet.

Michigan

The Census of Agriculture reported 453 farms in Michigan growing strawberries in 1992, with 2,131 harvested acres. The value of Michigan's strawberry crop was estimated at \$1.5 million in 1993 (USDA, NASS). Most farms have less than 5 acres in strawberries, with the largest having up to about 20 acres (Hanson).

Most of Michigan's crop is used fresh and marketed through pick-your-own and farm retail sales. Less than 20 percent of the Michigan crop is processed.

Berrien County in the southeast corner of Michigan has the largest acreage (300 acres) and the highest production. Other Michigan counties with more than 100 acres of strawberries in 1992 were Leelanau, Van Buren, Manistee, Washtenaw, and Kent. Strawberries are grown as a perennial crop in Michigan.

The major production perils include winter damage to the plants due to excessive cold, damage to the flowers and fruit from late spring frost, drought, and fruit rots due to excessive moisture (Hanson).

Minnesota

The Census of Agriculture reported 229 farms in Minnesota growing strawberries in 1987, with 827 harvested acres. (Data for 1992 are not yet available.) The value of Minnesota's strawberry crop was estimated at \$4.8 million in 1993 (USDA, NASS). Most growers have less than 10 acres of strawberries. Many growers also produce apples, potatoes, and other horticultural crops (Hoover).

Minnesota strawberry production is located mainly in the east central part of the state (Dakota, Hennepin, Sherburne, and Washington counties), near Minneapolis and St. Paul. Nearly all sales are through pick-your-own operations.

Growers usually plant several varieties to extend harvesting. Strawberries are grown as a perennial crop in Minnesota.

Harvest usually begins the second week in June and lasts until the first week of July. In some years, however, berries are ready as early as Memorial Day and, in other years, they have been picked as late as July 20. Strawberries are usually picked 2-3 times a week and as often as every other day during warm weather.

The most important production perils include drought and excess moisture. Spring freezes are not a serious problem because Minnesota's weather usually changes from winter to summer quite abruptly, and strawberries do not generally develop until after the last spring frost (Hoover).

New Jersey

The 1992 Census reported 255 farms in New Jersey producing strawberries, down from 269 farms in 1987. The counties with the greatest number of acres dedicated to strawberries in 1992 were Burlington, Cumberland, Gloucester, Monmouth, and Salem. Most of these counties are located in southwestern New Jersey along the Delaware River.

New Jersey strawberry growers, like those in New York, Ohio, and Pennsylvania, mostly grow strawberries as perennials, using the matted-row system (Fiola). However, there is a move toward an annual system, using plasticulture.

Strawberries are harvested for about three to four weeks in early June. Those grown as an annual crop are harvested somewhat earlier, beginning around May 7. Because of higher market prices early in the season, early-harvested berries generally have a higher market value than ones that are harvested later.

Most farms have only a few acres of strawberries, which are grown along with other fresh-market vegetables such as sweet corn and tomatoes. When using the

annual system, growers can double-crop their strawberry fields with pumpkins and other short-season vegetables. Strawberries are marketed mostly through pick-your-own operations and roadside stands.

Rain at harvest-time is the major production peril in New Jersey. Late May and early June can be warm and rainy in New Jersey. These two conditions are ideal for the uncontrolled development of gray mold. In addition, warm weather speeds up ripening and not all berries may be harvested before they decay.

Strawberries also are subject to late spring frosts in New Jersey, but yield losses due to frost alone generally are relatively small. Insects, such as thrips, the strawberry clipper, and spider mites occasionally cause yield losses on a local level.

There is no official yield data for strawberries in New Jersey, but many farmers are believed to keep their own records (Fiola).

New York

The 1992 Census reported 564 farms producing strawberries in New York, down from 594 in 1987. Acreage in strawberry production declined from 2,369 to 1,991. The Census reported that about one-third of these acres are irrigated, while Cornell University horticulturists estimate that almost all strawberry producers use overhead irrigation.

Strawberries are produced in almost every county in New York. The counties with the largest acreages in 1992 included Erie, Suffolk, Chautauqua, and Monroe. Farm sizes vary from 5 to 30 acres (Pritt). The majority of strawberries in New York are grown as a perennial crop.

Strawberries are planted from late April to late May depending on the part of the state in which the farm is located (Tomkins, et al.). Harvesting begins the last week in May and ends the first week of July, with (the majority of the berries harvested in June. In the northern part of the state, harvest ends about July 10.

The most popular varieties in New York are Earliglow, Honeyoe, Allstar, and Jewel. It is estimated, however, that over 30 varieties are grown (Pritt).

Over 90 percent of the strawberries in New York are marketed fresh through roadside stands, farmers' markets, retail stores, and pick-your-own operations. Pick-your-own operations at one time dominated the market, although their market share has been decreasing in recent years. Pick-your-own operations were estimated to account for about 50 percent of sales in 1994 (Pritt). The availability of adequate labor is often a problem at harvest-time for commercial operations. Smaller farms depend on local labor, often high-school students. The larger farms typically employ migrant workers.

Excessive rain and late spring frosts are the most serious production perils for New York growers. However, growers with overhead irrigation can generally

protect their crops from frost. Other weather perils include hot, humid weather, which quickens the ripening of the berries. This shortens the life of the berries and makes harvesting more difficult.

Substantial disaster assistance payments for strawberries were made in 1988 (for damage due to drought), 1989 (for loss due to a freeze that damaged the blossoms), and in 1992 (for losses due to wet weather early in the season and a frost in May that damaged the blossoms).

The most serious insect and disease problems include gray mold, black root rot, tarnished plant bug, blossom clippers, and picnic beetles. Insect outbreaks tend to be localized. Weed control is also a problem in strawberry production.

The state's small fruit specialist believes strawberry growers would be interested in crop insurance. He stated that strawberry production is quite variable, and growers expect a great deal of fluctuation in yields.

North Carolina

The Census reported 427 farms in North Carolina with strawberries in 1987. Production is scattered throughout the state. The Census reported the largest number of farms and the greatest number of acres in Surry County, but several other counties throughout the state reported nearly comparable acreage and production.

USDA reported nearly 11 million pounds of strawberry production for North Carolina in 1993, about 0.8 percent of total U.S. output (USDA, NASS). North Carolina's strawberries had a farm value of \$6.5 million in that year. Strawberry acreage has been rising gradually during the past 5 years in the state.

Plasticulture technologies, combined with adoption of the Chandler cultivar, is changing the way strawberries are grown in North Carolina. About a third of North Carolina's acreage was produced using the plasticulture system in 1993, with a typical operation being 3 to 4 acres in size (Poling, 1993). About 85 percent of the growers in North Carolina use plasticulture technology (Poling, 1994). Typical yields for strawberries grown with plasticulture in North Carolina are 17,000 to 18,000 pounds per acre.

A substantial amount of North Carolina's production is sold through direct market outlets, such as pick-your-own operations, farmers' markets, and roadside stands.

The major production perils reported for North Carolina are excessive rain, wind-borne freezes (due to evaporative cooling) in late winter, and drought for those producers who do not use irrigation. Wind-borne freezes may destroy flowers and developing berries if overhead irrigation is used during cold, windy weather. The cooling effects of the evaporating water more than offset the warming effects of the freezing water under windy conditions, and actually lower the ambient temperature. Evaporative cooling is a threat during late

winter when the young berries are developing. Summer drought and root rots due to excessively wet weather were cited as causes of yield losses for which disaster assistance payments were made in 1993.

The strawberry horticulturist at North Carolina State University indicated that he thought growers would be interested in multiple peril crop insurance (Poling, 1994). He said it would be useful to have a prototype policy so that the North Carolina industry could evaluate the role crop insurance could fulfill in their operations.

The North Carolina Strawberry Association (NCSA) represents strawberry growers from North Carolina, Virginia, Georgia, and Alabama. The Association has about 100 members, approximately 50 of which are growers from North Carolina (Slover).

Ohio

The Census reported 499 farms producing strawberries in Ohio in 1992, down from 545 in 1987. Fifty-four percent of Ohio's strawberry acreage was irrigated according to the 1992 Census. However, a state horticulturist at the Ohio State University reports that almost all producers use irrigation (Sheerens).

Strawberries are grown throughout Ohio, but Columbiana, Wayne, Lorain, and Mahoning counties report the largest number of acres. Acreage declined in Columbiana and Mahoning counties between 1987 and 1992, but rose in Wayne and Lorain counties.

Ohio strawberries are grown as a perennial crop using the matted-row system. Production practices in Ohio are similar to those in Pennsylvania and New York.

Most strawberry growers have small acreages and grow other berries, tree fruits and/or vegetables such as sweet corn and pumpkins. Most strawberries are sold for the fresh market, either by retail stores, farmers' markets, or pick-your-own operations. Pick-your-own operations accounted for less than half the strawberry marketings in 1994 and have been declining in recent years. A very small quantity is used for processing.

Excessive rain and excessive heat are the major production perils in Ohio. Excessive heat causes poor berry quality and exacerbates disease problems. Excessive rain causes gray mold and leather rot problems. Late spring frosts are also production hazards in Ohio, if the grower does not use overhead irrigation for protection. In some cases, birds eating the berries are reported as a production problem.

The largest disaster assistance payments for strawberries in Ohio were made in 1988, when very high temperatures during June caused the berries to ripen too quickly, causing them to rot before they could be picked.

