THE WALNUT INDUSTRY
IN CALIFORNIA:
TRENDS, ISSUES AND CHALLENGES

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PREFACE

This is one of a series of Competitive Edge reports published by the UC Agricultural Issues Center. These publications are designed to explore issues faced by selected agricultural industries in California during the 1990s and beyond.

Previous reports in this series have been concerned with issues involving the industries that produce, process and market California beef, canned fruits, and rice. The first volume of a report on the dairy industry is in print; the second will be published shortly.

The lead author of this detailed examination of California’s unique walnut industry is Janine Hasey, UC Cooperative Extension farm advisor in Yuba and Sutter counties, who conducted the surveys and analyses that contributed much new information about the industry’s resources and production trends. Jerry Siebert, Cooperative Extension economist, developed the section on marketing and trade. These two authors are primarily responsible for the section on proposed strategies to maintain the industry’s competitiveness.

Others who contributed significantly to the document are Gale McGranahan, pomologist, and Dave Ramos, extension pomologist, both of the UC Department of Pomology; and Karen Klonsky, extension specialist, Department of Agricultural Economics.

We also are grateful to Jill Murakoe, student in the Department of Agricultural Economics, for mapping and data tabulation; Eric Blackwell of Diamond Walnut for data base analysis; and Gail Nishimoto, of UC Biometrical Services, for statistical consultation.

Many others contributed to the study project and to the county survey which is an important part of it. They are listed in Appendix A.

Special thanks are due to members of the AIC Walnut Industry Study Group, listed on page iii, who contributed much to the planning and organization of this study project and whose comments contributed substantially to the final product.

Thanks also are due to the panel of reviewers for their many helpful suggestions. They were:

Dave Forry, Colusa walnut grower.
Lonnie Hendricks, UC Cooperative Extension farm advisor, Merced County.
Sam Keiper, director of member services, Diamond Walnut, Stockton.

Kirby Moulton, Extension economist, UC Berkeley.

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Al Sokolow, UC Cooperative Extension public policy specialist, UC Davis.

We gratefully acknowledge financial support for this project from the Walnut Marketing Board. Also, Deseret Farms contributed funds for student intern help.

AIC staff members Arden Culver and Sandra Fisher were responsible for production of the document. Marcia Kreith helped during planning of the study project.

Harold O. Carter
Director

EXECUTIVE SUMMARY

This is the report of a UC Agricultural Issues Center study project to identify and evaluate the major forces shaping the future of the walnut industry in California. Walnuts are one of the state’s leading fruit and nut crops.

The major forces of change influencing California’s walnut industry include (1) increasing pressure from urbanization and other competitors for the walnut industry’s basic resources of land, water and air, (2) increasing regulatory pressures which affect production practices, and (3) marketing trends such as the increasing importance of exports.

Highlights of the report:

- In the Central Valley, where most walnuts are now produced, about 60 percent of the acreage is in farms 100 acres or larger—and is farmed by 12 percent of the growers. Meanwhile, 35 percent of all Valley growers farm 10 acres or less. This dichotomy in farm size has important implications for the industry.

- Currently, the top walnut counties in terms of acreage are San Joaquin, Tulare, Stanislaus, Butte, Sutter and Tehama. Counties with greatest potential for expansion of walnut acreage during the next decade or two are Tehama, Butte, Yolo, Solano, Tulare, Kings and Kern.

- Depending on forces of growth, almost 25,000 acres of walnuts could be converted to urban development in California during the next 20 years. Also, thousands of acres could be converted to riparian habitats.

- Important developments in plantings of walnut varieties are taking place. Today’s dominant variety is Hartley, but the trend during the next 20 years is expected to be Chandler. The trend also is toward higher per-acre yields as a result of improved varieties and production practices, including closer tree spacing. (To some extent, this trend could be offset by plantings on marginal soils.)

- The trend in pest and post disease control is toward lower-impact treatments and tighter regulation. However, some chemical controls will remain crucial. Two particular problems are the possible loss of methyl bromide, and the appearance of a treatment-resistant strain of walnut blight.

- About two-thirds of all walnuts sold are shelled. Of the one-third marketed inshell, most are exported. However, exports of shelled walnuts are increasing. About 65 percent of all California walnuts are consumed in the U.S. Per capita consumption of walnuts in the U.S. appears to be declining slightly. The U.S. and China are the world’s largest walnut producers. The Chinese apparently are engaged in a
program to upgrade their production.

- High quality and on-time deliveries are important forces in the demand for California walnuts. New plantings should be made with these requirements in mind.

- Budgetary pressures restricting research, market development and promotion, collection of statistics and other programs will require some hard choices by the industry.

- Recommended strategies for the walnut industry:

  — Work to protect the resource base, with particular attention to such issues as local land use policies, water availability and air quality.

  — Prioritize certain areas of technological development, such as (1) breeding of improved varieties and (2) development of more environmentally acceptable pest and disease control methods, particularly alternatives to chemicals that may lose their registrations.

  — Increase demand for walnuts by continuing support for existing programs, developing new information, and promoting the industry’s interests during trade negotiations.

  — Document the benefits of walnut marketing orders.

  — Strengthen the linkage between research, extension and the industry, possibly including increased industry financial support in relation to public funding.

  — Strengthen information exchange and leadership development within the industry.

  — Increase industry efforts to inform the public.

I. INTRODUCTION

Walnuts are among the leaders in California’s fruit and nut crops. (Others in the top five are oranges, strawberries, almonds and grapes.) In 1992, the state’s 181,000 acres of bearing walnut orchards produced $279,720,000 in farm-gate value. About one-third of those walnuts were exported to other countries.

Virtually all walnuts commercially produced in the United States come from California. Clearly, walnuts make a significant contribution to this state’s economy and to the nation’s balance of trade.

The fact that California walnuts are effectively competing in—in many cases, dominating—both national and global markets is a result of the industry’s ability to consistently produce and market high quality products. Historically, this ability has been enhanced by development of new technology through research, and by coordination of the industry’s marketing efforts.

However, California’s walnut industry, like all of the state’s agribusiness, is being challenged today by rapid and not always predictable pressures for change—including a growing, increasingly urbanized and environmentally-conscious state population, as well as significant shifts in the global marketplace.

This report examines the current status of the walnut industry and developments which can be expected to influence it during the next 20 years. Any objective analysis of walnut growing and marketing in California today must take into account certain underlying trends, including:

- Increasing pressure on the industry’s resource base, particularly the loss of prime soils that are being converted to housing, and increasing competition for water.

- Increasing constraints on farming methods as a result of urbanization and environmental concerns.

- Growth of the walnut export market (now 35 percent
of total California sales), which, in addition to its advantages, means that the industry is becoming more vulnerable to global competition and to economic and political forces beyond this state's control.

Because California walnuts in recent years have been relatively profitable compared to many other crops, the current trend in the industry is toward increased plantings. The prospect of continued increases in walnut tonnage, combined with the possibility of increased competition domestically (pecans) and globally (walnuts), suggests that the industry needs to consider even more aggressive marketing.

This report is intended for members of the walnut industry as well as others interested in trends and issues that affect walnuts and how they are produced, processed and marketed—including resource agency and legislative staff, local government decision-makers, and the public.

Much information is presented in the appendices. This is for the use of readers who may want to take advantage of some of the very detailed information developed during this study project. For a glossary, see page 62.

The Study Project

To prepare this report, all of the California counties that contain 1,000 or more acres of walnuts (see map) were surveyed. The survey was designed to identify and evaluate forces shaping the future of the walnut industry, including:

- Urbanization and other land use impacts.
- Water supply and air quality.
- Acreage, yield changes and planting trends since 1980.
- Emerging regulations.
- Pest and disease problems.

The 23 surveyed counties comprise four regions that produce 99 percent of the walnuts in California:

- Sacramento Valley (38 percent of 1992 statewide production.)
- North San Joaquin Valley (34 percent.)
• South San Joaquin Valley (22 percent.)

• Central Coast (5 percent.)

As sites for the state’s walnut industry, these 23 counties provide a gamut of conditions. They contain not only diverse soils and climate but also diverse resource-use policies and public views about farmlands and their preservation. In this report, 20 of these counties are specifically rated as to potential for expansion or loss of walnut acreage during the next two decades.

In addition to the analysis of trends in walnut production, this report discusses other important economic aspects of the walnut industry, including marketing, demand, competition and trade issues.

Walnuts in California

Although hard-shelled English walnuts had been grown in California since the Spanish missions, the state’s walnut industry was launched in the 1860s and 1870s when the first soft-shelled varieties were planted.

Two pioneering nurserymen, Joseph Sexton of Santa Barbara and Felix Gillet of Nevada City, produced trees for these first commercial orchards. Sexton’s “Santa Barbara soft-shell” was well adapted to many parts of Southern California. Gillet’s varieties, imported from France and more frost-hardy, were grown in the north state. Also, some growers propagated promising trees in their orchards. Even today, much of California’s walnut production is from varieties first selected during these early years—for example, Franquette, Payne, Eureka and Hartley.

At first, many growers planted new walnut orchards with seedlings. As a result, yields and nut quality often suffered because of lack of uniformity among individual trees. During the following decades, vegetative propagation—grafting or budding English walnut scions onto black walnut or Paradox rootstocks—resulted in more uniform and vigorous orchards and was finally adopted by the entire industry.

Throughout California, walnut orchards thrived where soils were deep and climate was suitable. By World War I, a total of 34,138 acres of bearing trees were reported, mostly in Southern California. The industry continued to expand, and by 1932 the statewide total was 101,000 acres, still mostly in the southern part of the state. Almost three-fourths of this acreage was in young trees, indicating greater production yet to come.

