CALIFORNIA GEOGRAPHICAL SOCIETY
Volume XXVIII, 1988

THE CHANGING LOCATION OF CALIFORNIA ALMOND PRODUCTION

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During the last hundred years, dramatic changes have occurred in both the location and production of almonds within the United States. These changes were prompted by (1) enhanced knowledge of the areas where almonds can be successfully produced, (2) altered market conditions, (3) improved cultivation techniques, and (4) competing uses of the land.

Historically, almond production has been attempted in many places throughout the United States, including Oregon, Nevada, Arizona, and New Mexico. Due to their climatic requirements, however, more than 99 percent of almonds now produced in the United States are grown in California. Within California, itself, there have been major shifts in the location of the almond industry, as areas more suitable for production have been identified and as almond growing techniques have changed. These shifts can be described in their historical sequence.

Pre-1900—Early Development and Experimentation

The initial attempts to grow almonds in the United States were made in New England and the Middle Atlantic States about 1840. The earliest record of almond plant-

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ing in California took place at Mission Santa Barbara around 1800, at a time when the area was still part of New Spain. These first plantings were abandoned, however, due to unsatisfactory local conditions.[1] During the 1840's and 1850's, there were several additional experimental introductions of almonds into California. Early opinion held that almonds grew best in the strip of coast near the sea between San Diego and Santa Barbara. In the late 1860's and throughout the 1870's, almond planting continued to spread in California.[2] Thus, by 1890, almonds had been planted, at least experimentally, in no less than forty-nine California's fifty-six counties.

At this time the most densely settled part of California was the San Francisco Bay Area. This circumstance, coupled with reports of good returns from almonds in both the Bay Area and Santa Clara Valley, probably accounts for the early concentration of acreage in this region (Figure 1). In the Santa Clara Valley, it was felt that in those localities where almonds could be grown, there was no crop more profitable.[3]

Even so, during the late 1880's and on into the 1890's, there were many years when returns from growing almonds were disappointing. There was much trial and error, with barren almond trees often being grafted into prunes or made into firewood. Gradually, it was determined that in order to secure regularity and abundance in fruiting, sites for almonds orchards had to be picked with utmost care.[4]

Changes in location of almond acreage from 1890 to 1900 (Figure 1 and Figures 3-10) resulted primarily from the search for favorable climatic and soil conditions. Much of the shift in acreage occurred within individual counties and is, therefore, not apparent. Statistics from 1890-1900 indicate that almond acreage expanded rapidly in Southern California, while the Santa Clara Valley continued its decline from its earlier pre-eminence, and the Sacramento Valley was proving to be an area where con-