The director of the Ohio Fruit Growers Association believes that crop insurance is a good idea for Ohio strawberry growers (Pullins). However, because of the small size of the farms which grow strawberries, and the small size of their strawberry operations, he was not sure how receptive producers would be to buying crop insurance. He said the premium cost would be a major factor. He mentioned that some strawberry producers who also grow row crops are familiar with crop insurance.

Oregon

The Census reported 391 farms in Oregon with strawberries in 1992. The value of Oregon's strawberry output in 1993 is estimated at \$27 million (USDA, NASS). In that year, Oregon produced 62 million pounds of strawberries, of which 90 percent were processed.

Oregon's strawberry industry is centered in the northern Willamette Valley in northwest Oregon. Marion and Washington counties accounted for about three-fourths of that state's production in 1992, although seven other counties harvested more than 35 acres of strawberries (1992 Census).

Oregon has about 6,000 acres of strawberries, nearly 400 growers, and a dozen processors. Strawberry growers typically also produce other types of berries, such as raspberries and blackberries. Most growers have overhead irrigation systems to provide frost protection and for summer irrigation.

Oregon grows premium-quality berries for processing. A strong demand usually exists for Oregon's high-quality, excellent-tasting berries. They are blended with frozen berries from California to add quality and flavor to processed strawberry products. In the last three years, Oregon provided about 15 percent of the U.S. frozen strawberry pack. The processing varieties grown in Oregon are more perishable than those grown in California. Because of their extreme perishability, most of Oregon's strawberries sold for fresh-market use are marketed through roadside stands, farmers' markets, or pick-your-own operations. The Oregon Strawberry Commission collects funds for research and promotion.

Grower prices for strawberries average lower in Oregon than in states where strawberries are sold primarily for the fresh market. Processing prices for Oregon (and Washington) berries, however, average substantially higher than prices for processing berries in California.

Strawberries are grown as a perennial crop in Oregon, with plants being replaced after 4 or 5 years. Fields are picked about once a week during the 2-3 week harvest period. The harvest is usually complete by the end of June.

The most popular strawberry variety in the Northwest is Totem, which accounted for 77 percent of Oregon's 1993 acreage. Totem is especially suited to the Northwest climate and for processing use. The berries are richly-colored throughout, are smaller and more flavorful than most fresh-market varieties, and have a texture better suited to processing. Other strawberry varieties

grown in Oregon include: Benton (7 percent of 1993 acreage), Sumas, Shuksan, Hood, Ranier, and Redcrest.

Late spring frost is the major peril to Oregon strawberries. It causes distorted shapes (called "monkey facing" in Oregon) among the berries and can result in up to a 20 percent yield loss. Flooding is also a danger in low-lying areas. The most damaging pest is the strawberry root weevil, for which there are no effective, registered chemicals. If a field becomes infected, it must be abandoned and treated (fumigated) before strawberries are grown again. The most serious disease is gray mold, which is fostered by damp weather. Berries infected with gray mold cannot be harvested.

Pennsylvania

The 1992 Census reported 813 farms in Pennsylvania with sales of strawberries in 1992, down from 882 farms in 1987. About 50 percent of the acres in strawberries were irrigated. Strawberries are grown in just about every county in Pennsylvania, although production is concentrated around the larger cities. The counties with the largest number of farms growing strawberries are Lancaster, York, Berks, and Bucks.

Strawberries are grown as a perennial crop in Pennsylvania, and are planted in the matted-row system. Harvesting usually lasts about 2 weeks, starting about June 1. Most strawberry acreages are small. Farms are diversified with other berries, apples, and vegetables (Goulart, 1994b).

Strawberries are marketed fresh through retail stores, farmers' markets, and pick-your-own operations. Pick-your-own operations account for about 50 percent of Pennsylvania's strawberry marketings.

Excessive heat, excessive rain, extremely low winter temperatures, and late spring frosts are reported as the most serious production perils in Pennsylvania (Goulart, 1994b). Excessive heat at harvest-time can cause the berries to ripen too quickly, lowering berry quality. Also, extreme heat during harvest reduces the number of pick-your-own customers, resulting in over-ripe berries. These berries attract insects and are a source of disease infections, which may spread to good fruit. Cold winters can be a problem if the mulch layer is insufficient.

Weeds, if not controlled, can be a serious problem. Strawberries are short plants with shallow root systems and compete poorly with weeds. Verticillium wilt, red stele, powdery mildew, leather rot, leaf spot, and gray mold also affect strawberries in Pennsylvania. Pick-your-own harvesting was also mentioned as a production peril. Pickers leave small and over-ripened berries on the plant which attract insects and diseases that eventually affect good berries.

Excessive heat and drought, which caused irrigation ponds to run dry, were cited as the causes for disaster losses in 1988, the year in which Pennsylvania received its largest payments for strawberries.

A pomologist at the Pennsylvania State University indicated that she thought growers would have interest in buying crop insurance for strawberries. This is due to the risks involved in strawberry production and the high investment cost (Goulart, 1994b).

Tennessee

The Census reported 202 farms with strawberries in Tennessee in 1992, with 646 harvested acres. Production is scattered throughout the state, most being accounted for by pick-your-own operations.

The most common type of strawberry grown in Tennessee are the June-bearing varieties, which are usually grown using the matted-row system. A few growers are experimenting with the plasticulture system. Common cultivars include Earliglow, Cardinal, Red Chief, and Allstar.

Excessive moisture, late spring frosts, and spring drought are the major production perils in Tennessee (English, Upton, Wortman).

Virginia

The Census reported 520 acres of strawberries in Virginia in 1992, which were produced on 201 farms. The largest concentration of acreage, and about 20 percent of Virginia's production, was in Virginia Beach County in the far southeastern part of the state (O'Dell). Strawberry acreages range from one-half acre to 25 acres, but the typical size is 2 to 3 acres.

Most growers use the matted-row system in commercial strawberry production. A few growers use the plasticulture system. According to the Census, 53 percent of Virginia's strawberry acreage was irrigated in 1992.

The most popular variety is Earliglow, an early-ripening cultivar. Fruit from the Earliglow variety resists decay during wet weather better than other varieties. The Chandler variety is also grown to some extent, particularly by growers using the plasticulture system.

Virginia strawberries are marketed locally, primarily through pick-your-own operations. Virginia does not have a strawberry growers association, although some growers in Virginia are affiliated with the North Carolina Strawberry Association.

Common production perils in Virginia strawberry production are hail, frost, flooding, and prolonged drought (O'Dell, Huber). Even with irrigation, drought remains a peril for some growers because prolonged periods of dry weather can deplete their supply of irrigation water.

One source thought growers would be especially interested in purchasing crop insurance if there are no ad hoc disaster payments because "commercial strawberry production is a high risk investment which entails significant up-front costs." He thinks that growers need insurance protection against drought, even though they use irrigation. This is because extended periods of

drought can dry up their water sources, and may result in low yields and low returns (O'Dell).

Washington

The Census reported 146 farms in Washington with strawberries in 1992, and 1,679 harvested acres. The value of the Washington crop in 1993 was estimated at \$6 million. There are reportedly 6 processors in Washington. Some of Washington's strawberries are trucked to Oregon for processing.

Washington strawberries are grown mainly in Skagit and Whatcom counties in the Puget Sound Basin. Small acreages are grown in other counties west of the Cascade Mountain range.

The Washington and Oregon industries are similar in that both produce primarily for processing, and the cultural practices and production perils are similar in the two states.

Wisconsin

The Census reported 314 farms in Wisconsin with strawberries in 1992, with 1,243 harvested acres. One extension horticulturist estimated that there are about 350 growers in Wisconsin growing about 1,500 acres (Smith). Most strawberry operations are small, but some range up to 40 acres.

Wisconsin strawberry production is located throughout the state, frequently near cities such as Milwaukee, Madison, and Green Bay. Growers are often diversified with other horticultural crops, mainly apples, raspberries, and vegetables.

An estimated 80 percent of the berries are marketed through pick-your-own operations, and 20 percent are pre-picked. Most of the pre-picked berries are sold at farm retail stands, but some are sold wholesale by individual growers. A few large growers may use a broker.

Strawberries are grown as a perennial crop in Wisconsin, with plants replaced every 3 or 4 years, on average. According to the 1992 Census, 79 percent of Wisconsin's strawberry acreage is irrigated. Harvest begins June 1 in the south and lasts through July in the northern part of the state. Berries are picked at least twice a week during the 4-week harvest period. All varieties grown in Wisconsin are short-day (June-bearing), and produce a single crop.

The most common variety is Honeoye, which has been dominant in Wisconsin since the mid-1980's. Kent, another popular variety, accounts for about 15 percent of the acreage. The Annapolis, Cavendish, and Red Coat varieties each account for less than 10 percent of Wisconsin's acreage (Smith).

The most important production perils in Wisconsin include late spring frosts, winter injury, insects (tarnished plant bug, clipper weevil), and diseases (angular leaf spot, red stele, verticillium wilt). High disaster payments to

many counties in Wisconsin in 1988 were caused by a late spring freeze that was followed by drought and summer heat.

Ad Hoc Disaster Assistance for Strawberries

Ad hoc disaster assistance legislation was made available for losses of commercially-grown crops in each of the years 1988-93. Ad hoc payments provide an indication of high-loss areas during that period, and may indicate states and counties that would face relatively high risk under a potential FCIC strawberry policy. These data may also suggest the areas where the demand for a strawberry crop insurance policy would be relatively high.