Starting about 1940, walnut acreage in Southern California began a steady decline and during the 1950s and 1960s almost disappeared. This was largely due to post-World War II urbanization, but there were other reasons. Citrus production was highly profitable during and after the war, resulting in removal of many older, seedling-propagated walnut orchards. Also there was increasing competition from newer, more vigorous plantings north of the Tehachapis.

Total statewide walnut acreage climbed steadily higher in the decades following World War II. Since many Bay Area walnut orchards also were wiped out by expanding cities, most of the net increase was in the Central Valley, particularly in deep soils along rivers. Figure 1 illustrates these shifts in walnut production areas by county since 1955.

Figure 1

Marketing developments

In the 1870s and 1880s, as California’s new and unorganized walnut industry expanded, it was hampered by extreme price fluctuations and other marketing problems. Growers responded by forming local cooperatives to process their nuts. The first of these groups was organized in Los Angeles County in 1887. Within a few years, many other local walnut-grower cooperatives were formed, and a central association was set up to attempt to agree on prices. However, competition among the local groups continued. As a result, in 1912, the California Walnut Growers Association was formed to process, grade and market its members’ crops.

Until this time, California faced severe competition in the U.S. walnut market from French imports. By the end of World War I, however, California had captured half of the U.S. market and the Association’s “Diamond” brand was becoming widely known.

The California industry continued to expand and to capture a larger share of the national market. As a result of increasing output, including a very large crop of poor quality in 1931, a marketing order—the Walnut Control Board—was formed under federal law to set Pacific Coast walnut quality and marketing regulations. (Since 1962, it has been known as the Walnut Marketing Board.) Meanwhile, the Association controlled as much as 90 percent of California walnut production during the 1930s.

As a result of postwar shifts in California walnut acreage, in 1956 the Association moved its headquarters and main processing plant from Los Angeles to Stockton and changed its name to Diamond Walnut Growers, Inc. Then began a series of mergers with other leading agricultural cooperatives for marketing purposes—in 1974 with Sunsweet Growers, Inc. (prunes, dried apricots), and in 1980 with Sun-Maid Growers (raisins) and Valley Fig Growers. The final result is known as Sun-Diamond Growers of California.

While much of the early history of the industry is reflected in the growth of Diamond Walnut, independent walnut buyers and processors (handlers) have been an important factor in the industry’s development, providing an economic alternative for many producers. During the past 15 years, the role of the independent producers and handlers has steadily increased; they now control over half of the volume produced and marketed.

The ability of the cooperative and independent sectors to work collaboratively on areas of mutual interest has been a key factor in the success of the walnut industry. This collaboration has usually taken place through a federal marketing order and state walnut commission, described later.
II.
THE INDUSTRY

A discussion of the future challenges and the promise of California’s walnut industry must begin with background information about the industry as it exists today—characteristics of walnut growers and handlers, trends in walnut acreage and prices, and marketing arrangements.

Producers and Handlers of Walnuts

The acreages currently managed by walnut growers in the Central Valley are shown in Table 1. There is a substantial dichotomy in size. Almost 60 percent of the Valley’s walnut acreage is in orchards 100 acres or larger, and is farmed by 12 percent of the growers. At the same time, 35 percent of all Valley growers farm 10 acres or less. The proportion of very small growers would be even higher if the coastal and mountain counties were included, since 1-to-10-acre rural residential lots are common there.

<table>
<thead>
<tr>
<th>Acreage Range</th>
<th>Number of Growers**</th>
<th>Acreage Represented</th>
<th>Percent of Growers</th>
<th>Percent of Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10 Acres</td>
<td>1,300</td>
<td>7,050</td>
<td>35%</td>
<td>4%</td>
</tr>
<tr>
<td>11 - 20 Acres</td>
<td>715</td>
<td>11,707</td>
<td>19%</td>
<td>5%</td>
</tr>
<tr>
<td>21 - 30 Acres</td>
<td>355</td>
<td>9,255</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>31 - 50 Acres</td>
<td>469</td>
<td>16,167</td>
<td>11%</td>
<td>9%</td>
</tr>
<tr>
<td>51 - 75 Acres</td>
<td>280</td>
<td>17,326</td>
<td>8%</td>
<td>9%</td>
</tr>
<tr>
<td>76 - 100 Acres</td>
<td>192</td>
<td>16,780</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>100 - 250 Acres</td>
<td>849</td>
<td>51,627</td>
<td>9%</td>
<td>27%</td>
</tr>
<tr>
<td>&gt;250 Acres</td>
<td>127</td>
<td>53,724</td>
<td>3%</td>
<td>31%</td>
</tr>
<tr>
<td>Total</td>
<td>3,727</td>
<td>189,636</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Includes Northern San Joaquin Valley - all counties
Southern San Joaquin Valley - Tulare, Kings, Fresno Counties
Sacramento Valley - all counties except Shasta, Placer Counties
**Represents the person with a permit who farms the orchard and may underrepresent the actual number of landowners or farms. Therefore, there may be more smaller farms than are shown.
Source: County Agricultural Commissioners. 100% Pesticide Permit Reporting Database, 1993.
Farm characteristics

The most recent census of agriculture data, from 1978 to 1987, show a decrease in number of California walnut farms from 9,223 to 7,446. Meanwhile, total acreage went up from 193,551 to 210,204. (Other information sources differ slightly. See Appendix A.) These figures support those in the industry who feel the trend is toward an increase in larger farms. However, the number of 1-to-10 acre farms also may well increase as rural residential growth continues in both coastal and Valley counties. People with small acreages often plant walnuts because they are seen as a lower maintenance crop.

This widening split between small, commonly part-time, walnut growers and larger operators has implications for education and research—and for the industry’s ability to produce consistently high-quality crops. For example, precisely timed pest management may be more difficult for smaller growers relying on custom operators. For this and other reasons, they need extension programs geared to their level. Meanwhile, larger growers require extension programs reflecting the cutting edge of research.

Recent trends in acreage by region and county, and in plantings of various walnut varieties, are shown in Figure 3 on page 12. The top counties by acreage are San Joaquin, Tulare, Stanislaus, Butte, Sutter and Tehama.

Trends in walnut yields also are important. As Figure 4 on page 13 shows, average tonnage per acre did not vary much between the 1980-85 period and 1986-91 except in a few counties, mainly in the Sacramento Valley (due in part to some tree losses from seepage along the Sacramento River). Yields per acre in most of the coastal counties also were static during this decade. The low yields in Lake and San Luis Obispo counties are primarily because of non-irrigated orchards; Contra Costa county has blackline problems.
## Table 2

**English Walnut Acreage as of 1992 - Varieties and Age Groups - State Summary**

Acreage Planted during Years Shown and Standing in 1992

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>HARTLEY</td>
<td>46,006</td>
<td>1,605</td>
<td>1,387</td>
<td>1,602</td>
<td>1,960</td>
<td>1,469</td>
<td>1,130</td>
<td>1,021</td>
<td>1,165</td>
<td>585</td>
<td>381</td>
<td>361</td>
<td>115</td>
<td>54,849</td>
<td>4,787</td>
<td>69,636</td>
</tr>
<tr>
<td>SERR</td>
<td>21,479</td>
<td>732</td>
<td>399</td>
<td>393</td>
<td>301</td>
<td>104</td>
<td>68</td>
<td>62</td>
<td>21</td>
<td>54</td>
<td>14</td>
<td>13</td>
<td>23,431</td>
<td>236</td>
<td>23,667</td>
<td>12</td>
</tr>
<tr>
<td>PAYNE</td>
<td>19,972</td>
<td>503</td>
<td>440</td>
<td>400</td>
<td>225</td>
<td>146</td>
<td>106</td>
<td>68</td>
<td>22</td>
<td>58</td>
<td>2</td>
<td>0</td>
<td>21,824</td>
<td>246</td>
<td>21,870</td>
<td>11</td>
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<tr>
<td>FRANQUETTE</td>
<td>18,283</td>
<td>45</td>
<td>63</td>
<td>52</td>
<td>120</td>
<td>40</td>
<td>67</td>
<td>71</td>
<td>84</td>
<td>60</td>
<td>36</td>
<td>23</td>
<td>18,572</td>
<td>413</td>
<td>18,985</td>
<td>10</td>
</tr>
<tr>
<td>VINA</td>
<td>8,099</td>
<td>1,006</td>
<td>888</td>
<td>1,085</td>
<td>1,272</td>
<td>362</td>
<td>251</td>
<td>268</td>
<td>181</td>
<td>281</td>
<td>129</td>
<td>94</td>
<td>11,353</td>
<td>944</td>
<td>12,297</td>
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<tr>
<td>CHANDLER</td>
<td>1,259</td>
<td>424</td>
<td>863</td>
<td>1,267</td>
<td>7,047</td>
<td>1,222</td>
<td>1,099</td>
<td>1,013</td>
<td>927</td>
<td>744</td>
<td>904</td>
<td>920</td>
<td>578</td>
<td>7,121</td>
<td>5,086</td>
<td>12,207</td>
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<tr>
<td>ASHLEY</td>
<td>10,999</td>
<td>201</td>
<td>185</td>
<td>153</td>
<td>68</td>
<td>40</td>
<td>25</td>
<td>178</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>1</td>
<td>11,051</td>
<td>252</td>
<td>11,303</td>
<td>5</td>
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<tr>
<td>BUREVA</td>
<td>9,545</td>
<td>42</td>
<td>49</td>
<td>21</td>
<td>47</td>
<td>33</td>
<td>63</td>
<td>116</td>
<td>14</td>
<td>1</td>
<td>6</td>
<td>9</td>
<td>9,737</td>
<td>210</td>
<td>9,956</td>
<td>5</td>
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<tr>
<td>TENAMA</td>
<td>5,657</td>
<td>98</td>
<td>67</td>
<td>14</td>
<td>66</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>17</td>
<td>5,910</td>
<td>14</td>
<td>5,954</td>
<td>3</td>
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<tr>
<td>CHICO</td>
<td>2,229</td>
<td>373</td>
<td>331</td>
<td>336</td>
<td>212</td>
<td>150</td>
<td>52</td>
<td>21</td>
<td>61</td>
<td>1</td>
<td>34</td>
<td>0</td>
<td>2,552</td>
<td>210</td>
<td>2,762</td>
<td>2</td>
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<tr>
<td>OTHER</td>
<td>12,035</td>
<td>313</td>
<td>379</td>
<td>630</td>
<td>651</td>
<td>182</td>
<td>121</td>
<td>317</td>
<td>160</td>
<td>157</td>
<td>70</td>
<td>73</td>
<td>14,216</td>
<td>857</td>
<td>15,072</td>
<td>8</td>
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<tr>
<td><strong>ACREAGE TOTAL</strong></td>
<td>154,193</td>
<td>5,142</td>
<td>5,231</td>
<td>5,763</td>
<td>5,946</td>
<td>3,059</td>
<td>2,052</td>
<td>5,165</td>
<td>2,742</td>
<td>1,924</td>
<td>1,692</td>
<td>1,567</td>
<td>689</td>
<td>181,434</td>
<td>13,284</td>
<td>194,718</td>
</tr>
</tbody>
</table>