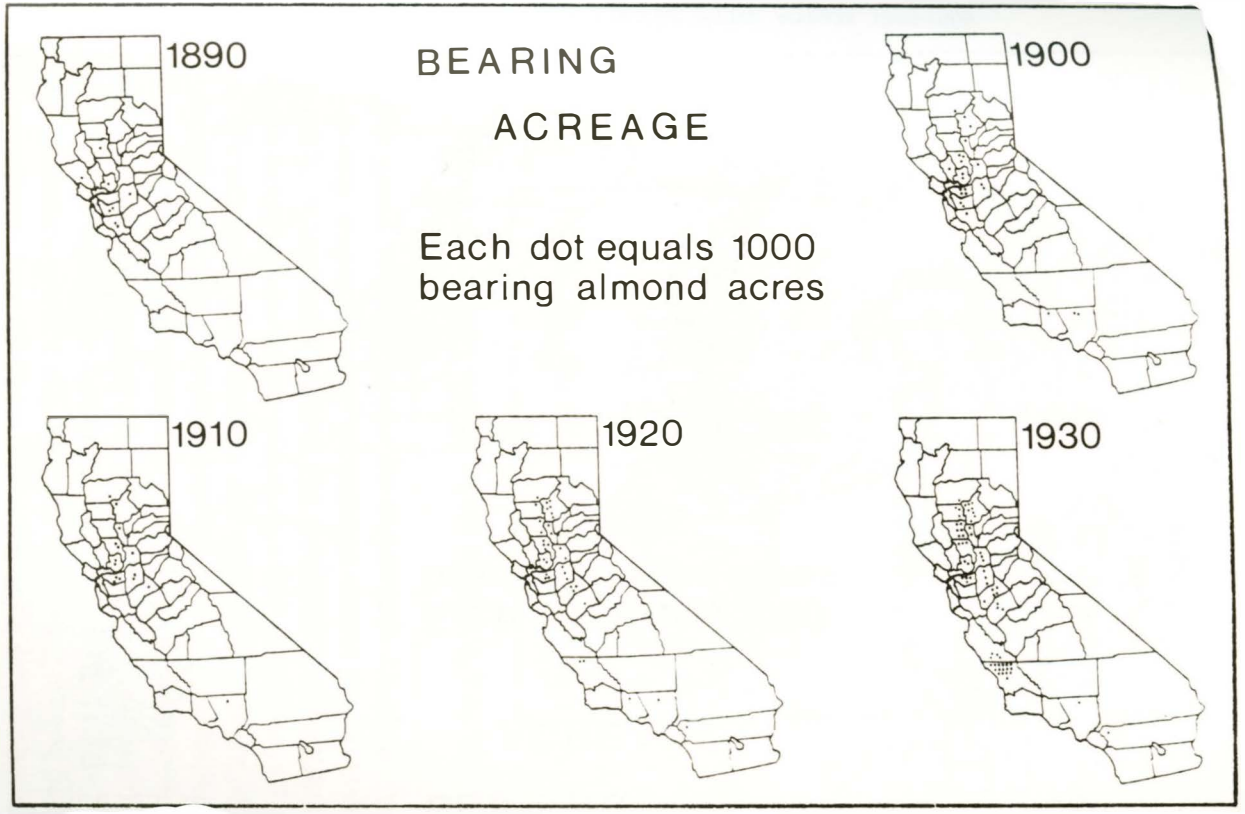

Figure 1. Distribution of California Bearing Almond Acreage, 1890-1930

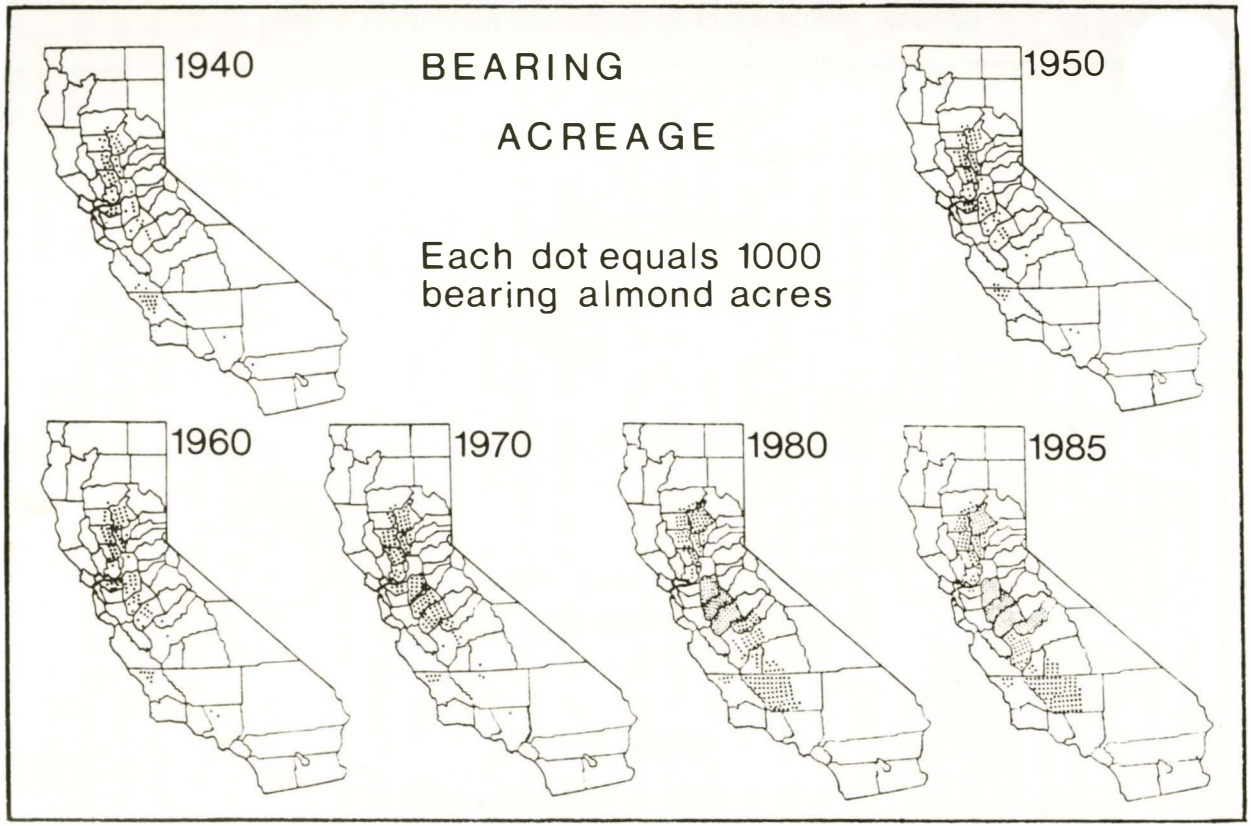

Figure 2. Distribution of California Bearing Almond Acreage, 1940-1985

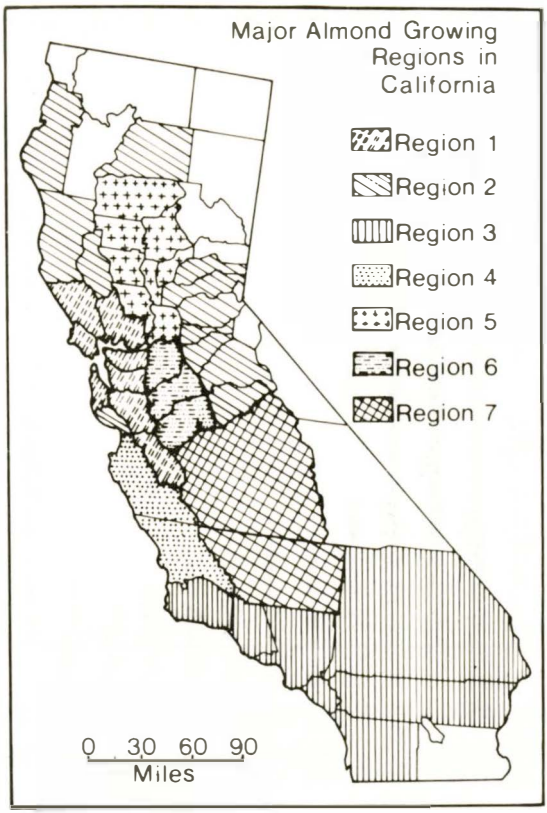

Figure 3. Major Almond Growing Regions in California, 1890-1985

sistently good returns could be expected. During this decade, many experimental plantings were undertaken in areas only marginally suited for almond production, and through these speculative plantings the effective, physical limits for almond production were gradually determined. The delineation of physical boundaries for almond production was not completed by 1900, and continues to a lesser degree even today. Aside from the physical factors affecting almond production, lack of knowledge about which varieties grew best, as well as about proper cultivation practices, led to crop failures and abandonment of many orchards.

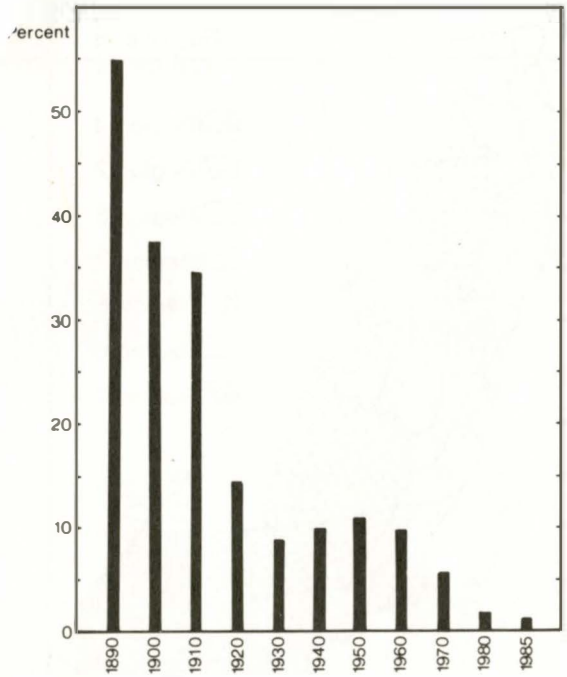

Figure 4. Percentage of Total Bearing Almond Acreage—Region 1
(Alameda, Contra Costa, Santa Clara, Marin, San Benito, Napa, and San Mateo Counties)

During this early period, many varieties of almonds were introduced from Europe, while others were developed in California; and there were many widely conflicting claims as to which varieties were superior. As might be expected, misinformation resulted in errors. Some orchard plantings consisted of either one variety or several varieties that were partially or completely sterile, while yet other orchards were set with varieties whose blooming periods did not coincide, resulting in little or no cross-fertilization.[5] Another aspect of almond production which was not fully appreciated was the importance of air and water drainage. Heavy losses from frosts and crown rot eventually resulted in general avoidance of terrain and soils with poor drainage.