Under the 1988-93 legislation, payments were made under the categories of participating program crops, nonparticipating program crops, sugar, tobacco, peanuts, soybeans, sunflowers, nonprogram crops, ornamentals, and at times, aquaculture. Producers without crop insurance--the case for strawberries--were eligible for payments for losses greater than 40 percent of expected production. If a producer had no individual yield data to use in calculating "expected production," county-level or other data were used as a proxy. Payment rates for strawberries were based on 65 percent of a 5-year average price, dropping the high and low years.

Disaster assistance payments for strawberry losses totalled about \$8.1 million over the 1988-93 period (Table 16). Payments for strawberry losses peaked at over \$4.1 million in 1988, and were about \$1.7 million in 1989. Payments between 1990 and 1992 averaged about \$500,000 per year, although payments in 1993 reached \$830,000.

Ad hoc disaster payments for strawberries were scattered over a geographically broad area. Thirty-seven states received payments in at least one of the six years, with thirteen states, mainly in the Midwest and Southeast, collecting payments in all years.

In an ordering of counties, Madison County, Tennessee ranked first in payments for strawberry losses, receiving nearly \$400,000 over the 6-year period. The next four counties in the series include: Erie County, New York (\$277,934); Crockett County, Tennessee (\$273,160); Gibson County, Tennessee (\$262,530); and Haywood County, Tennessee (\$212,097). A total of 619 counties received payments in at least one of the 6 years for strawberry losses. Six of the top-10 counties were located in Tennessee, two were in New York, and two were in Michigan.

By state, the largest payments were made to Tennessee growers (\$1,999,224) and Michigan growers (\$1,089,469). New York and Illinois growers received over \$500,000 over the six-year period for strawberry losses. Other states that received large payments include Indiana, Wisconsin, Ohio, Minnesota, and Pennsylvania.

Ad hoc disaster data can be used to indicate which strawberry-producing areas received large payments relative to their acreage (Table 16). The National

Table 16--Disaster assistance payments for strawberries, 1988-93

State	Average strawberry harvested acreage, 1988-93	Share of U.S. acreage	Total strawberry disaster payments, 1988-93	Share of U.S. strawberry disaster payments
	--Acres--	--Percent--	Thousand --Dollars--	--Percent--
California	21,783	45.5	0.0	0.0
Florida	5,150	10.8	320.5	3.9
Illinois	NR	NR	577.0	7.1
Indiana	NR	NR	462.7	5.7
Michigan	2,117	4.4	1,089.5	13.4
New York	3,067	6.4	743.1	9.1
Oregon	6,267	13.1	7.9	0.1
Tennessee	NR	NR	1,999.2	24.5
Washington	1,783	3.7	38.7	0.5
U.S.	47,878	100.0	8,143.9	100.0

NR = not reported.

Sources: USDA, NASS, and ASCS data files, compiled by the General Accounting Office.

Agricultural Statistics Service (NASS) does not report strawberry acreage in Tennessee, although that state accounted for an average 25 percent of U.S. ad hoc disaster payments made for strawberries between 1988 and 1993. Similarly, NASS does not estimate acreage data for Illinois and Indiana, although those states accounted for 6 to 7 percent of U.S. ad hoc payments for strawberries.

In contrast, California, Florida, Oregon, and Washington collected a smaller share of ad hoc payments relative to their acreage. California accounted for nearly 46 percent of U.S. strawberry acreage over the 1988-93 period and collected no ad hoc payments for that crop. Oregon accounted for over 13 percent of U.S. strawberry acreage, and only 0.1 percent of ad hoc payments for strawberries.

Disaster payments for the 13 NASS strawberry states averaged 0.2 percent of the strawberry crop value over the 1988-93 period (Table 17). Disaster payments as a percent of crop value were highest in Arkansas, Michigan, New Jersey, and Wisconsin, and lowest in California and Oregon. The low payments in these latter states likely reflect the relatively limited severity of production perils and growers' use of effective loss prevention methods.

Strawberry Insurance Implementation Issues

Adverse Selection

One opportunity for adverse selection when insuring strawberries is field location. Fields located in low, flat areas are more likely to suffer yield losses due to frost damage than fields located on sloping land at higher elevations. A grower's non-use of frost protection may be another opportunity. Strawberries without the benefit of sprinkler irrigation, row covers, or some other frost protection device are more likely to incur yield-reducing frost damage than berries that are protected.

Insuring Annual-crop vs Perennial Crop Strawberries

It may be advisable to offer separate policies for annual-crop strawberries and perennial-crop strawberries because of differences in the production perils encountered in each cultural system. Perennial-crop strawberries are exposed to production risks for a longer period than annual-crop strawberries. Planted in the spring a year before harvest, perennial crop strawberries are subjected to production hazards for 12-14 months before the first yield is picked, compared to annual-crop berries, which may be picked starting 3-7 months following planting. In addition, perennial berries are maintained for several harvest seasons, which extends the length of time the plants are exposed to production perils.

It also may be advisable to require growers of perennial-crop berries to insure for multiple years to reduce the incidence of adverse selection. Insuring after a planting is established would permit growers to select insurance only if they thought there was an increased likelihood of yield loss, due to an insect or disease infestation during the establishment year.

Table 17--Strawberries: Crop value and disaster assistance,
selected states, 1988-93

State	Total crop value	Total disaster payments	Disaster payments, percent of crop value
	-----1,000 dollars-----		Percent
Arkansas	2,711	79	2.9
California	2,673,784	0	0.0
Florida	515,477	321	0.1
Louisiana	22,868	26	0.1
Michigan	40,396	1,089	2.7
New Jersey	10,921	191	1.8
New York	86,358	743	0.9
North Carolina	35,467	67	0.2
Ohio	27,856	303	1.1
Oregon	167,057	8	0.0
Pennsylvania	41,418	248	0.6
Washington	36,508	39	0.1
Wisconsin	22,361	337	1.5
13 states	3,683,182	6,814	0.2

Source: ASCS data files, compiled by the General Accounting Office and USDA, NASS.

Setting Reference Prices

FCIC provides reference prices (price elections) for insured crops, which become the basis for assigning values to yield losses. Insured growers elect a price guarantee, normally between 30 and 100 percent of the reference price as the basis for indemnity payments.

A reference price for strawberries probably should represent the in-field value of the crop, because growers would not incur the expenses of harvesting and marketing on that portion of the yield that was lost. Because of the large labor costs associated with picking, variable harvesting and marketing expenses account for 40-78 percent of total production costs. Permitting growers to select a market-value price as the basis for indemnity payments would create situations where indemnity payments would exceed grower net returns had they harvested and marketed the crop. Such situations would provide undue incentive for moral hazard.

There are two approaches to arrive at an "in-field" reference price. One is to deduct the estimated harvesting costs from a market price. The second is to estimate the cost of production and use it as a proxy for the in-field price. The market price refers to the grower price and not the retail price.

Estimating APH

A complicating factor in determining a producer's APH is that yields vary with the age of the planting. Strawberries usually produce the largest yields the first harvest season and decline thereafter. Consequently, the age of the planting needs to be taken into account in developing an average yield.

Market prices also may influence yields, especially in Florida. Yields are measured in terms of the quantity of strawberries marketed. In Florida, growers tend to continue harvesting in the spring until large-volume shipments from California pull down market prices. During years in which strawberry prices hold up longer in the spring because of a delay in the California harvest, Florida growers continue harvesting longer and, consequently, report higher yields than in years when the California crop is earlier and prices decline sooner. Because of this relationship between market prices and yields, a grower's actual production history may not necessarily indicate farming ability.

Estimating "Appraised Production"

Estimating appraised production for strawberries (harvestable, but unharvested yield) requires taking into account the age of the planting (see the "Estimating APH" section), as well as the number of pickings already made or the likely number of pickings remaining in the season.

An appropriate formula for estimating unharvested yield would be: APH multiplied by a "remaining-season" adjustment. A gross remaining-season adjustment would be the percentage of the normal picking season remaining when harvesting stopped. This factor would tend to over-estimate appraised

production, however, because yield per picking usually declines as the season comes to an end. A refinement to the remaining-season adjustment would account for the higher yields per picking at the beginning of the season.

Insuring Price Risk

There may be less interest among strawberry growers in revenue insurance than among growers of most other perishable commodities. Price variability during most seasons appears to be less of a risk in strawberry growing than for crops such as lettuce and celery. Most of the strawberry crop is harvested between April and September, when prices are relatively stable from year-to-year. The reason for this relative stability is that strawberries can be diverted between fresh and processing uses as production rises and falls, and the processing price, consequently, more or less acts as a floor for the fresh price during the peak harvest (see the "Prices" section). Processing strawberry prices, in turn, are relatively stable from season to season, as the availability of import supplies and carryover stocks from the previous year help buffer the effects of changes in current supply on prices.

Market Prices and Moral Hazard

Low market prices are not as likely to be an incentive for moral hazard with a strawberry insurance policy as with some other perishable commodities because strawberry prices tend to be more predictable than prices for items such as celery and lettuce.

Availability of Individual Yield Data

Historical yield data for individual growers is more likely to be available in California than in other states. The California Strawberry Commission conducts an industry-wide survey each year to determine overall acreage, varieties planted by district, and planting dates. Survey results are reported in the Commission's newsletter, Strawberry Review. Although yields are not reported for individual growers, the Commission's data on acreage and production could be used to compute a historical yield series for individual growers.