**1/ Numbers for these years may be significantly lower than the actual acres planted. See Appendix B, California Agricultural Statistics Service.**

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### Figure 4

**Average Tons Per Acre 1980-85 vs. 1986-91**

#### San Joaquin

- **1980-85:** 1.45 Tons/Acre
- **1986-91:** 1.55 Tons/Acre

#### Stanislaus

- **1980-85:** 1.40 Tons/Acre
- **1986-91:** 1.45 Tons/Acre

#### Merced

- **1980-85:** 1.50 Tons/Acre
- **1986-91:** 1.55 Tons/Acre

Source: County Agricultural Reports.
Prices received by walnut growers have fluctuated in recent years. Following a sharp drop in the early 1980s, prices gradually recovered, approaching their previous levels by the end of the decade, as shown in Figure 5. The recovery can be attributed to several factors, including the relative weakness of the U.S. dollar which helped to spur exports; increased marketing and promotion programs; and short crop situations in competing nuts, particularly pecans. However, in deflated dollars, walnut prices are still substantially below their level of the early 1980s.

Another important factor for walnut growers is the cost of doing business. Cultural costs, harvest costs, overhead costs, yields, water cost, and pest pressures vary among the Sacramento Valley, the San Joaquin Valley and Coastal districts. For example, walnut blight is mainly a Sacramento Valley problem, while mites pose a bigger threat to southern San Joaquin Valley growers than in other growing regions. Coastal districts contend with walnut husf fly difficulties, but codling moth losses occur statewide.

A study of typical revenue, costs and net returns per acre for walnuts was conducted in Tulare County in 1993. The analysis indicated per-acre revenue of $2,600; total cash costs of $1,338; costs for equipment, land and trees of $630; and net returns of $630. Details of the study are given in Appendix C.

Marketing arrangements

Walnuts are marketed primarily through 68 handlers who either grow or buy their supplies from producers. The largest 10 handlers are estimated to account for over 80 percent of the walnuts marketed in California. The major cooperative handler is Sun-Diamond Growers, whose membership during the past 10 years has accounted for nearly half of the walnuts produced in California. Independent handlers vary from the very small to very large. Several large independents combine with the cooperative to provide leadership to the industry in marketing. A recent increasing trend in the California walnut industry is the advent of "producer-handlers," who grow for their own processing and marketing and also purchase from other producers.

In 1991, a bargaining association of independent producers was formed to represent their interests with the independent handlers. If this association represents a significant portion of the Independent producers in the future, a new leadership dynamic would be introduced into the California walnut industry.
Marketing Orders

Producers and handlers of walnuts operate under a federal marketing order which was established in July 1949, under the authority of the Federal Agricultural Marketing Act of 1937. The order provides for:

- Volume regulation in the form of reserve pools and minimum export prices.
- Quality control through the maintenance of grade and size regulations for inshell and shelled walnuts.
- Inspection and certification of shelled and inshell walnuts. The Cord Fruit and Tree Nut Association (CFTA) is the inspection service for the California walnut industry.
- Collection and dissemination of industry statistics through required reports submitted to the Walnut Marketing Board by handlers.
- Collection of assessments levied on handlers based on their merchantable walnut inspection totals.

The order does not authorize advertising programs.

The marketing order is administered by a 14-member board with representatives of both independent and cooperative growers and handlers, and a public member.

There is also a state program, the California Walnut Commission, initiated in 1987 and reauthorized by the California Director of Food and Agriculture in 1993 for another six years. The Commission deals with advertising, promotion, and marketing research. Its activities include:

- Promotion of walnut sales through better advertising and other promotional means for the purpose of maintaining and expanding present markets, and creating new and larger foreign markets for walnuts.
- Entering into joint advertising with other products.
- Education and instruction of the wholesale and retail trade in foreign markets on the proper methods of handling and selling walnuts.
- Marketing research and surveys, including the study, analysis, accumulation, and dissemination of information obtained from the research and surveys.
- Publication and distribution of information regarding Commission activities to producers and handlers.
- Presentation of facts to, and negotiation with, governmental agencies on matters that affect walnuts.

The activities of the California Walnut Commission are carried out through a 13-member commission composed of eight producer members, two handler members, two producer-handler members, and one public member.

The first six years of Commission activities focused on the promotion of exports, specifically in conjunction with the Federal Market Promotion Program (formerly called the Targeted Export Assistance, or TEA, program). This program provides assistance to agricultural industries that have been the victim of unfair trade practices by other countries. Administered by the U.S. Foreign Agriculture Service, it requires cost sharing by the industry requesting assistance.

The California Walnut Commission was formed to take advantage of this federal program. Market promotion efforts have been directed at key countries to enhance the sales of California walnuts. Producers are assessed to meet the cost-sharing requirements. Current levels of expenditures are more than $5 million per year, with growers contributing over $2 million.

Both the federal marketing order and the state export-enhancement program are financed by producer assessments and jointly administered under the same management. Recently, these programs, together with handler organizations, have been instrumental in developing with various trade partners, such as increased sales by the European Community, which were designed to reach market access of California walnuts.

III. THE RESOURCES

The basic natural resources that serve as a foundation for California's walnut industry are land, water, and air. All are threatened to some degree by the increasing urbanization of California and other land use impacts. All are crucial to the economic health of the walnut industry.

Where Walnuts Are Grown

Sites where walnuts can be grown successfully in California are determined largely by climate, soils and topography. The actual location of walnut-growing regions also is influenced by economic factors such as land prices (often influenced by development pressure) and the availability of a relatively inexpensive source of irrigation water. Within these constraints, walnuts have shown remarkable diversity in adaptation and economic viability throughout the state.

The climate

California’s Mediterranean-type climate—long, warm, dry summers and mild winters—is very similar to the more moderate parts of the original range of the English walnut (originally, and probably more accurately, called “Persian”). Consequently, the Mediterranean strains easily adapted to this new region. Still, climate is one of the major factors determining where walnuts can be successfully produced in California. Varieties commonly grown in this state may only be able to withstand winter temperatures down to 12–15°F without serious injury.

However, walnut-growing areas in California are limited more by insufficient winter chilling than by tolerance to cold. (Winter chilling is the cold temperature during winter months that is needed to break the trees' dormancy in the spring.) The commercial varieties that dominated the former industry in Southern California had a low chilling requirement and proved very adaptable to the mild winters there. In contrast, walnuts imported from France into Northern California—the basis of the industry’s present-day varieties—have a relatively high winter chilling requirement. If this condition is not met, the results can be seriously delayed bud opening, uneven bloom, poor crops, and branch dieback.
There is, however, another danger from excess cold: when walnuts begin their spring growth, their leaves, shoots, blossoms and nuts are easily killed if temperatures drop below freezing. This danger is usually restricted to mountainous and localized low-lying areas. The problem can be circumvented by choosing varieties that are late leafing, such as Hartley and Franquette. Still, spring frosts are one of the limitations to walnut production in areas such as the Sierra foothills and Lake County. Danger of autumn frosts also limits walnut production areas.

Another climatic factor is late spring rain, which encourages development of walnut blight. Early leafing varieties—particularly when grown in the higher rainfall areas of the north—are more prone to damage, especially in years with late spring rains. For this reason, early leafing varieties in the Sacramento Valley are being replaced by later leafing ones, which tend generally to escape infection.

Another factor is excessive summer heat, which can cause sunburning of the hull and dark, shrivelled kernels. Some damage to exposed nuts occurs at 100°F and damage is severe at 105°F or higher, especially when the trees are under moisture stress. The potential for damage is greatest at the hot northern and southern ends of the Central Valley.

The soil resource

Walnut trees perform best on deep alluvial soils which are medium textured and free of restricting layers, such as clay or hardpan. The largest concentrations of these desirable soils are along the principal rivers of the Central Valley. Today, most walnuts are grown on these more recent soils. (See Appendix D.)