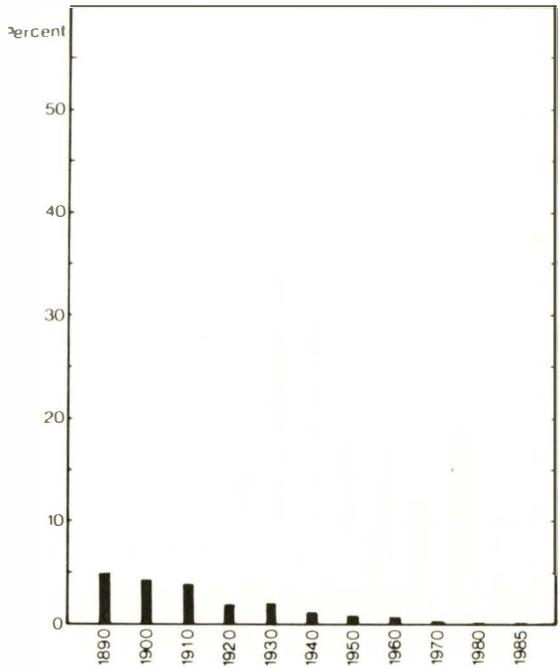

Figure 5. Percentage of Total Bearing Almond Acreage—Region 2 (Mendocino, Humboldt, Lake, Santa Cruz, Calaveras, El Dorado, Nevada, Amador, Shasta, Tuolumne, Placer, and Mariposa Counties)

1900-1920—Organization for Market and Price Control

The two decades from 1900 to 1920 were marked by a very rapid increase in almond acreage (Figure 11) and production (Figure 12). The Sacramento and northern San Joaquin Valleys were the only areas with significant increases in acreage (Figures 4-10). The remainder of the state, particularly the Santa Clara Valley and San Francisco Bay Area, decreased in importance. The early years of this period were marked by price instability. To assist in marketing and to obtain higher, more suitable prices, almond growers banded together and formed numerous grower organizations. In 1910, nine of these grower organizations combined to form the California Almond Growers

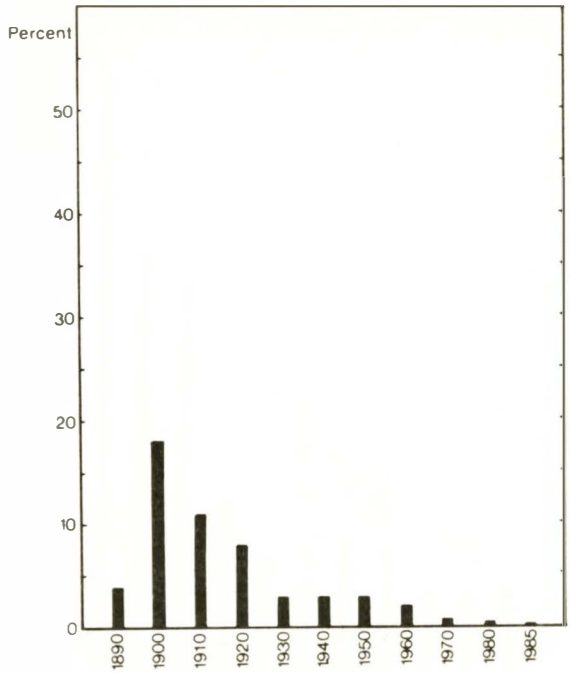

Figure 6. Percentage of Total Bearing Almond Acreage—Region 3 (Ventura, Los Angeles, San Bernardino, Santa Barbara, San Diego, Riverside, and Orange Counties)

Exchange. After many early trials, this organization expanded to become the leader in the marketing of almonds. In 1913 the introduction of a tariff provided American almond growers with some protection from foreign price fluctuations and competition. This, together with the grower organizations, resulted in more stable and higher prices during the latter part of this period. By 1920, nearly 70 percent of all bearing almond acreage was concentrated in the Sacramento Valley, particularly around Chico and the northern part of the San Joaquin Valley.

1920-1930—The Era of Land Speculation

During the period from 1920 to 1930, bearing almond acreage more than doubled. This increase was, at least in part, due to more stable prices and reasonable returns. The

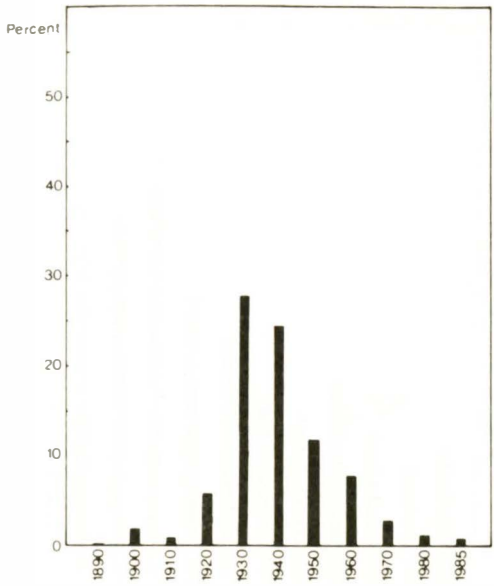

Figure 7. Percentage of Total Bearing Almond Acreage—Region 4 (San Luis Obispo and Monterey Counties)

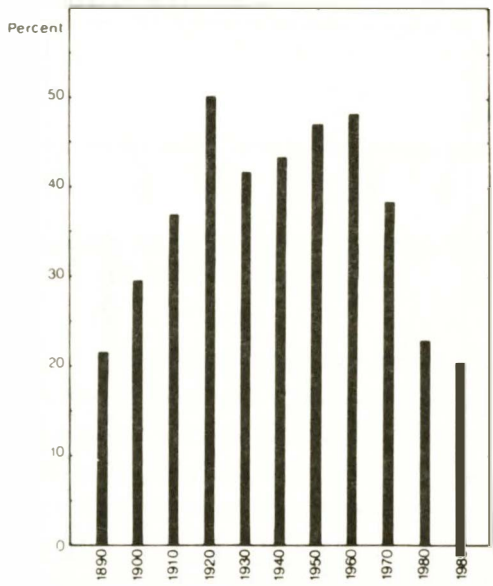

Figure 8. Percentage of Total Bearing Almond Acreage—Region 5 (Yolo, Colusa, Glenn, Tehama, Butte, Sacramento, Yuba, and Sutter Counties)