The County Agricultural Commissioners in California maintain a complete list of current strawberry growers and a record of the acreage of strawberries grown on each farm in conjunction with the monitoring of agricultural chemical use. The Agricultural Commissioners data could be used to augment and corroborate the Strawberry Commission's survey data.

Demand for Insurance

Our assessment is that strawberries are not a particularly good candidate for multiple-peril crop insurance in the major producing areas. The reason is that growers in California, Florida, and the Pacific Northwest (Oregon and Washington), who together produce 95 percent of reported U.S. output, are not likely to be very interested in such insurance. Growers in California, for example, face fewer serious production perils than growers in other parts of

the country. Further, the perils that California growers do face (mainly early spring frost and early fall rains) usually disrupt harvesting for only part of the picking season and are not likely to cause yield losses as large as 25 percent of average yield. Although excessive cold is a serious production peril in Florida, the bulk of Florida strawberries are protected from serious yield losses because of the widespread use of overhead irrigation and row covers.

As with California, strawberries grown in the Pacific Northwest are not likely to experience yield losses that exceed 25 percent of average yields. Disaster assistance payments to Oregon and Washington growers for yield losses for strawberries averaged only 0.047 and 0.106 percent of the crop value between 1988 and 1993.

The small amount of ad hoc disaster assistance paid to growers in California and Florida provides further evidence that there may not be very much demand for crop insurance. There were no payments made to growers in California for yield losses to strawberries between 1988 and 1993 and only \$320,522 (0.1 percent of the value of strawberry sales) to growers in Florida.

A comparison of disaster payments to strawberry growers with those paid to growers of several major field crops provides further evidence of the likely demand for insurance for strawberries. Disaster assistance payments to strawberry growers in the thirteen USDA-reported states amount to only 0.2 percent of the value of crop, compared to 2.4-6.6 percent for major field crops (Table 18). Crop insurance participation on these crops ranged from 24 to 41 percent. Participation in a strawberry insurance policy likely would be much less than for these field crops.

The greatest interest in strawberry insurance is likely to be among growers in southern, eastern, and midwestern states such as Illinois, Indiana, Michigan, Minnesota, New York, Pennsylvania, Tennessee, and Wisconsin. Most of the strawberries in these states are grown as a perennial crop using the matted-row system. Frequently, growers have inadequate protection against late spring frosts, extreme drought, and excessive rainfall. In addition, conditions of extreme heat and excessive moisture, which can result in losses exceeding 25 percent of average yields, are more likely to occur during the critical harvest period in these states than in California and Florida.

Disaster assistance payments during 1988-93 in the southern, eastern, and midwestern states tended to be larger than in the California, Florida, and in the Pacific Northwest. This further suggests that southern, eastern, and midwestern growers face a more serious array of production perils and would, therefore, be more interested in crop insurance.

Notwithstanding potential grower interest, sales of strawberry insurance in the South, East, and Midwest would be severely limited by the small amount of production in these areas. Growers in these areas generally have small strawberry acreages. Frequently, strawberries are grown near population centers, and rely on direct-market sales.

Table 18--Disaster assistance and crop insurance payments as a percent of crop value, selected crops, 1988-92

Crop	Disaster payments	Crop insurance payments	Total	1992 crop insurance participation
	-----Percent of crop value-----			--Percent--
Corn	1.7	1.2	2.9	29
Soybeans	1.4	1.0	2.4	24
Wheat	3.3	3.3	6.6	41
Strawberries	0.2	NA	0.2	NA

NA = not applicable.

Note: Strawberry data reflect 1988-93, and include only states for which NASS reports strawberry production. Data for other crops reflect 1988-92, and all states.

Source: ASCS data files, compiled by the General Accounting Office, and USDA, NASS.

Defining "Areas" for the Non-Insured Assistance Program

The Non-insured Assistance program (NAP) of 1994 Crop Insurance Reform covers crops that are not currently insured by FCIC--including strawberries--until the development of an insurance policy. Under NAP, an "area" must incur at least a 35-percent yield loss in order to trigger assistance payments. The definition of "areas" for purposes of calculating "area average yield" may determine whether or not growers with a qualifying yield loss (50 percent or greater of the individual average) can qualify for NAP payments.

In California, defining "areas" along county lines or perhaps the regions defined in earlier tables in this report would provide a more equitable method for triggering NAP payments than would defining areas along state lines. The reasons are that California is a large state, and growers in different regions harvest at such different times of the year that a condition causing yield losses in one part of the state or during one part of the season most likely would not affect yields in other regions in the same way.

Having made the argument for defining sub-state areas, it needs to be pointed out that in the case of strawberries, California growers probably would not qualify for NAP payments regardless of the area definitions. The reason is that area average yields in California are not likely to fall below 65 percent of normal with any area definition.

In the minor strawberry states, area yields may need to be defined along state lines, or at least at a greater level of aggregation than along county lines. The reason is that in some counties there are so few growers and most of the growers have such small acreages that one larger grower's yield may effectively determine the county average.

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Strawberry Contacts

California:

David Riggs, President
California Strawberry Commission
Watsonville, California
(408) 724-1301

George Faxon, Manager
Processing Strawberry Advisory Board of California
Watsonville, California
(408) 724-5454

Norman Walch, Farm Advisor
Santa Cruz-Monterey Counties
Watsonville, California
(408) 736-8040

Florida:

Chip Hinton, Executive Director
Florida Strawberry Growers Association
(813) 752-6822

Tim Crocker, Extension Horticulturist
University of Florida
Gainesville, Florida
(904) 392-4711 Ext. 310

Indiana:

Bruce Bordelon, Extension Horticulturist
Purdue University
West Lafayette, Indiana
(317) 494-8212

Illinois:

Alan Otterbacher, Professor of Horticulture
University of Illinois
Urbana, Illinois
(217) 333-4210

Michigan:

Eric Hanson, Extension Horticulturist
Michigan State University
(517) 355-2261

Minnesota:

Emily Hoover, Extension Horticulturist
University of Minnesota
(612) 624-6220

New Jersey:

Joseph Fiola, Extension Horticulturist
Rutgers University
Cream Ridge Research Center
(609) 758-7311

New York:

Marvin Pritt, Small Fruit Specialist
Cornell University
Ithaca, New York
(607) 255-4568

Frank Wiles, Director
N.Y. State Berry Growers Association
(607) 687-2874

North Carolina:

E.B. Poling, Professor
Dept. of Horticulture
North Carolina State University
(919) 515-5365

Sara Stover, Secretary
North Carolina Strawberry Association
(919) 515-1221

Ohio:

Mike Pullins, Director
Ohio Fruit Growers Association
(614) 249-2424

Joseph Sheerens, Professor of Horticulture
Ohio Agricultural Experiment Station
Wooster, Ohio
(216) 263-3826

Pennsylvania:

Barbara Goulart, Professor of Pomology
The Pennsylvania State University
University Park, Pennsylvania

(814) 863-2303

Oregon:

Jan Marie Schroeder, Administrator
Oregon Strawberry Commission
Salem, Oregon
(503) 399-8456

Bernadine Strik, Extension Berry Specialist
Oregon State University
(503) 737-5434

Washington:

Norval Johanson, Manager
Washington Strawberry Commission
Olympia, Washington
(206) 491-6567

Wisconsin:

Brian Smith, Extension Horticulturist
University of Wisconsin at River Falls
(715) 425-3851

Appendix table 1--Farms producing strawberries and acres harvested and irrigated, 1982, 1987, and 1992

State and major counties	1992			1987			1982		
	Number of farms	Harvested acres	Production Acres	Irrigated Farms	Harvested acres	Production Acres	Irrigated Farms	Harvested acres	Production Acres
		1,000 pounds			1,000 pounds			1,000	
California	534,002	723	12,423	831	16,600	725,431	831	16,600	723 12,423
Fresno	1,879	33	112	27	219	6,923	27	219	33 112
Los Angeles	8,543	25	267	30	235	8,109	30	235	25 267
Monterey	111,871	176	2,898	163	3,600	136,331	163	3,600	176 2,898
Orange	81,023	54	2,250	63	2,279	91,223	63	2,279	54 2,250
San Bernadino	4,833	13	92	21	194	4,721	21	194	13 92
San Diego	51,288	35	1,299	39	1,089	35,477	39	1,089	35 1,299

San Luis Obispo	:		:	46	410	15,010	46	410	:	18	207		
9,594	18	207	:										
Santa Barbara	:		:	220	2,564	110,149	220	2,564	:	127	1,206		
69,834	127	1,206	:										
Santa Clara	:		:	13	192	6,587	13	192	:	28	270		
10,210	28	270	:										
Santa Cruz	:		:	102	1,951	83,158	102	1,951	:	86	1,278		
59,538	86	1,278	:										
Ventura	:		:	33	3,718	225,461	33	3,718	:	33	2,314		
121,816	33	2,314	:										
Other	:		:	74	149	2,282	74	149	:	95	230		
3,573	95	230	:										
	:		:										
	:		:										
	:		:										
Florida	:	215	4,175	80,835	202	4,119	195	3,559	51,203	186	3,544	208	3,942
60,464	196	3,922	:										
Hillsborough	:	137	3,418	72,677	134	3,373	123	2,851	44,156	122	2,843	134	3,141
51,641	132	3,130	:										
Manatee	:	8	156	(N)	8	156	11	77	539	10	(N)	12	277
3,670	12	277	:										
Pasco	:	5	102	933	5	102	12	171	1,813	12	171	9	119
1,331	8	119	:										
Dade	:	6	53	292	5	50	7	44	597	7	44	3	33
318	3	33	:										
Palm Beach	:	6	51	224	4	47	(N)	(N)	(N)	(N)	(N)	(N)	(N)
(N)	(N)	(N)	:										
Polk	:	3	49	(N)	3	49	5	92	(N)	5	(N)	4	(N)
(N)	4	(N)	:										
Other	:	50	346	6,709	43	342	37	324	4,098	30	486	46	372
3,504	37	363	:										
	:		:										
	:		:										
Illinois	:	239	571	1,390	99	323	291	914	2,977	119	556	332	858
3,080	85	406	:										