In contrast, the terraces of older alluvium along the outer edges of the Central Valley are more difficult to manage and do not have a history of successful walnut production. However, they share the same climate and can be productive if drainage problems in hardpan or claypan soils can be corrected. These soils, long considered marginal, may become more important in the future—but their suitability for walnut production remains to be proven.

Trends in Land Use

Within California, the major competitors for the better soils—those suitable for walnuts—include:

- Other tree crops, including almonds, apples, peaches, prunes, grapes, cherries, pistachios, shipping fruit and pecans.
- Vegetable crops, including processing tomatoes, beans and specialty crops.
- And a very significant competitor: houses.

Many California cities, particularly in the inland valleys, are on the most productive soils where walnuts are also located. Thus, walnuts often are in the pathway of urban expansion. This trend has implications not only for potential loss of walnut acreage, but also for reduced farm size where commercial walnut acreage is parceled into rural residential development. Another potential loss in tonnage is through conversion of walnut acreage along the Sacramento River into riparian wildlife habitat, as described later.

Land conversion in the Valley

Almost 95 percent of the state’s walnut production comes from the Sacramento and San Joaquin Valleys, which are experiencing very rapid population growth and urbanization. Many thousands of acres in the Valley have been converted from agricultural to urban land uses over the last 20 years. In addition to direct urbanization, the American Farmland Trust estimates that 120,000 acres of land in the eight San Joaquin Valley counties plus Sacramento and Yolo Counties are currently zoned rural residential (10 acre parcel size or less). (Personal communication.) At least some of this land is or will be undergoing conversion to “ranchettes.” The figures for rural residential acreage would be even higher if coastal counties such as Contra Costa and Santa Clara were included. These historically important walnut growing areas underwent rapid urbanization in the 1960s and 1950s; and now have a mere fraction of their original walnut acreage.

Walnut acreage is directly affected by conversion to subdivisions at the city’s edge and by residential development...
in rural areas. Indirect impacts also are felt by growers whose farms are near houses. Compared to most other California tree crops, walnuts are desirable for homesteads because of their size and beauty and because they are relatively accommodating to the rural residential lifestyle. Some counties, such as Kings, view 10 acre parcels, of which many are in walnuts, as a desirable buffer between cities and the more intensive agricultural crops like cotton.

This implies that much walnut acreage is, and will continue to be, farmed at the urban edge—a fact which poses many challenges for growers there, who must cope with more restrictions on pesticide use and other cultural practices, complaints from neighbors, vandalism and theft, and higher land values.

Farther out from the city, rural residential development involving walnuts takes place either where commercial-sized farms are divided into residential parcels, or where land is converted to rural homesteads and the owners then decide to plant walnuts. Planners in some counties believe that this type of residential growth in rural areas has had even more impact on agricultural land than urban expansion. Parelization reduces the viability of agriculture where lots are too small to support commercial agriculture—and even where larger lots, such as 40 acres with a dwelling, are scattered throughout agricultural areas.

As walnut acreage is lost, are the agricultural service and supply industries, making operations increasingly difficult for the remaining growers. Central Valley growers need only to look at coastal counties and Southern California to see the significant impact that rapid urban development can have on their industry and its infrastructure.

Local land-use approaches

Land-use policies vary a good deal among California’s walnut-growing counties. In at least some counties, the degree of protection they provide may well be important to the future of the local walnut industry.

Most agricultural land is either under temporary protection as farmland, or is planned for development. The majority of the walnut-growing counties have right-to-farm ordinances. Agricultural zoning designations and other interim measures also are protecting some walnut acreage for the short term. Only about a third of the counties are even considering long-term protection of agricultural land by purchasing conservation easements or development rights.

More than half of the counties have 20 acre minimum parcel size for agriculture. Almost as many have a 40 acre minimum; the handful remaining have either 10 or 5 acre minimums. All but three participate in the Williamson Act, some including mostly grazing land while others have both crop and grazing land. However the trend under the Williamson Act has been toward more nonrenewals, especially where development pressures are increasing.

Potential losses survey

To estimate the amount of California walnut acreage that could be converted to urban uses within the next 10 to 20 years, two main sources were used:

1. California Department of Water Resources (DWR) land use surveys on which all crop acres are mapped for each county.

2. Local Agency Formation Commission (LAFCO) Sphere of Influence (SOI) boundary maps for each incorporated city within the 23-county study. (See Glossary)

County planners also were interviewed to determine where growth was occurring elsewhere in the county and what other land use decisions could affect walnut acreage.

The study indicated that an estimated 24,861 acres of walnuts could be converted to urban development in California during the next 20 years. This represents about 11 percent of the walnut acreage for the surveyed counties, using DWR acreage figures. When effects of losses of land already acquired for riparian conversion (see following page) are included, the total walnut tonnage potentially lost is 26,680. That is about 12 percent of the walnut industry’s average output for the years 1991 and 1992.

Detailed results of this survey are in Appendix E.

Potential acreage gains

Concurrent with acreage losses, new plantings of walnuts also can be expected. There is currently a trend from some other tree crops, especially almonds, to wal-
Since 1969, an ongoing reconfiguration is occurring throughout the nation, with soils on the West Coast being in the forefront. These soils are highly productive, with low-volume, high-quality production. Soils on the East Coast are being reclassified as high-volume, low-quality. The reconfiguration is based on the need to maximize crop yields and minimize environmental impact. No differences have been found between soils on the West Coast and those on the East Coast.

Table 3: Current and Potential Expansion and Loss of Walnut Plantings

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>LAND AVAILABILITY</th>
<th>SOIL QUALITY</th>
<th>WATER AVAILABILITY</th>
<th>WATER QUALITY</th>
<th>RIPARIAN CONVERSION</th>
<th>URBAN IMPACT</th>
<th>RATING</th>
<th>CROP SHIFTS TO WALNUT FROM</th>
<th>CROP SHIFTS FROM WALNUT TO</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shasta</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>Np</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Pending residential development impact</td>
</tr>
<tr>
<td>Tehama</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>13</td>
<td>Alfalfa, field crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>New plantings-better and poorer soil (westside)</td>
</tr>
<tr>
<td>Glenn</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>12</td>
<td>Row crops, field crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>New plantings-better and poorer soil (westside)</td>
</tr>
<tr>
<td>Butte</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>Row crops, field crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Chlorine production protecting many acres</td>
</tr>
<tr>
<td>Colusa</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>Row crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Westside-expansion potential-class 2 and 3 soils, drainage and water critical</td>
</tr>
<tr>
<td>Sutter</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>Troll and row crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Expansion-crop shifts mainly; some wells-chloride</td>
</tr>
<tr>
<td>Yuba</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>Tree crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Expansion-crop shifts mainly; more potential for urban impact in Westland area</td>
</tr>
<tr>
<td>Yolo</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>Almond, row crops and grapes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Potential expansion areas have good soil; water-some boron</td>
</tr>
<tr>
<td>Solano</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>Tree crops, tomatoes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Water availability could limit new plantings</td>
</tr>
<tr>
<td>San Joaquin</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>12</td>
<td>Almond, field crops, alfalfa</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Crop shifts-replace walnuts lost to urbanization; westside-salinity</td>
</tr>
<tr>
<td>Stanislaus</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>Tree crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Water and salinity problems-westside; blackline problems</td>
</tr>
<tr>
<td>Mariposa</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>Tree crops</td>
<td>Cherry, apricot</td>
<td>Water and salinity problems-westside; blackline problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresno</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>10</td>
<td>Almond, annual crops</td>
<td>Grapes, stone fruit</td>
<td>New plantings-southwest off Highway 99; deep bark canker problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tulare</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>13</td>
<td>Tree crops</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Large amount of suitable land for expansion; deep bark canker problems</td>
</tr>
<tr>
<td>Kings</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>14</td>
<td>Cotton-northern county</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Deep soils near Wasco, Shafter for expansion; water limiting</td>
</tr>
<tr>
<td>Kern</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Deep soils near Wasco, Shafter for expansion; water limiting</td>
</tr>
<tr>
<td>Lake</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>10</td>
<td>Pasteur or untrimmed</td>
<td>Grapes</td>
<td>Premium critical with low tonnage; some rearrangement conversion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contra Costa</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>11</td>
<td>No</td>
<td>Cherry, apples</td>
<td>Blackline limiting production despite water availability, no new areas left with adequate soil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Benito</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>11</td>
<td>Apricots, lower value land</td>
<td>Cherry, row crops</td>
<td>New plantings-South Co. and Monterey Co.; blackline problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>Grazing land, barley</td>
<td>Grapes, apples</td>
<td>New plantings-irrigated; expansion-from parcelled down land</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The table includes 20 of the state's walnut-producing counties. Walnut acreage shifts in most soils will occur either through lower-valued row and field crops, or new plantings primarily on soils not traditionally available. Table 3 also indicates which counties are more likely to have new plantings, indicating which areas have the most potential for expansion. India will be considered for future expansion. No differences have been found between soils on the West Coast and those on the East Coast.
acres of existing riparian habitat or farms in the floodplain where walnuts are the major crop, due to the deep soils.

Under this program, which is likely to take place over the next 20 years, the USFWS purchases an orchard and then directs its management. At first, growers would lease back the land, enabling the USFWS to use profits from the farming to fund riparian habitat restoration. During this period, pesticides or riparian management systems would be scrutinized closely and used only by USFWS permission. Some of this leased land may be converted to riparian habitat within the next few years, if economic returns are low.

Resources: Water

Water availability, sources and quality differ greatly among the many counties where walnuts are grown. Growers may use wells or depend on surface water—which may be from a local source or be imported by the Central Valley Project (CVP) or, in some localities, the State Water Project (SWP). Where walnuts traditionally have not been irrigated, as in Lake and San Luis Obispo counties, new plantings are going in on irrigation.