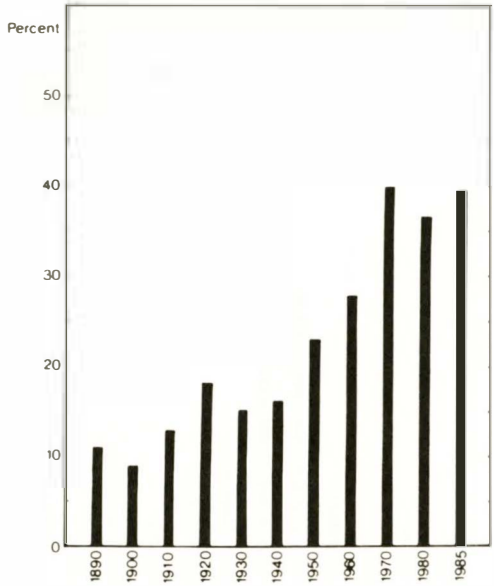

Figure 9. Percentage of Total Bearing Almond Acreage—Region 6 (San Joaquin, Merced, and Stanislaus Counties)

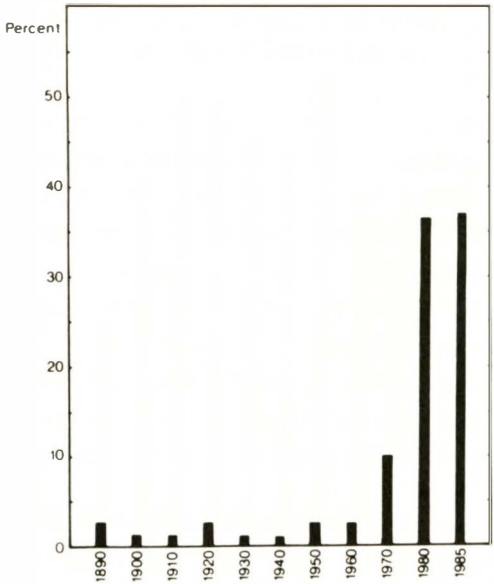

Figure 10. Percentage of Total Bearing Almond Acreage—Region 7 (Kern, Kings, Tulare, Fresno, and Madera Counties)

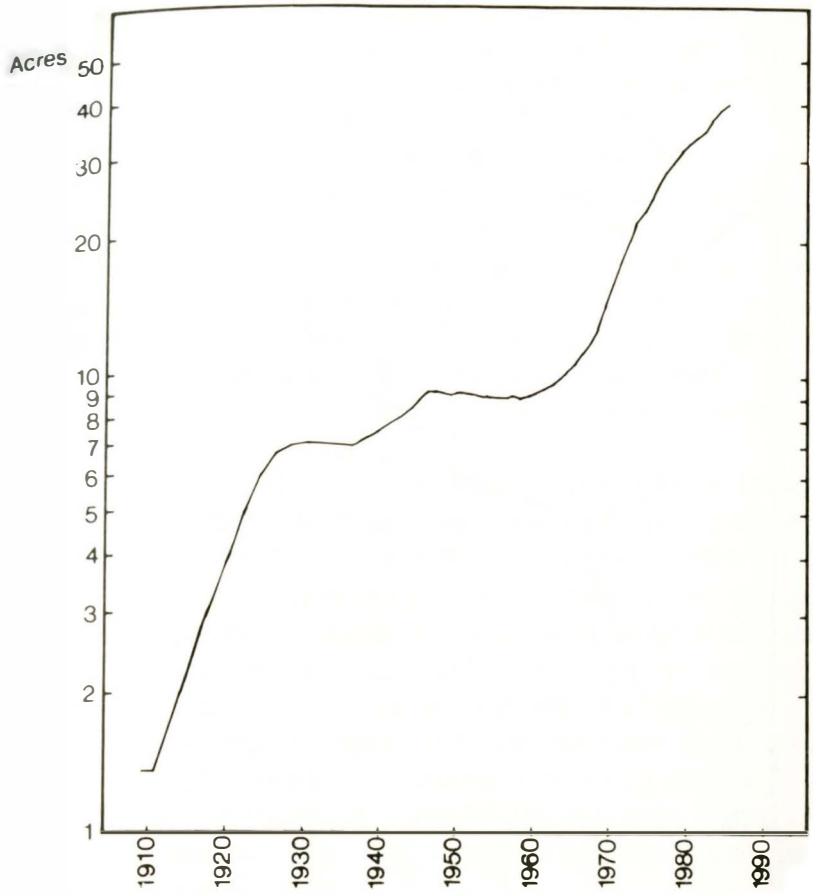

Figure 11. Five-Year Running Average of California's Bearing Acreage
(In tens of thousand of acres)

primary areas of increased acreage were the Sacramento Valley, the northern part of the San Joaquin Valley, and the Paso Robles area. In the Sacramento and the northern San Joaquin Valleys bearing almond acreage increased by 60 and 95 percent respectively. However, because of the almost 950 percent increase in bearing acreage in the Paso Robles area, the other areas experienced negative relative changes (Figures 4-10). The Paso Robles area had proven to be an area where satisfactory yields, using then current