(N)	McHenry	:	7	33	(N)	5	31	:	7	31	145	4	27	:	(N)	(N)
	(N)	(N)	:													
14	Effingham	:	5	28	24	(N)	4	:	4	(N)	29	2	(N)	:	5	(N)
	(N)	(N)	:													
150	Fayette	:		(not reported)					:	11	69	224	4	24	7	39
	(N)	(N)	:													
92	Lake	:	4	27	15	3	25	:	5	86	159	4	81	:	6	30
	2	(N)	:													
3,066	Other	:	227	510	1,366	94	288	:	280	883	2,803	113	529	:	327	858
	85	406	:													
	:															
	:															
Indiana	:	252	718	2,283	97	479	:	319	993	3,492	115	620	:	385	1,037	
4,567	103	622	:													
568	Clark	:	19	92	163	5	63	:	19	106	466	4	66	:	13	84
	5	(N)	:													
88	Floyd	:	6	43	(N)	1	(N)	:	16	52	98	2	(N)	:	21	(N)
	(N)	(N)	:													
190	La Porte	:	8	38	87	7	37	:	5	(N)	18	3	8	:	8	60
	6	60	:													
(N)	Vanderburgh	:	6	31	122	2	(N)	:	6	(N)	220	3	(N)	:	(N)	(N)
	(N)	(N)	:													
	Other	:	213	514	1,911	82	379	:	273	835	2,690	103	546	:		
	:															
	:															
	:															
	:															

Continued :

	Kennebec	:	13	45	160	5	20	:	20	126	352	8	(N)	:
		:												
	Cumberland	:	15	44	240	8	30	:	20	54	217	8	20	:
		:												
	Lincoln	:	5	41	190	1	(N)	:	4	61	228	1	(N)	:
		:												
	Penobscot	:	7	34	139	3	(N)	:	17	84	263	5	(N)	:
		:												
	Androscoggin	:	11	27	107	4	17	:	13	43	177	5	27	:
		:												
	Other	:	62	162	519	26	99	:	89	220	851	34	172	:
		:												
		:												
		:												
	Maryland	:	202	431	1,518	71	246	:	221	568	2,034	79	360	:
2,278	58	342	:											269
	Prince Georges	:	19	72	351	6	35	:	20	91	397	12	75	:
		:												
	Montgomery	:	9	46	(N)	4	46	:	10	69	303	6	62	:
		:												
	Other	:	174	313	1,167	61	165	:	191	408	1,334	61	223	:
		:												
		:												
	Michigan	:	453	2,131	8,858	311	1,795	:	532	2,911	14,543	347	2,360	:
18,630	445	3,048	:											759
	Berrien	:	46	305	1,939	32	289	:	55	476	2,953	43	391	:
3,962	51	547	:											571
	Leelanau	:	10	162	632	10	149	:	5	207	1,279	13	(N)	:
1,683	21	198	:											25
	Van Buren	:	11	144	952	9	143	:	21	331	1,889	16	311	:
2,725	21	327	:											27
	Manistee	:	12	140	608	12	140	:	20	211	1,406	20	(N)	:
1,274	20	201	:											21
	Washtenaw	:	18	112	372	10	75	:	15	104	429	10	97	:
961	13	(N)	:											23
														162

616	Kent	:	21	112	259	15	68	:	18	97	459	11	66	:	30	159
	18	97	:													
470	Genesee	:	12	93	317	12	93	:	12	88	355	9	79	:	18	136
	11	132	:													
514	Alpena	:	10	78	149	5	63	:	8	73	592	8	(N)	:	12	105
	8	94	:													
512	Oakland	:	9	49	222	6	43	:	12	56	214	11	46	:	19	106
	13	97	:													
144	Houghton	:	16	49	93	10	26	:	19	73	106	8	29	:	21	63
	11	36	:													
410	Macomb	:	8	47	218	2	(N)	:	16	101	441	5	(N)	:	22	78
	4	45	:													
244	Kalamazoo	:	8	44	103	5	23	:	13	47	132	9	37	:	13	56
	6	(N)	:													
29	Bay	:	8	41	50	4	37	:	6	(N)	58	3	(N)	:	10	(N)
	3	(N)	:													
173	Saginaw	:	8	39	155	5	32	:	11	29	72	4	11	:	19	104
	7	52	:													
242	Lapeer	:	5	36	236	5	36	:	10	61	409	7	(N)	:	8	38
	5	(N)	:													
4,671	Other	:	251	680	2,553	169	578	:	291	957	3,749	170	1,293	:	420	1,232
	233	1,222	:													
	:															
	:															
	:															

Continued :

Appendix table 1--Farms producing strawberries and acres harvested and irrigated, 1982, 1987, and 1992, continued

State and major counties	1992			1987			1982		
	Number of farms	Harvested acres	Production Acres	Irrigated Farms	Harvested acres	Production Acres	Irrigated Farms	Harvested acres	Production Acres
		1,000 pounds			1,000 pounds			1,000	
Minnesota	2,458	124	602		229	827	2,804	135	644
Dakota	(N)	7	32		11	47	220	7	35
Hennepin	159	10	43		10	39	71	7	22
Houston	(N)	1	(N)		5	47	142	2	(N)
Otter Tail	82	6	36		9	33	122	7	15
Sherburne	(N)	8	(N)		8	147	149	6	137
Washington	648	7	(N)		12	118	660	11	117

	Other	:	0	0	0	0	0	:	174	396	1,440	95	318	:	206	513
1,569	85	491	:					:						:		
		:						:						:		
	New Jersey	:	255	532	1,407	119	306	:	269	598	2,161	123	309	:	310	(N)
2,487	137	382	:					:						:		
	Burlington	:	26	80	229	13	47	:	36	135	606	16	73	:		
		:						:						:		
	Cumberland	:	21	67	143	13	58	:	26	52	154	14	27	:		
		:						:						:		
	Gloucester	:	30	47	115	17	39	:	22	51	191	12	45	:		
		:						:						:		
	Monmouth	:	28	45	123	9	7	:	33	92	305	13	26	:		
		:						:						:		
	Other	:	150	293	796	67	155	:	152	268	904	68	138	:	310	0
2,487	137	382	:					:						:		
		:						:						:		
	New York	:	564	1,991	7,297	277	1,298	:	594	2,369	8,938	321	1,575	:	717	2,817
10,278	310	1,528	:					:						:		
	Chautauqua	:	24	186	589	11	108	:	27	233	423	14	38	:		
		:						:						:		
	Erie	:	30	184	585	19	138	:	38	309	1,382	21	274	:		
		:						:						:		
	Monroe	:	34	178	585	17	93	:	36	170	567	18	87	:		
		:						:						:		
	Suffolk	:	47	149	561	31	117	:	68	246	931	53	215	:		
		:						:						:		
	Onondaga	:	20	126	477	9	67	:	20	157	764	11	126	:		
		:						:						:		
	Niagara	:	27	74	335	7	31	:	22	43	136	8	(N)	:		
		:						:						:		
	Jefferson	:	9	65	(N)	3	49	:	6	(N)	286	5	(N)	:		
		:						:						:		
	Cayuga	:	11	61	182	6	40	:	6	(N)	98	2	(N)	:		
		:						:						:		

	Ontario	:	14	58	307	11	55	:	15	46	169	10	41	:
		:												
	Oneida	:	14	52	192	4	28	:	14	57	181	5	(N)	:
		:												
	Dutchess	:	10	49	181	5	42	:	10	70	354	10	56	:
		:												
	Columbia	:	19	45	179	10	33	:	14	55	212	8	26	:
		:												
	Tioga	:	10	44	213	6	29	:	6	37	304	6	(N)	:
		:												
	Wayne	:	31	44	119	8	19	:	30	65	208	13	35	:
		:												
	Oswego	:	21	42	184	8	27	:	23	83	285	9	70	:
		:												
	Broome	:	7	40	183	6	40	:	4	30	135	4	(N)	:
		:												
	Ulster	:	15	36	75	9	27	:	13	30	207	8	(N)	:
		:												
	Other	:	221	558	2,350	107	355	:	242	738	2,295	116	607	:
10,278	310	1,528	:											
			:											
			:											
			:											
			:											

Continued :

Appendix table 1--Farms producing strawberries and acres harvested and irrigated, 1982, 1987, and 1992, continued

State and major counties	1992			1987			1982			
	Harvested Irrigated	Number of farms	Harvested acres	Harvested Irrigated	Number of farms	Harvested acres	Harvested Irrigated	Number of farms	Harvested acres	
			1,000 pounds			1,000 pounds			1,000	
North Carolina	4,242	190	644	427	1,255	4,369	252	944	460	1,205
Cumberland	(N)	2	(N)	3	45	282	3	(N)	3	(N)
Davidson	122	8	(N)	9	35	83	6	29	18	(N)
Guilford	84	11	43	22	82	188	15	37	25	(N)
Rockingham	97	12	(N)	17	69	211	13	61	22	54
Stokes	137	12	(N)	16	49	135	11	36	20	53
Surry	121	6	(N)	36	101	294	16	60	32	74
Union	(N)	2	(N)	6	40	143	5	(N)	4	(N)