Appendix G lists for each county the percentage of walnut acreage on surface water, well water or both. Even in the absence of drought, increasing urbanization and environmental demands for water will continue to influence surface water delivery to agriculture in California. Surface and groundwater rights may be affected by legal or political developments. Because of groundwater overdrafting, especially in the southern San Joaquin Valley, more surface water may be allocated to groundwater recharge. All this will make the issue of water conservation even more critical in the future. In any case, both surface and groundwater costs seem likely to increase.

In many counties, especially those rich in groundwater in the Sacramento Valley, the major source of water for walnut orchards is from wells. Because of concerns about water transfers, many of these counties now have or are drafting county ordinances restricting groundwater exports. How effectively groundwater is managed at the local level may well determine whether there will be more restrictions on groundwater extraction, or possibly even statewide control, in the future.

Water quality is another important consideration. Nonpoint source pollution of waterways could lead to on-farm regulations for quality control of water leaving the farm. Pesticide runoff contamination and leaching of nitrate due to excess fertilization are particular concerns.

Quality of irrigation water supplies is another consideration, although this is not currently a significant limiting factor for statewide walnut production. High levels of sodium, chloride, and boron are detrimental to walnut trees. Besides the specific toxic effects, increased salt concentrations in the soil decrease water availability to the tree, so orchards need more frequent irrigation. Soil/water salinity potentially harmful to walnut trees is found along the West Side of the San Joaquin Valley and in some parts of the Sacramento Valley and the Central Coast. A more detailed description of these areas is in Appendix H.

Technology for efficient irrigation

As both surface water costs and pumping costs increase, economics will drive a greater demand for more efficient irrigation. Water quality, quantity and cost will determine whether a grower converts to a new system.

Low volume (micro) sprinkler and drip (trickle) systems have been used in some walnut orchards for several years. Water savings usually result from reduced deep percolation, reduced runoff, and reduced evaporation. Frequent applications of water, made feasible by these systems, is very critical for young trees. Low-volume systems also make it possible to use more saline water than with other irrigation methods. However, salts may accumulate in the periphery of the root zone, posing a hazard if they are not monitored and leached.

While low volume systems provide more efficient use of irrigation water, their increased use in orchards could have long-term consequences on groundwater recharge. Since only enough water is applied to meet the trees’ needs, virtually none is lost to deep percolation, with flood irrigation—which does contribute to recharge of aquifers. Although this is not a direct concern of individual growers, collectively it may need to be considered by water resource management agencies.

Resources: Air Quality

There is reason to be concerned about both the impact of air pollution on agriculture and agriculture’s contribution to air pollution. With rapid population growth in the Central Valley, air quality may well worsen as vehicular and industrial emis-
Agricultural Burning

It is possible that within the next 10 years burning could be further restricted for tree crop growers. Any such regulation may be similar to the phase-down program for rice burning in the Sacramento Valley. In this case, walnut growers would need to find alternative methods to dispose of prunings and stumps.

In several counties where cogeneration plants are nearby, some growers are already chipping walnut brush—often at no cost to them. As cogeneration plants become more widespread, this would serve as a viable alternative to burning, particularly if chippers are available to the many small walnut acreages as well as to the larger growers. (This has been a problem.) Project Clean Air, a voluntary program in Kern County funded through grants from the air pollution district, is working to get chippers to smaller acreages. This program could serve as a prototype for other areas.

Air pollution control districts can set standards, but can only intercede when permits are required for operation. Under state law, agriculture is currently exempted from permits for air pollution control, except for agricultural burning and on-farm processing.

The PM10 problem

The Federal Clean Air Act of 1990 is intended to reduce fine particulate (PM10) emissions which exceed the national ambient air quality standards. Air pollution control districts are in the beginning stages of developing tools needed to regulate PM10, but they do not yet have the research-based information needed to set specific guidelines for agriculture. Although specific PM10 regulations for cultural practices are not imminent, districts not in compliance with federal EPA regulations eventually may be forced to comply—which could lead to regulation without sound scientific backing.

Agricultural interests are working with agencies such as the San Joaquin Valley Unified Air Pollution Control District to determine what can be done to reduce PM10 emissions. For example, studies are being conducted for the almond industry to develop methods to measure PM10 and to determine its effects during each almond operation. This data will be useful to the walnut industry as it considers ways to improve equipment or modify harvesting to contain dust in the future. In addition to dust containment, controls on agricultural burning as a way to reduce PM10 have been considered.

Besides PM10, other air quality issues may involve the walnut industry. Possibilities of reducing the volatile organic compounds that serve as carriers for pesticides are being examined. Timing and pesticide application methods could be restricted to reduce air toxics; state regulatory zones may be developed in more critical areas. In addition, diesel and gas irrigation pumps are being surveyed to see if they are contributing to the ozone problem. Depending on the findings, they could be restricted in the near future. Another impact could be tighter standards for tractor diesel engines and fuel.

Ozone damage to walnuts

The major air pollutant that potentially could affect walnut production is ozone, which is produced primarily by exhaust from combustion engines. The negative impact of ozone pollution on agricultural production is well documented in Southern California. In the southern San Joaquin Valley, current levels of air pollution have been shown to significantly decrease yields of crops such as cotton, grapes, oranges, alfalfa hay and dry beans.

Although the effects of ozone on walnuts are unknown, tests have shown that effects on almonds differ by variety. (Nonpareil was the most sensitive; Carmel, Merced, and Butte had a less severe response; and Mission was unaffected, even by exposure to high ozone levels.)

Within the main walnut growing regions, the highest ozone levels are found in the southern San Joaquin Valley, where Tulare County is the largest walnut growing area (See Appendix I for PM10 and ozone levels in walnut-growing counties.) There also are high ozone levels in Kern and Fresno Counties which presently have small walnut acreages but have potential for expansion—especially Kern County, as shown in Table 3. Kings County, which has a moderate amount of walnut acreage and good potential for expansion, did not have high ozone levels during 1989-91. Stanislaus County had fairly high ozone levels during this period.
IV. TRENDS IN PRODUCTION PRACTICES

Responding to economic and regulatory pressures, walnut growers are continually shifting to more efficient or more environmentally acceptable practices. The chief factors affecting future production practices include new varieties and rootstocks; close spacing or, possibly, hedgerow planting; and new approaches to pest control, including integrated pest management.

Varieties and Varietal Development

Statewide, the dominant variety is Hartley, as shown in Table 2. Hartley is the main variety in both the Sacramento and San Joaquin Valleys and in San Luis Obispo County on the coast. Payne dominates the westside of Stanislaus and Merced Counties and San Benito County. Serr is the main variety in Kern County, Franquette in Lake County, and Eureka in Contra Costa County. Other important varieties are Vina, Ashley and Serr in the Sacramento Valley, and Serr and Vina in the southern San Joaquin Valley.

Based on recent plantings, the trend expected during the next 20 years is toward Chandler on Paradox in almost all counties. This expectation is supported by Table 4, which shows that 75 percent of all grafted walnut trees delivered in

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Nursery-grafted Walnut Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Delivered in 1993 For New Plantings</td>
</tr>
<tr>
<td></td>
<td>Percent By Variety — All Rootstocks</td>
</tr>
<tr>
<td>Chandler</td>
<td>75.0%</td>
</tr>
<tr>
<td>Vina</td>
<td>8.9%</td>
</tr>
<tr>
<td>Hartley</td>
<td>7.5%</td>
</tr>
<tr>
<td>Franquette</td>
<td>3.2%</td>
</tr>
<tr>
<td>Cisco</td>
<td>2.6%</td>
</tr>
<tr>
<td>Tulare</td>
<td>1.2%</td>
</tr>
<tr>
<td>Other</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

Based on 1993 delivered nursery-grafted trees from major walnut nurseries in the Sacramento and San Joaquin Valleys. Other varieties include Sunland, Howard, Serr and Eureka. Trees sold for replants in existing orchards are not included.
1993 from major walnut nurseries were Chandler. This trend is expected to continue in 1994 and 1995. Cisco and Franquette are planted primarily as pollenizers for Chandler. Tulare, the most recently released variety, is early bearing, harvests at mid-season, and appears adapted to hedgerow planting.

Table 5 shows trends in plantings of major varieties from 1988 to 1993, demonstrating the trend to Chandler. Projected bearing acreage of major varieties through the year 2000 is shown in Table 6. Because of higher-yielding newer varieties, the industry trend should be toward significantly higher production in the future.

In regard to Table 5, walnut acreages planted during 1988-91 were reported by the California Agricultural Statistics Service (CASS). These numbers are possibly low for the most recent years reported. (See Appendix B.) The 1992 and 1993 planted acres were estimated from a survey of major walnut nurseries in the Central Valley. An average of 56 trees per acre was used to calculate the acreage from the reported number of trees sold. The California Association of Nurseriesmen estimates that the nurseries included in the survey for 1993 were responsible for about 80-85 percent of the trees sold that year.

In regard to Table 6, the bearing walnut acreage for each year was projected by adding the non-bearing acreage from five years before to the bearing acreage from the previous year. For example, the trees planted (non-bearing) in 1991 were added to the bearing trees in 1995 to get projected bearing acreage for 1996. The base 1992 bearing acres are numbers reported by CASS. The projected acres are based on numbers from Table 5. Table 6 assumes that older walnut orchards are being replaced with new walnut orchards, and that no orchards are being taken out for other purposes. For projected losses due to other land use purposes, see Appendix E.