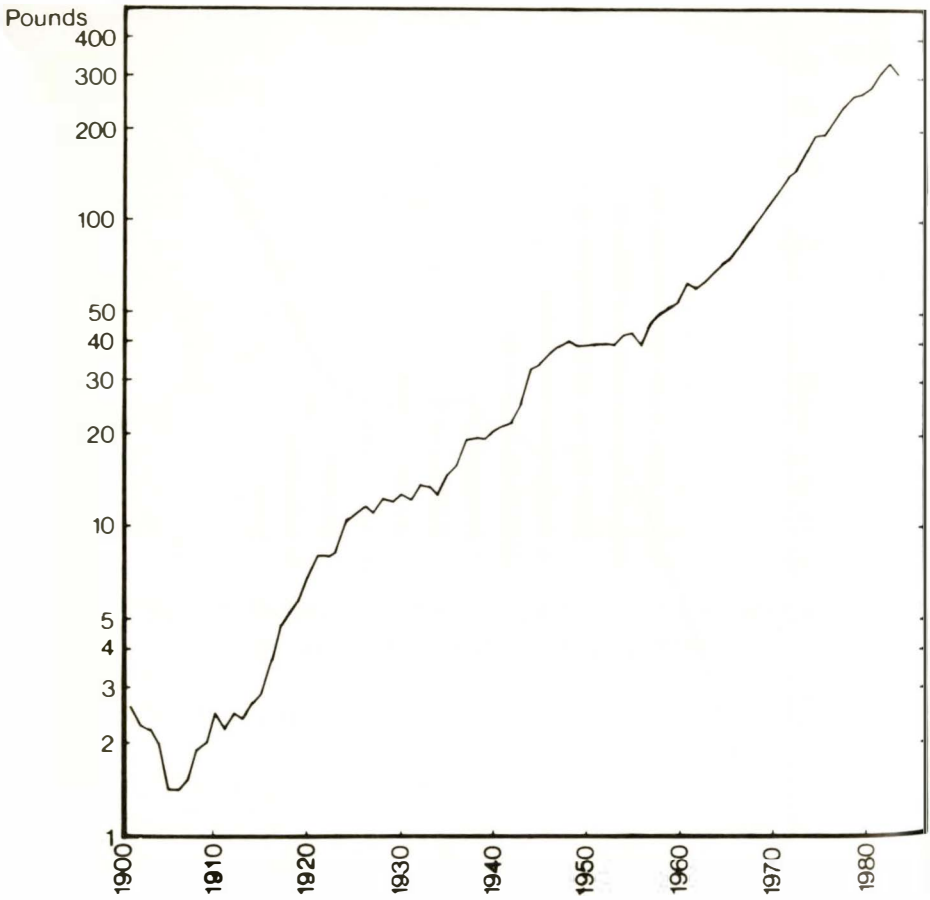

Figure 12. Five-Year Running Average of Production
(In thousands of in-shell tons)

techniqes, could be obtained. Although this was certainly a prerequisite and contributing factor for the increase, it was not the primary factor. The primary reason was a land development plan proposed by the Associated Almond Growers of Paso Robles.[6] Among other things, this plan suggested that ". . . a conservative investor, by making a moderate initial payment and small monthly payments for a few years thereafter, may be assured of a life income . . ."[7] and then went on to assert: "It may seem

incredible to you when we say that . . . a few dollars a month out of your surplus earnings may be made to work for you to such an extent as to yield from 40 percent to 50 percent a year on your investment."[8]

The Paso Robles Association explained how a whole staff of experts would assist new almond orchardists, or, if so desired, how it would manage the land while a buyer stayed at home and reaped the profits.[9] This development scheme was, in large measure, responsible for making Paso Robles one of California's leading almond growing districts from the late 1920's through the 1940's. At its peak, this district contained over one-third of California's total bearing almond acreage.

Prior to 1930, almonds typically were grown in areas marginal to other crops and dry-farmed (not irrigated). The orchards in the Paso Robles area were of this nature. During the 1920's, however, the advantages of planting almond orchards on good soil and irrigating them were realized. Paso Robles area orchards were on rolling or hilly terrain; and since the technology for irrigating orchards in this type of area had not yet been fully developed, these plantings soon became uncompetitive.[10] The large, overall increase in almond production (Figure 12) during this period was due primarily to large increases in bearing acreage (Figure 11).

1930-1950—Consolidation and Development

By 1930, almond acreage was concentrated in the Sacramento and San Joaquin Valleys as well as the Paso Robles area (Figure 1 and Figures 4-10). Extensive new plantings (Figure 13) in the years immediately preceding and including the early 1920's,resulted in the doubling of bearing acreage from 1920-1930 and generated concerns of overproduction. The decrease of new plantings in the middle to late 1920's was partially due to these concerns. In the early 1930's, on the other hand, a fall off in new plantings was probably due to the Depression. In any case, from 1923

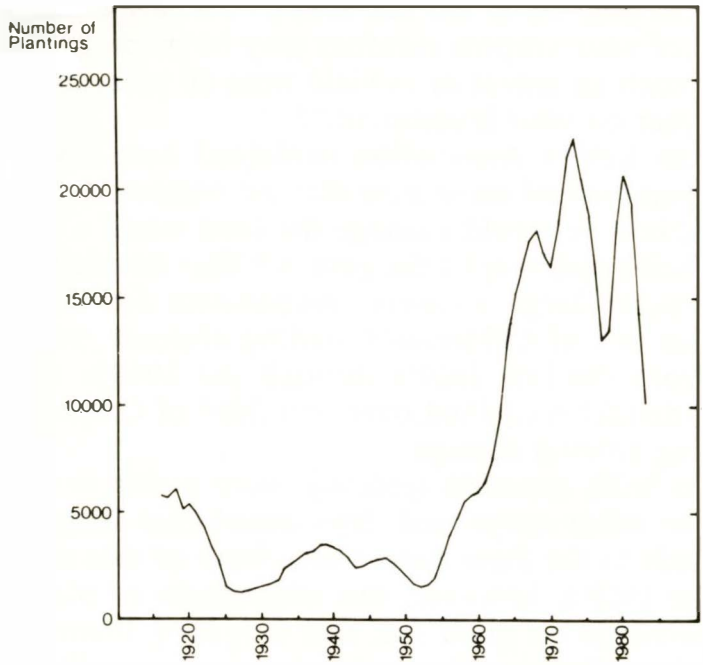

Figure 13. Five-Year Running Average of New Plantings

to 1933, apart from a minor increase in acreage in the northern Sacramento and northern San Joaquin Valleys, there were relatively few new almond plantings; and, as a result, bearing acreage was relatively stable from 1930 to 1940 (Figure 11).[11]

During the 1930's and early 1940's, the shift from non-irrigated to irrigated orchards progressed at a rapid rate. This, together with the slow elimination of less productive areas, resulted in a major increase in average yield per acre (Figure 14) and was a significant factor in a rapid rise in the average return per acre (Figure 15). The future looked good for almond growers; and, in spite of the Depression, there was an increase in new plantings, in the middle to late 1930's which reached a peak of over 5,000 acres in 1940 (Figure 13). This resulted in a moderate increase in bearing acreage from 1939-1949. Large production

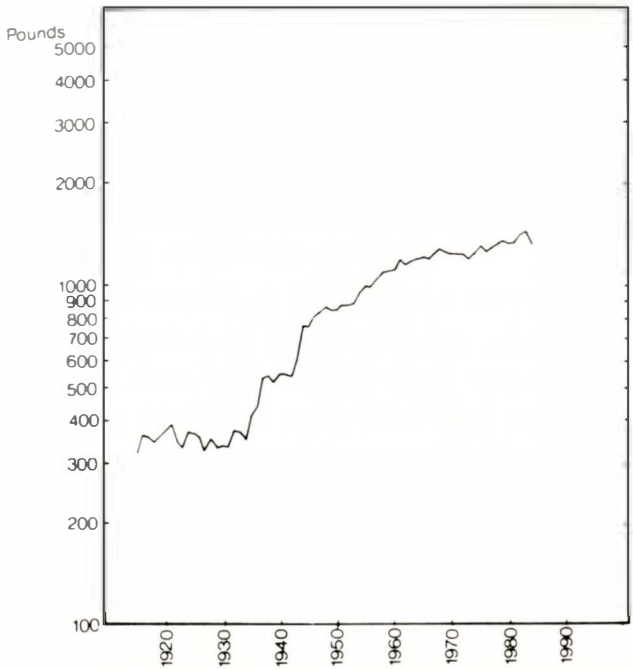

Figure 14. Five-Year Running Average of Yields Per Acre, Non-Shelled Basis

increases (Figure 12) in this period, however, were due primarily to a rapid increase in yields per acre (Figure 14).