156	Wake	:						7	51	279	7	51	:	8	25	
	8	25	:													
	Other	:	0	0	0	0	0	311	783	2,753	176	670	:	328	999	
3,525	129	576	:													
			:													
			:													
Ohio		:	499	1,274	4,973	158	686	:	545	1,811	8,265	237	1,314	:	715	2,122
10,699	200	1,440	:													
	Columbi ana	:	22	98	407	8	50	:	25	146	698	9	76	:		
		:														
	Wayne	:	29	83	167	3	3	:	24	52	318	6	39	:		
		:														
	Lorain	:	24	74	347	9	56	:	28	57	174	10	23	:		
		:														
	Mahoning	:	15	73	282	5	29	:	22	113	470	8	58	:		
		:														
	Tuscarawas	:	5	64	230	2	(N)	:	6	(N)	900	4	(N)	:		
		:														
	Mi ami	:	9	54	186	6	13	:	5	(N)	(N)	4	(N)	:		
		:														
	Portage	:	7	49	182	4	31	:	10	67	433	3	(N)	:		
		:														
	Ottawa	:	6	46	243	4	(N)	:	5	(N)	(N)	2	(N)	:		
		:														
	Franklin	:	7	39	129	5	35	:	9	61	338	7	59	:		
		:														
	Other	:	375	694	2,800	112	469	:	411	1,315	4,934	184	1,059	:	715	2,122
10,699	200	1,440	:													
			:													
			:													
Oregon		:	391	5,743	53,480	343	5,156	:	487	7,897	76,319	397	6,354	:	547	6,268
54,331	434	4,961	:													
	Marion	:	114	2,320	21,537	106	2,171	:	128	2,384	24,935	117	2,142	:		
		:														
	Washington	:	57	1,919	19,350	53	1,824	:	104	2,675	29,615	80	1,920	:		
		:														

Clackamas	:	44	586	6,239	31	458	:	79	860	7,853	54	593	:
	:												
Yamhill	:	25	289	2,484	20	259	:	23	406	2,851	19	368	:
	:												
Multnomah	:	21	228	1,635	13	68	:	21	481	2,846	12	354	:
	:												
Linn	:	27	140	1,103	25	139	:	23	180	976	19	177	:
	:												
Lane	:	23	51	282	23	51	:	24	121	548	23	114	:
	:												
Polk	:	12	37	227	11	35	:	17	234	2,093	14	218	:
	:												
Columbia	:	4	(N)	(N)	2	(N)	:	9	368	(N)	4	(N)	:
	:												
Other	:	64	173	623	59	151	:	59	188	4,602	55	468	:
	:												
	:												
	:												
	:												

Continued :

Appendix table 1--Farms producing strawberries and acres harvested and irrigated, 1982, 1987, and 1992, continued

State and major counties	1992						1987						1982			
	Irrigated		Production				Irrigated		Production				Irrigated		Production	
	Number of farms	Harvested acres	Farms	Acres	Production	Farms	Acres	Number of farms	Harvested acres	Farms	Acres	Production	Farms	Acres	Number of farms	Harvested acres
	Farms	Acres	Farms	Acres	1,000 pounds	Farms	Acres	Farms	Acres	Farms	Acres	1,000 pounds	Farms	Acres	Farms	Acres
Pennsylvania	813	1,547	240	774	6,108	882	1,899	280	1,038	1,022	2,064					
8,143	232	1,017														
Lancaster	148	123	27	31	531	144	178	37	81							
York	56	122	11	46	495	66	194	16	69							
Erie	21	79	12	66	548	27	104	20	93							
Indiana	13	72	7	68	175	8	20	2	(N)							
Bucks	31	69	7	15	230	35	73	8	33							
Cumberland	20	66	8	19	172	20	77	8	36							

Columbia	:	12	54	287	3	(N)	:	14	49	199	1	(N)	:		
	:														
Berks	:	48	52	268	16	33	:	33	54	156	12	27	:		
	:														
Franklin	:	21	43	161	7	19	:	26	46	108	11	29	:		
	:														
Mercer	:	16	43	150	6	27	:	21	92	237	4	(N)	:		
	:														
Washington	:	8	41	118	5	39	:	10	30	156	4	(N)	:		
	:														
Bradford	:	8	37	101	4	34	:	6	16	51	3	(N)	:		
	:														
Schuylkill	:	22	36	98	5	7	:	19	45	147	8	23	:		
	:														
Other	:	389	710	2,775	122	370	:	453	921	3,449	146	647	:		
	:														
	:														
Tennessee	:	202	646	2,783	42	200	:	312	694	2,019	76	296	:	371	861
2,411	30	241	:												
	:														
	:														
Virginia	:	201	520	1,979	73	274	:	274	752	2,475	107	422	:	317	917
2,770	78	377	:												
Virginia Beach	:	11	95	396	5	54	:	8	107	401	1	(N)	:		
	:														
Other	:	190	425	1,583	68	220	:	266	645	2,074	106	422	:		
	:														
	:														
Washington	:	146	1,679	12,601	94	773	:	211	2,749	20,886	123	1,267	:	232	2,581
17,906	177	1,074	:												
Skagit	:	18	625	4,702	4	3	:	25	983	8,177	9	101	:		
	:														
Whatcom	:	14	488	4,829	10	478	:	20	609	6,030	20	588	:		
	:														

Pierce	:	18	142	695	12	62	:	20	289	1,648	10	113	:
	:												
Snohomish	:	9	91	744	1	(N)	:	22	202	848	5	(N)	:
	:												
King	:	11	91	283	3	(N)	:	20	157	1,003	3	6	:
	:												
Thurston	:	7	52	311	7	52	:	8	96	498	8	96	:
	:												
Other	:	69	190	1,037	57	178	:	96	413	2,682	68	363	:
	:												
	:												
	:												
	:												

Continued :

Appendix table 1--Farms producing strawberries and acres harvested and irrigated, 1982, 1987, and 1992, continued

State and major counties	1992					1987					1982	
	Number of farms	Harvested acres	Production Acres	Irrigated Farms	Acres	Number of farms	Harvested acres	Production Acres	Irrigated Farms	Acres	Number of farms	Harvested acres
			1,000 pounds					1,000 pounds				1,000
Wisconsin	314	1,243	4,687	176	977	292	1,282	4,748	157	1,055	447	1,629
Dodge	11	65	177	4	22	3	(N)	(N)	2	(N)		
Oconto	5	55	100	3	54	3	(N)	(N)	1	(N)		
Marathon	6	50	279	6	48	(N)	(N)	(N)	(N)	(N)		
Dane	18	49	217	8	36	23	62	311	12	45		
Barron	6	48	(N)	4	(N)	5	37	159	3	(N)		
Waupaca	8	48	169	4	47	2	(N)	(N)	2	(N)		

Jackson	:	10	43	176	5	25	:	6	14	70	2	(N)	:
	:												
Racine	:	4	42	(N)	2	(N)	:	7	(N)	(N)	2	(N)	:
	:												
La Crosse	:	8	37	89	4	(N)	:	10	(N)	97	3	(N)	:
	:												
Other	:	238	806	3,480	136	745	:	233	1,169	4,111	130	1,010	:
	:												
	:												
	:												
These States	:	4,667	22,961	188,925	2,311	17,392	:	7,170	48,573	943,093	4,032	39,780	:
749,024	3,866	34,604	:										
United States	:						:	9,398	53,085	958,739	5,020	42,584	:
763,719	4,686	36,690	:										

(N): Indicates "not available" or "not published" to avoid disclosure of individual operations.

Note: Counties are sorted by 1992 harvested acreage.

Source: Censuses of Agriculture, various years.

Appendix table 2--Size distribution of farms producing strawberries, 1987

State	All farms	-----Total value of crop sales-----				
		\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
	-Number-	-----Percent of farms-----				
Arkansas	98	0	5	5	7	83
California	831	20	18	11	15	36
Florida	195	11	39	22	7	20
Illinois	291	0	7	11	9	73
Indiana	319	1	8	7	7	78
Michigan	532	2	16	11	10	61
New Jersey	269	1	15	9	13	62
New York	594	2	19	12	13	54
North Carolina	427	0	9	10	10	71
Ohio	545	1	11	11	11	66
Oregon	487	8	29	15	12	36
Pennsylvania	882	1	9	8	14	68
Washington	211	7	18	9	13	53
Wisconsin	292	1	8	8	12	71
Other States	3,425	1	6	7	10	77
U.S.	9,398	3	12	9	11	65

Source: 1987 Census of Agriculture.