It is important to note that new plantings currently are limited by the supply of nursery trees available. There is increasing interest in propagating one-year-old nursery trees rather than taking two years as is the current practice, largely because of the trend to higher-density plantings discussed in the next section. As nurseries develop and adopt this technology, the availability of young trees may increase and the cost may decrease.

Chandler has become a popular variety because of nut

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</tr>
</thead>
<tbody>
<tr>
<td>Chandler</td>
<td>927</td>
<td>744</td>
<td>904</td>
<td>900</td>
<td>2,434</td>
<td>2,944</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hartley</td>
<td>1,195</td>
<td>686</td>
<td>381</td>
<td>361</td>
<td>261</td>
<td>294</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vina</td>
<td>161</td>
<td>281</td>
<td>129</td>
<td>34</td>
<td>301</td>
<td>349</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Franquette</td>
<td>94</td>
<td>69</td>
<td>36</td>
<td>23</td>
<td>96</td>
<td>126</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Subtotal</td>
<td>2,377</td>
<td>1,680</td>
<td>1,450</td>
<td>1,336</td>
<td>3,052</td>
<td>3,713</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Other [a]</td>
<td>365</td>
<td>244</td>
<td>232</td>
<td>229</td>
<td>762</td>
<td>995</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>2,742</td>
<td>1,924</td>
<td>1,682</td>
<td>1,567</td>
<td>3,814</td>
<td>4,708</td>
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2/ Personal communications with major nurseries for new plantings.

[a] Includes seedlings and several other varieties not listed above.

Nursery sources indicate both more Chandler and a larger total of trees sold for 1994, with a similar trend predicted for 1995.

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandler</td>
<td>7,121</td>
<td>8,048</td>
<td>9,678</td>
<td>10,616</td>
<td>13,265</td>
<td>16,209</td>
<td>19,153</td>
<td>22,096</td>
<td></td>
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<tr>
<td>Hartley</td>
<td>54,649</td>
<td>56,064</td>
<td>59,260</td>
<td>59,543</td>
<td>60,275</td>
<td>58,912</td>
<td>57,301</td>
<td>55,256</td>
<td>59,520</td>
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<tr>
<td>Vina</td>
<td>11,353</td>
<td>11,514</td>
<td>11,795</td>
<td>11,504</td>
<td>11,958</td>
<td>12,072</td>
<td>12,620</td>
<td>12,699</td>
<td>13,318</td>
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<tr>
<td>Franquette</td>
<td>18,572</td>
<td>18,656</td>
<td>18,725</td>
<td>18,761</td>
<td>18,864</td>
<td>18,697</td>
<td>19,023</td>
<td>19,149</td>
<td>19,275</td>
</tr>
<tr>
<td>Subtotal</td>
<td>91,885</td>
<td>94,262</td>
<td>95,842</td>
<td>97,092</td>
<td>98,730</td>
<td>102,071</td>
<td>105,783</td>
<td>109,497</td>
<td>113,209</td>
</tr>
<tr>
<td>Other [a]</td>
<td>88,529</td>
<td>85,904</td>
<td>90,148</td>
<td>90,380</td>
<td>90,603</td>
<td>91,976</td>
<td>92,670</td>
<td>93,365</td>
<td>95,960</td>
</tr>
<tr>
<td>Total</td>
<td>180,414</td>
<td>180,166</td>
<td>186,006</td>
<td>187,772</td>
<td>189,339</td>
<td>194,046</td>
<td>198,753</td>
<td>203,462</td>
<td>208,169</td>
</tr>
</tbody>
</table>

1/ Estimated without losses to urbanization, riparian conversion or other losses (See Appendix E).

[a] Includes seedlings and other varieties.

quality and minimal insect and disease problems. The large, light kernel makes it an excellent shelling variety that cracks into halves easily; growers often get premiums for it. One minor drawback to quality is a tendency towards some tip shivel on the kernel. Because Chandler is later leafing and blooming, blight and codling moth have not been problems. In addition to the varieties listed in Table 6, there also appears to be some interest in planting Howard which has a similar bearing time as Chandler, although it harvests earlier.

The inshell market is dominated by Hartley. With fewer new Hartley plantings and the demise of older blocks of trees from deep bark canker and other stress-related problems,
another variety such as Vina eventually may fill that market. However, since the mid-1980s the walnut industry has seen a decline in the use of walnuts in the inshell form, and this trend is likely to continue.

Rootstocks

In all regions, Northern California black is the most common rootstock in existing orchards. However, Paradox rootstock dominates in San Joaquin County and is about 50 percent of the plantings in Kings and Fresno counties. Other counties have lower percentages of Paradox. In Contra Costa County where blackline disease is a major problem, English rootstock is also commonly used along with the major rootstocks.

In 1993, about 70 percent of trees delivered by nurseries were on Paradox rootstock. Nurseries reported that most growers want Paradox but the supply is limited. Some growers still prefer to plant Northern California black rootstock either because their soil is infested with crown gall or because they are less concerned with the tree vigor associated with Paradox.

Research is underway on clonal rootstock. Once this process of propagation is commercially viable, clonal rootstock may be able to solve specific root-related problems.

Certification of English rootstock and scion wood free from the virus causing blackline has been considered by the California Department of Food and Agriculture. Although the preliminary response by the nursery industry was unfavorable, in time a certification program may become desirable as rootstocks tolerant to the virus become available.

Variety and rootstock improvement

Techniques for genetic improvement have changed significantly in the last decade but the need for long term field trials of promising selections has not. Much of the breeding and engineering work being done today will have its major impact on production in 20 years or more.

What varietal improvements can growers expect? The traits being worked on by UC plant breeders include:

- Blight resistance.
- Precocity (higher yields on younger trees).
- A wider range of harvest dates.
- Higher frequency of half-kernels during processing.
- Better adaptation to hedgerows.

Now that chemical pest control is becoming less desirable, resistance to codling moth and nematodes is also of high priority.

What problems will not be pursued in the breeding program? Because tree breeding is long term and expensive, any problems that can be satisfactorily dealt with by improvements in cultural practices should not be part of a breeding program. Also, problems that are more environmentally than genetically controlled, such as number of good kernels, are difficult to change through breeding.

Problems that appear inextricably linked with a positive trait also are difficult. One example of this may be the pearl color of the Chandler variety. If the color is good because the harvest is late, then it would be difficult to develop an early-harvesting Chandler type. However, if Chandler's color is good because it is less sensitive to heat—a trait which is under genetic control—then the plant breeders can aim for early harvest and reduced heat sensitivity to develop an early harvesting Chandler-type kernel.

The new technology of genetic engineering has great potential for expanding the number of traits that can be manipulated in the walnut, but the time when genetic engineering will actually impact walnut production is still distant. Rootstocks will probably be the first genetically engineered commercial product, since this would avoid the problems of having a foreign gene in the edible and reproductive part of the tree. Also, some of the root pests such as nematodes are relatively localized so that any resistance that built up in the nematodes probably would not spread. In addition, the desired attributes of a rootstock are not as stringent as those for a scion—and so clones now in culture might be suitable for the addition of a nematode-resistance gene. Such a gene is being

Plant Breeding: A Slow Process

Developing an improved tree variety takes a long time. For example, the crosses that produced Chandler's parents were made in the early 1950s, and the cross that produced Chandler was made in 1963—but not until today, 30 years later, is Chandler becoming a prominent variety.

Chandler was one among almost 6,000 seedlings produced in the UC breeding program begun about 1947. Over the next 30 years the breeders made 196 crosses, evaluated almost 6,000 seedlings and released 13 varieties, including Vineland, Chico and Serr in 1968, and Howard, Chandler and Tulare in 1978. Tulare, released recently, is also one of the seedlings from these crosses.

At present 3,000 seedlings are under evaluation and about 600 are added every year.
UC Research on Walnuts

In the early 1900s, UC walnut research was concentrated in Southern California, dealing primarily with some of the early problems encountered by the industry. Studies during the 1920s and 1930s laid the foundation for present day understanding of how environmental influences and various pests and diseases affect walnuts—for example, winter injury or dieback of walnuts, codling moth and walnut blight.

In the late 1940s, UC Davis embarked on an extensive walnut breeding program to incorporate lateral bud fruitfulness—associated with high early yields—with characteristics associated with later bearing such as high nut quality. Ten new English walnut varieties resulted from the 1960s. Several of these—for example, Seri, Chico and Vina—significantly influenced the industry. Even more important were the releases in the 1970s of Howard and Chandler, two outstanding later-leafing varieties. Chandler, in particular, now comprises most of the new walnut plantings and appears likely to become the dominant walnut variety in California in the near future.

The program was revitalized in 1982, adding to its goals of high quality and late leafing: (1) the adaptation of walnuts to new technology, (2) introduction of germplasm to widen the genetic base and (3) resistance to pests and diseases.

Diseases and Pests

Two major industry problems were addressed during the 1970s and 1980s through cooperative UC and USDA studies: blackline disease, caused by the polynectored cherry leaf roll virus; and root and crown rot associated with several soildic Phytophthora species.

In the early 1970s, blackline was considered a major limit to walnut production in the northern San Joaquin Valley and coastal areas, and a serious threat to the entire industry. Research led to both long- and short-term solutions to the problem. Extensive studies of root and crown rot disease also identified 13 different Phytophthora species involved with root and crown rot. New information about the disease and rootstock testing resulted in increased use of the more resistant Paradox rootstock and more careful soil-wa
ter management—thereby mitigating tree losses from crown and root rot.

Research contributions by UC entomologists have included the introduction of a parasitic wasp, troxys pallidus, to control the walnut aphid, once a major pest of walnuts. This has resulted in much less use of pesticides in walnut orchards, and is an outstanding example of biological control of plant pests. Current efforts are focused on more integrated management of codling moth, the most serious pest of walnuts.