Major increases in almond acreage took place in the northern parts of the San Joaquin and Sacramento Valleys. Essentially, these increases resulted as successful farmers expanded their acreage and, by their success, encouraged others to plant almonds. From 1930 to 1950, Paso Robles had a large, negative relative change (Figure 7), as many almond orchards had been planted in areas marginal even for dry farming. A few dry years in the late 30's and early 40's resulted in low returns and conversion of many orchards to pasture. Inability to obtain low-cost water for irrigation has been one of the primary reasons for the continuing decline in the Paso Robles area. Thus, by 1950, almond production, which had earlier been attempted in many different parts of California, was firmly

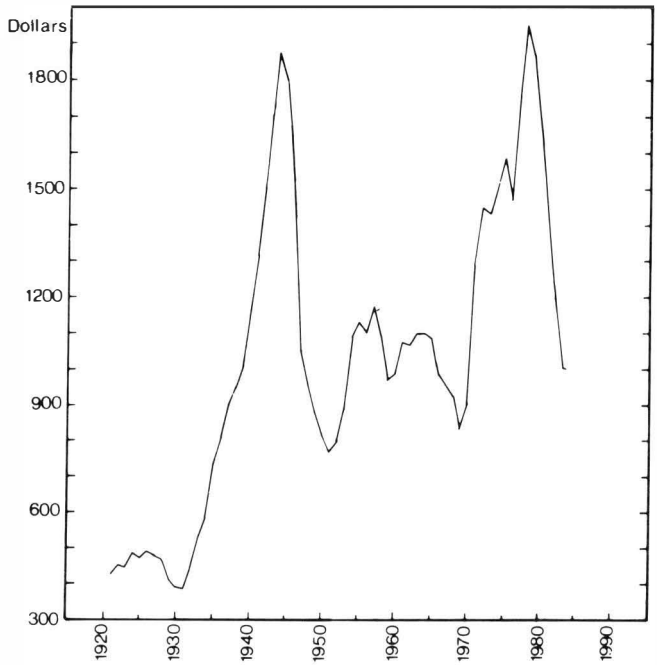

Figure 15. Five-Year Running Average of Return Per Acre in 1986 Constant Dollars

concentrated in the Sacramento and northern San Joaquin Valleys, with a minor secondary center around Paso Robles (Figures 1-10).

1950-1960—More Consolidation, Improved Production

During the 1950's, bearing almond acreage remained fairly constant (Figure 9), with the 90,496 bearing acres of 1950 declining slightly to 89,118 acres by 1960. The northern San Joaquin and Sacramento Valleys experienced a slight, relative increase in acreage (Figures 4-10), while the Paso Robles area continued to decline in relative importance. A large increase in production (Figure 12) was due entirely to a continued increase in per-acre yields (Figure 14). A small part of this increased production was consumed domestically; the remainder was exported.

During this period, however, the basis for rapid expansion during the 1960's, 1970's, and early 1980's was being

laid. Factors which would promote acreage expansion included:

(1) 1950's advances in mechanized almond production,

(2) Improvements in sprinkler irrigation which allowed rolling areas to be planted into almonds without extensive grading,

(3) Continuing high returns per acre (Figure 15) and,

(4) Completion of water projects which opened many areas that previously were too dry to be intensively exploited with fruit and nut cultivation.

By 1960, for example, almond production had become the most mechanized of the fruit or nut crops grown in California. This had two immediate effects:

(a) Solving many of the labor related problems, thus providing almonds a competitive advantage over crops not yet mechanized, and

(b) Making areas too hilly for mechanization undesirable for almond orchards.

1960-1985—Renewed Expansion

From 1960 to 1985 bearing almond acreage increased by 366 percent, from 89,118 to 415,000 acres (Figure 11). Per-acre yields continued to increase substantially (Figure 14), resulting in a continued, exponential increase of production (Figure 12). Due largely to increasing per-acre yields and high to very high prices, return per acre for most of this period varied from good to excellent and reached all time highs in the late 1970's (Figure 15).

Bearing almond acreage increased in all counties in the Sacramento and San Joaquin Valleys except Sacramento County, which in response to pressures of urbanization experienced a decline.[12] Despite a 98 percent increase in bearing almond acreage in the twenty-five years from 1960 to 1985, the Sacramento Valley's relative importance de-

creased (Figures 7-10), due to larger acreage increases in the San Joaquin Valley; and all other almond growing areas declined in both relative and absolute terms.

The rate of increase was particularly rapid in the southern part of the San Joaquin Valley (Figure 10), where bearing almond acreage expanded by more than 72,000 percent, from 210 acres in 1960 to 151,416 in 1985. This enormous increase was made possible largely by new water delivery systems, such as the California Water Project. Many large, corporate plantings were a response to the potential for short-term tax write offs as well as the outlook for long-term gain.

In the late 1960's and early 1970's, the number of farms on which almonds was grown reached an all-time low. A large increase in new plantings during the 1970's, however, at least partially, resulted from additional people planting almonds, which meant that the number of people growing almonds more than doubled by the mid 1980's (Figure 16). The number of bearing almond acres per orchard, which had remained relatively constant from 1920 until the early 1960's, increased rapidly during the middle to late 1960's, reaching a peak in the early 1970's. Since then, the number has remained relatively constant (Figure 17). Increased bearing acreage during the 1960's stemmed, at least in part, from large corporations planting hundreds or even thousands of acres.

1987 and Beyond

The major question with respect to almond production is, can sufficient markets, at a satisfactory price, be found for the large crops that are anticipated during the late 1980's and early 1990's? Domestic consumption has almost doubled during the last twenty years, a time period during which production approximately quadrupled. So far, the widening difference between production and domestic consumption has been made up by a rapidly expanding export market. Further, large increases in the export mar-