Appendix table 3--Organizational type of farms growing strawberries,
by sales, class, 1987

Organizational type and state	All farms	-----Total value of crop sales-----				
		\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
		-----Number of farms-----				
Individual or family						
Arkansas	82	0	2	4	7	69
California	578	55	104	66	95	258
Florida	142	3	60	35	9	35
Illinois	247	0	12	29	19	187
Indiana	280	1	15	18	17	229
Michigan	461	5	61	43	47	305
New Jersey	227	0	29	12	29	157
New York	458	1	56	58	57	286
North Carolina	373	1	25	37	38	272
Ohio	458	0	31	44	51	332
Oregon	377	15	92	65	44	161
Pennsylvania	758	1	35	50	113	559
Washington	172	6	26	16	25	99
Wisconsin	250	0	12	19	29	190
Other	2,960	5	110	166	273	2,406
U.S.	7,823	93	670	662	853	5,545
Partnership						
Arkansas	11	0	2	1	0	8
California	149	52	29	16	19	33
Florida	25	6	9	6	3	1
Illinois	33	0	4	3	3	23
Indiana	26	1	2	2	3	18
Michigan	50	5	15	9	6	15
New Jersey	22	2	3	10	5	2
New York	83	5	28	8	16	26
North Carolina	41	0	11	2	2	26
Ohio	48	0	10	14	4	20
Oregon	56	10	18	7	9	12
Pennsylvania	89	2	27	14	9	37
Washington	15	1	4	0	2	8
Wisconsin	20	1	4	2	2	11
Other	288	7	44	27	44	166
U.S.	956	92	210	121	127	406

Continued

Appendix table 3--Organizational type of farms growing strawberries,
by sales, class, 1987, continued

Organizational type and state	All farms	-----Total value of crop sales-----				
		\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
-----Number of farms-----						
Corporation						
Family held						
Arkansas	1	0	1	0	0	0
California	80	55	13	4	4	4
Florida	18	11	2	2	1	2
Illinois	9	1	4	0	2	2
Indiana	8	0	8	0	0	0
Michigan	20	2	8	5	2	3
New Jersey	17	0	9	2	2	4
New York	50	6	28	5	3	8
North Carolina	10	1	1	3	2	3
Ohio	35	3	19	3	2	8
Oregon	52	13	31	1	4	3
Pennsylvania	26	5	12	5	2	2
Washington	21	8	8	2	1	2
Wisconsin	20	2	7	3	3	5
Other	133	17	34	23	15	44
U.S.	500	124	185	58	43	90
Other than family held						
Arkansas	0	0	0	0	0	0
California	9	4	0	0	5	0
Florida	8	2	6	0	0	0
Illinois	1	0	0	0	1	0
Indiana	1	0	0	0	0	1
Michigan	0	0	0	0	0	0
New Jersey	0	0	0	0	0	0
New York	2	0	2	0	0	0
North Carolina	0	0	0	0	0	0
Ohio	2	1	0	1	0	0
Oregon	2	0	1	0	0	1
Pennsylvania	6	1	4	0	1	0
Washington	1	0	0	0	0	1
Wisconsin	0	0	0	0	0	0
Other	11	0	3	0	1	7
U.S.	43	8	16	1	8	10

Continued

Appendix table 3--Organizational type of farms growing strawberries,
by sales, class, 1987, continued

Organizational type and state	-----Total value of crop sales-----					
	All farms	\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
	-----Number of farms-----					
Other						
Arkansas	4	0	0	0	0	4
California	15	0	3	4	4	4
Florida	2	0	0	0	1	1
Illinois	1	0	0	0	1	0
Indiana	4	0	0	2	1	1
Michigan	1	0	0	1	0	0
New Jersey	3	0	0	0	0	3
New York	1	0	0	0	0	1
North Carolina	3	0	1	1	0	1
Ohio	2	0	0	0	1	1
Oregon	0	0	0	0	0	0
Pennsylvania	3	1	1	1	0	0
Washington	2	0	0	0	0	2
Wisconsin	2	0	0	0	0	2
Other	33	0	3	7	5	18
U.S.	76	1	8	16	13	38

Source: 1987 Census of Agriculture.

Appendix table 4--Principal occupation and number of days worked off the farm by operators of farms growing strawberries, by sales class, 1987

Item	-----Total value of crop sales-----					
	All farms	\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
-----Number of farms-----						
Farming is main occupation						
Arkansas	60	0	5	5	7	43
California	731	158	140	82	112	239
Florida	147	21	70	31	12	13
Illinois	139	1	20	28	18	72
Indiana	151	2	22	17	17	93
Michigan	327	12	82	50	49	134
New Jersey	163	2	41	24	25	71
New York	438	12	110	63	60	193
North Carolina	255	2	34	40	40	139
Ohio	331	4	56	55	45	171
Oregon	368	38	140	64	38	88
Pennsylvania	612	8	76	66	111	351
Washington	134	15	36	16	19	48
Wisconsin	174	3	23	20	29	99
Other	1,935	27	179	210	270	1,249
U.S.	5,965	305	1,034	771	852	3,003
-----Percent of all farms-----						
Arkansas	61.2	0.0	5.1	5.1	7.1	43.9
California	88.1	19.0	16.9	9.9	13.5	28.8
Florida	75.5	10.8	35.9	15.9	6.2	6.7
Illinois	47.8	0.3	6.9	9.6	6.2	24.8
Indiana	47.3	0.6	6.9	5.3	5.3	29.2
Michigan	61.5	2.3	15.4	9.4	9.2	25.2
New Jersey	60.6	0.7	15.3	8.9	9.3	26.4
New York	73.7	2.0	18.5	10.6	10.1	32.5
North Carolina	59.8	0.5	7.9	9.4	9.4	32.6
Ohio	60.8	0.7	10.3	10.1	8.3	31.4
Oregon	75.6	7.8	28.8	13.1	7.8	18.1
Pennsylvania	69.4	0.9	8.6	7.5	12.6	39.8
Washington	63.5	7.1	17.1	7.6	9.0	22.7
Wisconsin	59.5	1.0	7.9	6.8	9.9	33.9
Other	56.5	0.8	5.2	6.1	7.9	36.5
U.S.	63.4	3.2	11.0	8.2	9.1	31.9

Continued

Appendix table 4--Principal occupation and number of days worked off the farm by operators of farms growing strawberries, by sales class, 1987, continued

Item	-----Total value of crop sales-----					
	All farms	\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
-----Number of farms-----						
Operator days off-farm						
None						
Arkansas	42	0	4	4	4	30
California	452	134	100	41	59	118
Florida	120	17	55	19	10	19
Illinois	105	1	18	21	12	53
Indiana	109	2	11	11	14	71
Michigan	241	12	62	31	30	106
New Jersey	117	2	33	17	13	52
New York	322	10	91	40	42	139
North Carolina	175	1	25	31	22	96
Ohio	230	2	43	37	33	115
Oregon	262	36	108	41	21	56
Pennsylvania	384	7	62	51	69	195
Washington	94	14	26	10	12	32
Wisconsin	122	2	16	14	21	69
Other	1,287	21	146	131	171	818
U.S.	4,062	261	800	499	533	1,969
Any						
Arkansas	50	0	0	1	3	46
California	317	28	38	41	65	145
Florida	66	3	17	22	4	20
Illinois	177	0	2	9	13	153
Indiana	197	0	10	10	7	170
Michigan	262	0	14	23	20	205
New Jersey	135	0	6	5	18	106
New York	248	0	20	28	31	169
North Carolina	231	1	11	10	19	190
Ohio	287	0	15	23	22	227
Oregon	210	1	29	29	35	116
Pennsylvania	427	3	13	17	46	348
Washington	109	1	10	8	14	76
Wisconsin	162	0	6	9	13	134
Other	1,975	6	37	85	154	1,693
U.S.	4,853	43	228	320	464	3,798

Continued

Appendix table 4--Principal occupation and number of days worked off the farm by operators of farms growing strawberries, by sales class, 1987, continued

Item	-----Total value of crop sales-----					
	All farms	\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
-----Number of farms-----						
Operator days off-farm, continued						
1 to 99 days						
Arkansas	13	0	0	1	3	9
California	95	12	12	11	18	42
Florida	17	3	6	3	3	2
Illinois	27	0	2	4	4	17
Indiana	32	0	6	4	0	22
Michigan	60	0	10	13	9	28
New Jersey	20	0	4	4	4	8
New York	76	0	11	14	9	42
North Carolina	51	1	4	4	9	33
Ohio	58	0	7	10	4	37
Oregon	72	1	22	14	10	25
Pennsylvania	138	1	8	11	25	93
Washington	29	1	5	3	4	16
Wisconsin	36	0	3	5	1	27
Other	487	5	19	48	70	345
U.S.	1,211	24	119	149	173	746
100 to 199 days						
Arkansas	14	0	0	0	0	14
California	97	4	7	14	27	45
Florida	11	0	3	4	0	4
Illinois	28	0	0	2	3	23
Indiana	44	0	3	3	4	34
Michigan	68	0	4	6	4	54
New Jersey	35	0	2	0	2	31
New York	63	0	5	6	12	40
North Carolina	30	0	1	4	2	23
Ohio	59	0	2	5	8	44
Oregon	38	0	3	4	12	19
Pennsylvania	84	1	2	5	11	65
Washington	21	0	3	2	6	10
Wisconsin	40	0	2	3	5	30
Other	399	0	5	14	29	351
U.S.	1,031	5	42	72	125	787

Continued

Appendix table 4--Principal occupation and number of days worked off the farm by operators of farms growing strawberries, by sales class, 1987, continued

Item	-----Total value of crop sales-----					
	All farms	\$500,000 or more	\$100,000 to \$499,999	\$50,000 to \$99,999	\$25,000 to \$49,999	Less than \$25,000
-----Number of farms-----						
Operator days off-farm, continued						
200 days or more						
Arkansas	23	0	0	0	0	23
California	125	12	19	16	20	58
Florida	38	0	8	15	1	14
Illinois	122	0	0	3	6	113
Indiana	121	0	1	3	3	114
Michigan	134	0	0	4	7	123
New Jersey	80	0	0	1	12	67
New York	109	0	4	8	10	87
North Carolina	150	0	6	2	8	134
Ohio	170	0	6	8	10	146
Oregon	100	0	4	11	13	72
Pennsylvania	205	1	3	1	10	190
Washington	59	0	2	3	4	50
Wisconsin	86	0	1	1	7	77
Other	1,089	1	13	23	55	997
U.S.	2,611	14	67	99	166	2,265
Not reported						
Arkansas	6	0	1	0	0	5
California	62	4	11	8	3	36
Florida	9	2	5	2	0	0
Illinois	9	0	0	2	1	6
Indiana	13	0	4	1	0	8
Michigan	29	0	8	4	5	12
New Jersey	17	0	2	2	5	8
New York	24	2	3	3	3	13
North Carolina	21	0	2	2	1	16
Ohio	28	2	2	2	3	19
Oregon	15	1	5	3	1	5
Pennsylvania	71	0	4	2	10	55
Washington	8	0	2	0	2	4
Wisconsin	8	1	1	1	0	5
Other	163	2	11	7	13	130
U.S.	483	14	61	39	47	322

Source: 1987 Census of Agriculture.