Other significant UC research contributions have been:
- Demonstration of the need for early and prompt harvest to minimize navel orangeworm and mildew damage as well as loss of kernel color.
- Development of the growth regulator ethephon as a harvest aid to increase hullability and removal of walnuts, thereby improving kernel quality.
- Improved drying procedures for walnuts, including the use of moisture meters to avoid over-drying.
- Higher tree densities, including the walnut hedgerow planting system.
- Correction of zinc deficiency, a major nutritional problem in walnuts.
- Better understanding of the nature of pistillate flower abortion (PFA) which can cause significant crop loss in some walnut varieties such as Seri.
- Effective biological—preventive and chemical control procedures for reducing the incidence of crown gall, a serious soildic disease mainly associated with Paradox and English rootstocks.

This UC research activity during the past 25 years has been made possible by financial support provided through the Walnut Marketing Board, as well as public funding. Industry funding began in the early 1970s and now amounts to more than $400,000 annually.

developed by private industry for other crops and may be available for walnuts in the future.

Close spacing/hedgerow planting

Most new orchards are being planted at a spacing of 30 feet square or less, and this trend will continue. As walnuts expand onto poorer soils, more 24 to 28 foot square spacings can be expected, due to reduced tree size and need for higher and earlier yields.

Hedgerow planting, a recent innovation, has potential for wider use during the next 20 years. With this system, trees are planted more closely in the row than is standard practice, are trained to produce a continual wall of foliage and nut-producing shoots, and are pruned mechanically.

Based on 14 years of yield data for standard and hedgerowed walnuts in an experimental planting established near Vina in 1974, a net present-value analysis shows significantly higher returns from the hedgerow system. However, initial capital costs associated with the increased number of trees per acre may limit adoption of the hedgerow option. In addition, most of the experience to date with hedgerow plantings has been with Chico, a variety in disfavor because of its small nut size and difficult shelling. Currently there are an estimated 1,300 acres of hedgerowed walnuts, mostly in the interior valleys. The plantings are small, typically in 10 to 20 acre blocks. This trend is expected to continue. However, hedgerow plantings may increase if more desirable varieties (Chandler, Howard, Tulare) show improved yields compared to standard plantings.

Pests and Diseases

In the future as in the past, walnut growers will have to deal with an array of plant pests and diseases. The threat varies according to the species of pest or disease, the growing region and the walnut variety involved.

Among the major problems, at least in certain regions and for certain varieties, are blackline, walnut blight, nematodes, the replant problem, crown gall, Phytophthora crown and root rot, deep bark canker, Armillaria root rot, codling moth, walnut husk fly, and navel orangeworm.
One of these problems, walnut blight, has traditionally been controlled with copper sprays. However, recent research has uncovered copper-resistant strains of the disease-causing bacterium. This has generated renewed interest in blight, which may pose a significant potential economic risk to the future production of walnuts—particularly in the northern part of the state.

A detailed discussion of these biological threats is in Appendix J.

Changes in pesticide use

Producers and processors in the California walnut industry face a number of shifts in their operational environment. Chief among these changes will be increasing regulations—particularly those arising from environmental concerns, such as use of pesticides. Many pesticides are now being reviewed in order to bring their registration up to current standards. For some, there are either no substitutes or very limited alternatives.

Because of re-registration and costs to fill data gaps, the walnut industry has already lost many effective pesticides and, in the case of Zolone, one of its least disruptive insecticides. This trend, along with newer new pesticides (because of increased research and development costs, and state and federal regulations), could make control of pests like codling moth and husk fly extremely difficult until consistently effective, economical alternative controls are found.

Many pesticides used by the California walnut industry are considered to be “minor use.” Even though withdrawal of the registration would have major impact on walnut growers, chemical companies may well choose not to make the investment of tens or hundreds of thousands of dollars to provide additional documentation if they feel sales volume does not justify it. Hence, the walnut industry may have to spend the money to get critical pesticides registered—either itself or in cooperation with other commodities.

Methyl bromide

A critical chemical to the walnut industry is methyl bromide, which is scheduled to be eliminated by the year 2001 or before because of its potential ozone-depleting capabilities. Methyl bromide is used both for soil fumigation when planting new trees and for post-harvest treatment of walnuts. No currently registered chemicals that can be used as an alternative for soil fumigation are as effective. However, Telone is in the process of being reregistered; if that occurs, it will provide an effective alternative for soil fumigation.

A number of alternatives exist for methyl bromide as a post-harvest treatment, including phosphine, carbon dioxide controlled atmosphere, heat/cold treatments, biological control, and irradiation. However, these techniques will greatly add to the cost of post-harvest treatment and in some cases may create a problem of timely deliveries of walnuts into the market. Another alternative would be to allow the use of methyl bromide in sealed facilities with recapturing devices to keep it out of the atmosphere. However, no such facilities exist, and building and operating one would be very expensive. Hence, the cancellation of methyl bromide will be costly to the industry and ultimately will be reflected in its overall cost structure.

Another impact also could result from the cancellation of methyl bromide—one with even more serious consequences. The fumigant is used to treat walnuts going to foreign countries, such as Japan and Korea, that have prohibitions regarding the codling moth. If such countries placed an absolute ban on California walnuts because they could not be treated to insure that codling moths are not present, that loss of market access would reverberate through other markets as the displaced product is sold elsewhere.

<table>
<thead>
<tr>
<th>Pest Management Systems</th>
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<tr>
<td>For well over a decade, integrated pest management (IPM) has implemented in various degree in many California crops such as walnuts. IPM provides long-term management strategy for minimizing losses caused by pests with as little disruption to the environment and cost to the grower as possible. As suburban encroachment continues in the future, it will be even more important to improve IPM practices to include reduced sprays with less disruptive or non-disruptive pesticides, more alternative treatments, and more biological control. Although the integrated approach, with more pest monitoring and the judicious use of pesticides, already has been adopted by many walnut growers, all of them will need to approach pest management in the future with these strategies. In addition, shifts of walnut varieties to those requiring less maintenance and higher kernel quality as well as insect and disease resistance will be needed. There are substantial needs for research and extension in discovering, developing and implementing either effective and economic biological controls or new and less disruptive pesticides. The industry and the public need to understand that this is a very long process in which the interaction between the pest, the host, and the control agent must be well understood for IPM to succeed. Meanwhile, growers will continue to need available spray materials as researchers and agribusiness look for less disruptive and economic ways to manage pests. Even organic growers use organically approved pesticides when all other pest control strategies fail.</td>
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</table>
Stricters, more costly regulation

Increasing agricultural chemical restrictions and stricter, narrower enforcement of pesticide regulations will continue. Safe use of products within an integrated pest management system will be emphasized as well as alternative products and natural predators and parasites. Growers near urban areas, especially, will need to be ready to adopt economic alternative control methods as they become available. These growers already are more often restricted in what chemicals they can apply and how they can apply them.

Future regulations may well be more costly to walnut growers in general for various reasons, including (1) changes in pesticide carriers as a result of new findings about volatility, (2) requirements for cleaner engines and diesel fuel cost increases, (3) equipment conversion for dust containment, (4) agricultural burning fees and higher fines, (5) more pest monitoring and (6) increased grower time involved in record keeping and training for worker safety. Even if less pesticide is used, more benign treatments are not necessarily cheaper. All of these potential costs will challenge the grower's ability to sustain a profit.

Aerial applications are another issue, especially sensitive in the more urbanized coastal regions. Aerial spray surveillance is very labor intensive. Because of costs and budget cuts, aerial spraying may be unavailable in the future in some counties.

Other areas in which regulatory pressures could affect the walnut industry include:

- Noise restrictions. Noises associated with farming such as aerial spraying, irrigation pumps, tractors and gas canons to repel bird pests lead to frequent complaints by the public to county agricultural commissioners. These complaints are very much an agriculture/urban interface problem. As urban encroachment increases in the future, more noise restrictions on general farming practices can be expected.

- Wetlands. Because walnuts are often near or in riparian zones, walnut growers should be aware of current federal and state wetlands regulations. Farm-related activities that are prohibited include expansion of farming activities into wetlands, and discharging of dredge or fill materials, debris or toxic materials. See Glossary, "Wetlands."
V.
THE MARKETS

California walnuts are sold in a changing and dynamic market. While the U.S. remains the largest outlet, increasing export sales are important to the disposition of the crop. Exports currently account for nearly 35 percent of production; thus the industry is increasingly becoming exposed to international competitive influences. The markets for California walnuts not only are subject to availability and prices of foreign produced nuts, but also to the vagaries of exchange rates and the policies of other countries that both restrict imports of walnuts and subsidize their own production and marketing.

Part of California's success in building increased exports can be attributed to the availability of market promotion funds. Currently, these are provided on a matching basis by the federal government. If federal funds were significantly curtailed or eliminated and not replaced from other sources, the export market for California walnuts would suffer.

Inshell and shelled supply

Walnuts are packed either inshell or shelled. Approximately two-thirds of California's production is shelled, as shown in Figure 6. During the past decade, the amount of

![Figure 6](image)

Source: Walnut Marketing Board Records.
walnuts packed inshell has remained relatively stable; changes in total production have largely reflected changes in the shelled product. During this period, walnuts packed inshell averaged 138.2 million pounds compared to 291.1 million pounds of shelled nuts (inshell basis).

Figure 7 shows the total supply of inshell and shelled walnuts during the same decade, including both production and handler carryin (defined as the amount of inventory carried over from a previous marketing year by handlers). Carryin varies significantly and serves as a balance between long and short crop years. Average carryin for inshell walnuts is lower than that for the shelled product.