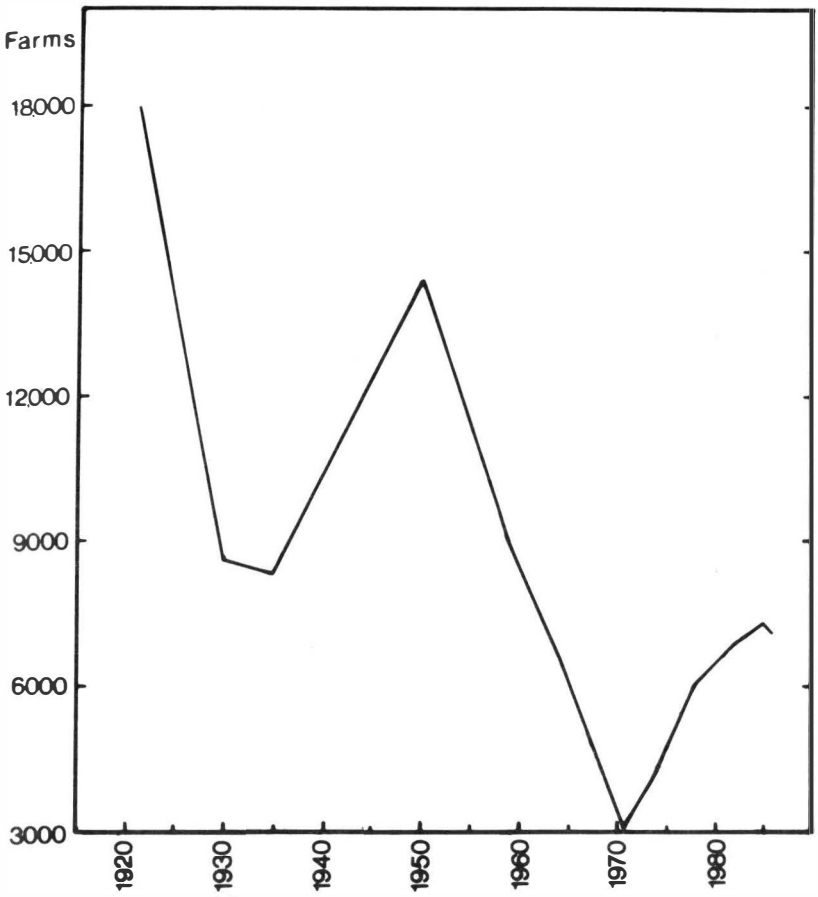

Figure 16. Number of Farms on Which Almonds Are Grown

ket are anticipated because of the weakness of the United States dollar and the reduction of import tariffs by the European Economic Community. However, with large increases in bearing almond acreage in both California and Spain, it is hard to imagine a condition without some overcapacity and a reduction in return per acre.

Since it takes a relatively large investment of time and money for an orchard to begin bearing and give a return on investment, it will take more than just a few bad years before many almond orchardists are willing to accept a

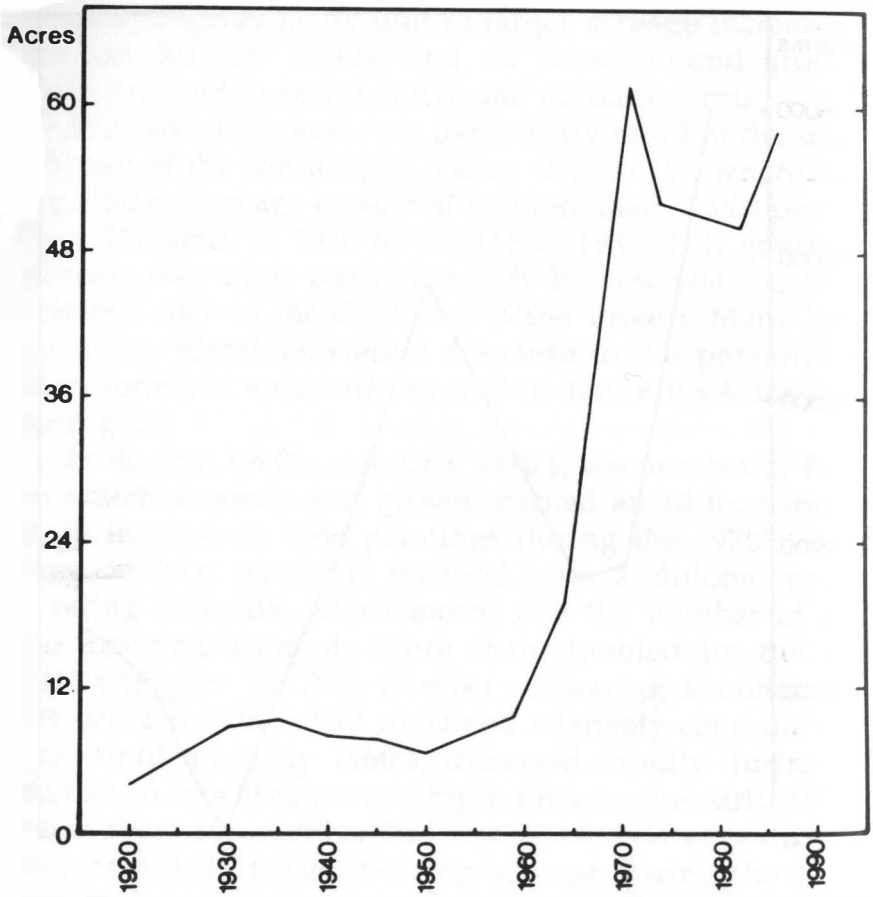

Figure 17. Average Number of Bearing Acres Per Farm

loss and convert their orchards to other crops. However, five particular conditions may pose problems which are likely to result either in the planting of alternate crops or people seeking other uses for their land. They are:

(1) Older growing areas where production is less profitable because almond trees are either dry-farmed[13] or beyond their peak production years.

(2) Areas where almonds are under urban pressure, such as in Los Angeles, Sacramento, Butte, and Contra Costa Counties. Most orchards threatened

by urbanization are fairly old, and many are dry-farmed.

(3) Large, corporate orchards with large staffs, greater over-head, a smaller profit margin, and poorer returns.

(4) Those orchards growing in areas less favorable for almond production.

(5) Orchards experiencing problems of low production due to non-infectious bud failure.[14]

Because of the fear of overproduction and lower returns per acre, new plantings have dropped significantly below the replacement rate.[15] As a result, bearing almond acreage is expected to decrease for the rest of the 1980's and well into the 1990's.

Summary and Analysis

In 1890 considerably more than 50 percent of almond production was concentrated in the Santa Clara Valley and San Francisco Bay Area (Figure 4). Many early favorable reports specifically encouraged expansion of production in this region. Because of a greater disease problem due to higher humidity and lower nut production resulting from cooler spring temperatures,[16] however, the region has declined in importance. Many of its remaining orchards are old and threatened by urbanization. Even so, some people with a few acres who desire to have an orchard may choose to grow almonds here, for they can be dry-farmed, given practically no care, and still be productive. Nevertheless, Region 1 (Figure 3) is expected to continue to decline in both absolute and relative terms. Currently, only around 1 percent of California's bearing almond acreage is found in this region.