Appendix table 5--Strawberry acreage, yield, and production in California, selected counties, 1980-92

County	Year	Harvest		Production	Fresh Market	Processed Market
		Area	Yield			
		Acres	Tons/acre	Tons	Tons	Tons
Fresno	1980	105	15.00	1,580		
	1981	83	11.30	934		
	1982	75	11.00	825		
	1983	218	15.60	3,400		
	1984	247	12.00	2,960		
	1985	250	10.30	2,580		
	1986	210	15.50	3,260		
	1987	181	17.00	3,080		
	1988	200	13.80	2,760		
	1989	275	12.50	3,440		
	1990	180	13.50	2,430		
	1991	650	13.70	8,880		
	1992	680	11.20	7,600	n/a	
Los Angeles	1980	401	22.60	9,063		
	1981	405	24.90	10,092		
	1982	430	21.20	9,116		
	1983	384	20.10	7,720		
	1984	404	20.80	8,390		
	1985	395	23.70	9,335		
	1986	305	21.80	6,645		
	1987	279	20.40	5,681		
	1988	348	14.00	4,886		
	1989	216	17.40	3,758		
	1990	173	26.10	4,520		
	1991	203	29.90	6,070		
	1992	191	27.50	5,250	n/a	
Monterey	1980	2,785	21.25	59,185		
	1981	2,560	22.54	57,695		
	1982	2,650	28.73	76,145		
	1983	2,945	27.90	82,165		
	1984	3,245	29.40	95,400	80,800	14,600
	1985	3,500	28.87	101,058	84,000	17,058
	1986	3,625	27.88	101,050	93,000	8,050
	1987	4,065	26.94	109,500	97,500	12,000
	1988	5,105	24.95	127,360	118,200	9,160
	1989	5,050	23.13	116,800	102,000	14,800
	1990	5,830	31.46	183,400	147,000	36,400
	1991	6,320	26.98	170,500	147,000	23,500
	1992	6,960	28.84	200,700	180,000	20,700

Continued

Appendix table 5--Strawberry acreage, yield, and production in California, selected counties, 1980-92, continued

County	Year	Harvest		Production	Fresh Market	Processed Market
		Area	Yield			
		Acres	Tons/acre	Tons	Tons	Tons
Orange	1980	1,751	34.10	59,727		
	1981	2,164	32.10	69,486		
	1982	2,396	30.00	71,880		
	1983	2,468	29.80	73,522		
	1984	2,756	30.00	82,680		
	1985	2,790	30.30	84,537		
	1986	2,413	35.30	85,251		
	1987	2,498	28.40	70,993		
	1988	2,336	28.10	65,735		
	1989	2,197	26.80	58,880		
	1990	1,536	32.50	49,920		
	1991	1,820	32.20	58,695		
	1992	1,731	30.30	52,363	n/a	
San Bernadino	1980	92	19.10	1,760		
	1981	91	24.50	2,230		
	1982	115	25.80	2,970		
	1983	165	23.50	3,880		
	1984	180	30.50	5,490		
	1985	255	30.00	7,650		
	1986	235	31.20	7,330		
	1987	263	29.50	7,765		
	1988	339	22.80	7,733		
	1989	214	22.30	4,777		
	1990	174	22.00	3,828		
	1991	170	21.20	3,597		
	1992	181	21.00	3,801	n/a	
San Diego	1980	915	22.00	20,130	20,130	
	1981	969	32.90	31,880	31,880	
	1982	1,004	29.00	29,116	29,116	
	1983	1,220	24.70	30,134	30,134	
	1984	1,086	24.50	26,607	20,707	5,900
	1985	1,344	24.80	33,331	18,332	14,999
	1986	1,045	22.50	23,513	15,284	8,229
	1987	1,193	20.59	24,567	16,378	8,189
	1988	1,103	22.00	24,266	14,560	9,706
	1989	872	28.68	25,010	19,010	6,000
	1990	834	28.91	24,111	17,956	6,155
	1991	943	28.06	26,460	19,567	6,893
	1992	1,078	25.42	27,403	19,178	8,225

Continued

Appendix table 5--Strawberry acreage, yield, and production in California, selected counties, 1980-92, continued

County	Year	Harvest	Yield	Produc-	Fresh	Processed
		Area		tion	Market	Market
		Acres	Tons/acre	Tons	Tons	Tons
San Luis Obispo	1980	140	19.10	2,678		
	1981	141	21.80	3,067		
	1982	161	18.00	2,898		
	1983	207	26.00	5,382		
	1984	212	24.00	5,088		
	1985	212	26.00	5,512		
	1986	246	26.50	6,519		
	1987	349	24.00	8,376		
	1988	369	24.00	8,856		
	1989	426	22.00	9,372		
	1990	596	22.70	13,548		
	1991	518	18.80	9,738		
	1992	805	17.40	14,031	n/a	
Santa Barbara	1980	836	20.10	16,804	16,804	
	1981	750	16.80	12,600	12,600	
	1982	924	32.25	29,800	29,800	
	1983	996	30.50	30,378	30,378	
	1984	1,203	30.48	36,665	32,990	3,675
	1985	1,616	30.66	49,542	42,905	6,637
	1986	1,687	30.04	50,678	45,144	5,534
	1987	2,611	25.79	67,345	61,458	5,887
	1988	3,428	23.27	79,772	60,003	19,769
	1989	4,617	22.78	105,159	84,883	20,276
	1990	4,530	19.64	88,954	71,423	17,531
	1991	5,014	21.47	107,636	70,031	37,605
	1992	5,280	15.26	80,578	58,666	21,912
Santa Clara	1980	290	19.00	5,510		
	1981	250	15.00	3,750		
	1982	240	19.00	4,560		
	1983	330	18.00	5,940		
	1984	320	21.00	6,720		
	1985	250	20.00	5,000		
	1986	235	21.00	4,935		
	1987	300	19.00	5,700		
	1988	250	20.00	5,000		
	1989	210	17.00	3,570		
	1990	205	17.00	3,485		
	1991	200	18.00	3,600		
	1992	295	12.50	3,688	n/a	

Continued

Appendix table 5--Strawberry acreage, yield, and production in California, selected counties, 1980-92, continued

County	Year	Harvest	Yield	Produc-	Fresh	Processed
		Area		tion	Market	Market
		Acres	Tons/acre	Tons	Tons	Tons
Santa Cruz	1980	1,355	24.20	32,798		
	1981	1,378	25.40	35,022		
	1982	1,190	23.40	27,812		
	1983	1,758	20.30	35,747		
	1984	2,089	28.20	59,000		
	1985	1,450	24.00	34,800		
	1986	2,056	24.30	50,043		
	1987	2,285	26.50	60,529		
	1988	2,210	27.20	60,200		
	1989	2,241	28.80	64,451		
	1990	2,771	20.70	57,276		
	1991	2,580	28.90	74,639		
	1992	2,578	31.60	81,568	n/a	
Ventura	1980	2,419	25.20	60,983	60,983	
	1981	2,535	23.70	60,105	60,105	
	1982	2,227	22.40	49,820	49,820	
	1983	2,300	28.80	66,345	66,345	
	1984	2,760	20.80	73,490	57,345	16,145
	1985	3,006	22.40	84,897	67,248	17,649
	1986	3,027	18.70	81,866	56,628	25,238
	1987	3,468	18.20	99,936	62,966	36,970
	1988	3,500	23.40	107,420	82,000	25,420
	1989	3,938	19.10	98,565	75,217	23,348
	1990	4,200	18.70	125,231	78,474	46,757
	1991	4,435	18.00	135,717	79,866	55,851
	1992	5,550	14.50	120,113	80,434	39,679

Source: County Agricultural Commissioners' Reports.

Appendix table 6--Strawberry cost of production budgets for selected states

Fresh market: California--Santa Barbara County (2 pages)
Florida--Plant City area (2 pages)
Louisiana--(2 pages)
Virginia--(4 pages)
Ohio--(2 pages)
Pennsylvania--(4 pages)
Tennessee--(5 pages)

Processed: California--Fresno County (1 page)
Oregon--Washington County (2 pages)
Washington--western part of state (2 pages)