Because the exact climatic requirements for almond production were not originally known, almonds initially were planted in many areas throughout California with varying degrees of success. Some of the most peripheral of

these plantings are included in Region 2 (Figure 5). This region has been declining, both in absolute and relative terms, and by 1985 it accounted for only about .08 percent of California's total bearing almond acreage.

Southern California (Region 3, Figure 6) reached its peak in relative importance in 1900 and has been declining since. Most of the remaining orchards are old, dry-farmed and threatened by urbanization. In the Antelope Valley (northern part of Los Angeles County) almond blossom festivals are held each spring. Some of the orchards may thus be preserved for the sake of tradition. Urbanization and accompanying high land values and taxes have caused most of the areas where almonds are presently grown to be unsuited for almond production. This region has been declining in both absolute and relative terms and by 1985 accounted for only about .05 percent of California's total bearing almond acreage.

Paso Robles (Region 4, Figure 7) experienced a rapid increase in bearing almond acreage in the late teens and early twenties. At its peak, Paso Robles contained about one-third of California's total bearing almond acreage.

One of the primary factors in this rapid increase was the result of a "get rich quick" land development scheme. This region may have been competitive by then current methods of production. However, the region began to decline with the advent of flood irrigation, as it was difficult to convert these hilly, dry-farmed areas. The generally poorer soils in this area pre-empted a large rejuvenation with either the advent of sprinkler irrigation in the 1950's or the importation of water in the 1960's. Since the 1930's, this region has declined in both absolute and relative terms. By 1985 less than 1.5 percent of California's total bearing almond acreage and considerably less than that of its production came from this district.

For a sixty-year period (1900-1960), the Sacramento Valley (Region 5, Figure 8) was California's leading almond district. Bearing almond acreage has increased in every

decade under consideration, and almond production has consistently proven quite successful. Yet, despite large increases in bearing acreage during the 1960's and 1970's (98 percent), this region's relative importance decreased from around 50 percent in 1960 to 21 percent in 1985 (Figure 8). In the Sacramento Valley, however, the probability of damage from frosts, rains, higher relative humidity, and cooler temperatures during bloom results in smaller crops and higher costs of production than in the Northern San Joaquin Valley. Nevertheless, because of the large capital investment needed to bring an almond orchard in production, it is doubtful that many orchards will be removed prematurely. Even so, should return decrease, almond orchardists may consider other crops when replanting. In essence, the basic consideration is not which area, the Sacramento or Northern San Joaquin Valley, is more suited for almond production, but whether there is another crop which might result in higher returns for the farmer. Thus, the Sacramento Valley's bearing almond acreage, which has steadily increased for the last seventy years, should level off and could begin to decline slightly in the late 1980's and early 1990's.

The northern San Joaquin Valley (Region 6, Figure 9) is now, and for the foreseeable future will continue to be, the largest almond-growing district in California. Bearing acreage has increased in every decade since 1900. While the climatic differences between it and the Sacramento and southern San Joaquin Valleys are slight, they may be sufficient to result, on the average, in slightly higher yields and lower costs of production. Although a severe reduction in return per acre could result in a slight reduction in bearing acreage, it is unlikely that many fully productive orchards will be removed. When planting, however, if the prospects for almonds look poor, other crops may be selected.

Since 1960, the southern San Joaquin Valley (Region 7, Figure 10) bearing almond acreage has increased at a very

rapid rate. Primarily, this has been because of good returns from almonds, the discovery of local sources of and the importation of water, the advent of sprinkler irrigation allowing the cultivation of rolling areas without leveling, and a high degree of mechanization.

The southern San Joaquin Valley has three potential problems which may prove significant. First, the warmer climate of this area seems to promote bud failure. Advances are being made in efforts to breed trees free of this problem. Despite these advances, however, the problem has by no means been solved; and it has already caused the premature removal of thousands of acres. If, as has been suggested, it proves to be a genetic breakdown stimulated by high temperatures,[17] then all trees now planted in the southern San Joaquin Valley may be susceptible. A second factor which may result in reduction of acreage is that many almond plantings in the southern San Joaquin Valley are owned by a few large cooperatives; and because they face higher operating costs, these organizations could become disenchanted with poor returns and change to more profitable uses of the land. Small operators who have grown almonds for much of their lives have an investment in their knowledge and experience, and frequently they are reluctant to switch crops. Large operators, on the other hand, through firing and hiring can usually acquire needed expertise required. The third problem is that much of the water in the southern San Joaquin Valley is imported and thus is generally more costly. If either bud failure or the length and severity of the reduction in returns per acre prove to be a bigger problem than anticipated, bearing almond acreage may decrease significantly in this region.

NOTES

1. Harry M. Butterfield, *A History of Subtropical Fruits and Nuts in California*, (University California Division of Agriculture: 1953), p. 1.

2. Elizabeth M. Riley, "The History of the Almond Industry in California, 1853-1934" (University of California at Berkeley: unpublished M.A. Thesis, 1948), pp.8-11.

3. Ibid.

4. Edward J. Wickson, *The California Fruits and How To Grow Them* (San Francisco: Pacific Rural Press, 1889), p. 257.

5. There are numerous varieties of almonds. A single variety of almond cannot pollinate itself. In addition, varieties are also partially or completely sterile to certain other varieties.

6. Associated Almond Growers of Paso Robles, *A Life Income Plus California* (Chicago: 1920), pp. 1-42.

7. Ibid., p. 1.

8. Ibid.

9. Ibid., pp. 1-42.

10. Irrigated almond orchards in the 1920's and 1930's were watered by flood (gravity) irrigation. This method required leveling an area to be planted to almonds. When the almonds needed water the field was flooded.

11. Five years after planting, an almond tree is considered to be bearing (productive). In reality, some almonds may be harvested as early as the second year after planting, while any given orchard may not reach maximum productivity until after its tenth year.

12. The effects of urbanization on the location of almond acreage in Sacramento, San Joaquin, Butte, Los Angeles, and Riverside Counties is considered by Robert A. Aron in "The Changing Location of the Almond Industry in California" (California State University, Long Beach: unpublished M.A. Thesis, 1970).

13. Return per acre on dry-farmed almond orchards in the Paso Robles area is usually only one-fifth of the mean for California.

14. Noninfectious bud failure (BF) is a disorder caused by a genetic abnormality characteristic of certain varieties. Trees affected by BF have sparse foliage with many twigs lacking foliage. Many branches are produced. These branches change direction giving the tree a crooked, tangled appearance. BF is progressive, with no know cure; and it permanently reduces production.

15. Only 1496 almond trees were planted in 1985 (the last year for which data was available).

16. Cool spring temperatures may result in a prolonged bud break, reduced bee activity, and a smaller fruit set.

17. Personal correspondence with Dale E. Kester, Professor of Pomology, University of California at Davis.