Total supply of inshell walnuts is on a slight downward trend while total supply of shelled walnuts is on a strong upward trend, reflecting the increased direction of walnuts to those channels.

Exports of inshell and shelled walnuts in relation to total packs during the period are shown in Figure 8. About three-quarters of all inshell walnuts go to the export market; however, total tonnage shipped has dropped slightly in recent years. Meanwhile, although...
most shelled walnuts still are sold domestically, the amount exported has gradually increased and now accounts for a significant part of the total pack.

**Walnut consumption**

Per capita consumption of walnuts and other tree nuts in the U.S. for 1980-81 is shown in Table 7. Consumption of walnuts is less than one-half pound per person and appears to be declining slightly. The other two nut types with comparable per-capita consumption increased during the decade—pecans slightly and almonds significantly. (Industry sources indicate that the apparent increase in pecan consumption may be due to more complete reporting of smaller shipments.) Pistachios also have increased their rate of consumption.

No public data exists on the disposition of walnuts into various trade channels, other than shelled and inshell shipments domestically and for export. However, industry sources indicate that walnuts are used primarily in baking and as condiments with other foods. The Marketing Board has promotion programs directed at consumers, food service, and food manufacturers.

**Domestic and International Demand**

The demand for walnuts is a mixed picture. Shipments to domestic markets have grown over the last 12 years, but not as rapidly as total U.S. population. Overall, shipments of walnuts into domestic channels have increased nearly 27 percent since 1980-81. Meanwhile, shipments into export channels have grown nearly 55 percent. As a result, exports now account for nearly 35 percent of total shipments, compared to under 30 percent in 1980-81.

The demand for walnuts, like that of similar products, depends on quality and price; the quality and price of competing products; consumer income; and such intangibles as cultural preferences. The domestic and export markets must be analyzed independently.

**Quality factors**

Quality, in particular, has a major impact on the demand for California walnuts, both domestically and internationally. This state is known for its ability to deliver high-quality walnuts and to get a premium for them. Another advantage is the ability of the California walnut industry to deliver its product to markets on time. These two factors have significant implications for walnut producers, since handlers can sell only what is delivered to them. Hence, before planting new trees, walnut producers will need to look at market requirements in order to determine demand. For example, there is need for early-harvested walnuts to be shipped inshell to foreign markets in time for the holiday season. There is an even larger need for walnuts with thin shells for cracking, to go into shelled channels. The internal qualities of these nuts are important in marketing, and a pricing system is needed to reflect quality premiums.

Compared to its competitors, California has an advantage on the demand side by providing a high-quality product. It is important to maintain this advantage and possibly enhance it through improved varieties and other means if possible.

**Demand for exports**

As noted previously, exports are an important channel for marketing California walnuts. Figure 9 shows exports to the European Community, Japan, and other countries for the period 1980-91. It is clear that the European Community has been an important market for both inshell and shelled California walnuts. Within the EC, Germany is the most important outlet for inshell walnuts. In the marketing year 1990/91, Germany imported 26 percent of total inshell shipments compared to U.S. domestic consumption of 22 percent. The next most important countries importing California inshell walnuts were Spain (22 percent), Italy (14 percent), Canada (2 percent), United King-
dom (1.5 percent), and Greece (1 percent).

While most shelled shipments of California walnuts (83.2 percent) are consumed in the U.S., exports are rapidly growing. In addition to Japan as the major export outlet for shelled walnuts, with 4 percent of the total, other nations that import shelled walnuts—each 2 percent of the total or less—are Germany, Israel, Canada, Spain, Taiwan, Greece, and Austria.

**Export market development**

Key factors in export markets include the price of California walnuts compared to those of competing countries; quality; currency exchange rates; and import barriers. One major advantage in marketing California walnuts has been the ability of handlers to provide consistently high quality and timely delivery. Also, the U.S. walnut industry has made significant investments in developing export markets into a major outlet.

However, with more walnuts being exported by other countries, notably China, market promotion has become an essential factor in marketing walnuts. Whether or not exports from other countries increase, California walnut producers will need to continue to invest in market development programs. A number of handlers have developed export markets by investing their own resources. These have been supplemented during the last six years with monies from the California Walnut Commission.

Fluctuations in exchange rates also have played a key role in marketing California walnuts in export channels. When the dollar is strong against an export customer's currency, walnuts become more expensive for that customer. When the dollar weakens, as it has in the recent past, the export customer can purchase more walnuts for the same amount of local currency.

The impact of income on demand is positive. While walnuts cannot be considered a luxury item, consumer decisions to buy walnuts have some relation to level of income. Hence, in considering marketing strategies, particularly in foreign countries, promotion and education programs should be directed at those who have the purchasing power to buy walnuts. As less developed economies become stronger, the opportunity to sell walnuts there will be greatly enhanced.

**Current and Emerging Competition**

In the U.S., competition to California-produced walnuts comes from two sources: (1) domestically produced competing nuts, pecans in particular and (2) foreign produced walnuts. Figure 10 shows the production of tree nuts in the United States
from 1980 to 1993. California grows virtually all of the nation's commercial walnuts, almonds and pistachios. Other tree nuts produced in the U.S. are filberts, pecans and macadamias.

Growth in the U.S. nut industry is dominated by almonds, whose production has doubled since 1980. Growth has also taken place in pistachios for which production has varied but still has attained new highs. Almonds and pistachios, unlike walnuts, are considered primarily snack foods.

Production of pecans, which can be easily substituted for walnuts and so are a significant competitor, has been highly erratic. Pecan production has shown an overall decline since 1986, and appears to be at the same level as in the early 1980s. A large pecan crop decreases demand for walnuts and brings significant pressure to bear on walnut producer prices. It should be noted that pecan plantings in California have been increasing. In addition, the pecan industry now has a national marketing order which may, in the long run, increase competitive pressure on walnuts by providing more organization to a geographically diverse industry.

**Change in the world market**

Although the United States has been the world's leading producer and exporter of walnuts, significant changes have occurred during the past 10 years. As shown in Figure 11, world walnut production is dominated by six countries—the U.S., Mainland China, Turkey, France, India and Italy. These six countries produced 544,600 tons in 1991/92, almost half of which came from the U.S. However, significant increases have taken place in other countries. Since the early 1980s, Mainland China has increased its production by over 40 percent, France by 34 percent and Italy by 22 percent. Production in India appears to be stable and in Turkey appears to be declining—although recent water development projects in Turkey could spur production there. Not listed in Figure 11 is production in South America (Argentina, Brazil, and Chile) which amounted to 18,500 tons in 1990, with significant growth in production taking place in Chile.

In recent years, China has appeared to be attempting to take over the position of leading world walnut producer. A California Walnut Commission-sponsored team to China has described the program there to both plant more walnut trees and topwork old trees to make them more productive. The Chinese have viewed walnut production as an opportunity to secure foreign exchange which is needed for their economic development. However, as seen from the data in Figure 11, China's production is variable. Furthermore, statistics from China may be inaccurate or incomplete.

France and Italy are members of the European Commu-
nity which has a subsidy program in place for the production and marketing of walnuts. While it cannot be determined how much this program has led to the increased planting of walnuts in those countries, sustained production increases clearly have taken place.

The combination of production increases by China, France, and Italy could mean increased competition for the U.S., particularly in its export markets. Figure 12 presents data on exports by the six leading walnut-producing countries. The U.S. continues to dominate the export market, with 61 percent of the

total exported by the six leaders. Of these six, only the U.S. has shown sustained ability to increase exports during the past 10 years. China appeared to be in a position to challenge the U.S. in 1988/89, but faltered due to decreased production. Still, if China's investment in increasing its production capacity pays off, it could pose significant competition to the U.S. as the world's leading exporter. However, a great deal of this future production could go to China's domestic consumers as its economy continues to develop. China currently has one of the world's lowest per capita consumption rates of walnuts.

France and Italy also export significant amounts of their
crops. However, while a factor in world trade, it is unlikely that their exports will play a major role in the near future.

Trade issues

In international markets, the underlying issue is "free trade" versus "restricted trade." World trade has been dominated by quotas, tariffs, subsidies, and other mechanisms that distort trade. However, the newly-completed Uruguay Round of GATT will reduce trade barriers and assist in the continued development of a freer trade environment. The recently signed North American Free Trade Agreement (NAFTA) also will reduce barriers to trade among the U.S., Canada, and Mexico. With both the Uruguay Round and NAFTA completed, the California walnut industry will likely benefit, since in the past it has faced numerous trade restrictions and has been involved in various trade disputes.

Another issue affecting trade is that of the less developed countries and economies of the world. With the demise of communism in Eastern Europe and the former Commonwealth of Independent States (CIS) countries, accommodations are being sought to strengthen their economies and support democracy. Since most of these economies are largely rural and agricultural, markets may be opened to them through diplomatic negotiation in order to provide the hard currency necessary for their economic development. In the short run, these countries could well pose a threat to U.S. agricultural products in various markets; in the long run as their economies develop, they could become customers. To a degree, this situation also exists in Latin America. Hence, the California walnut industry must be aware of these developing economies as a potential competitor for its markets, and also as future customers.
VI.
STRATEGIES TO MAINTAIN COMPETITIVENESS

In considering possible actions and priorities to maintain the walnut industry's competitive edge within an urbanizing environment and a global market, one important complicating factor involves regulation. In all of California agriculture, short and long term trends will be towards stricter regulation of pest and disease control chemicals. Environmental regulations involving air quality, water quality, and endangered species will become more restrictive. Water use and conservation is likely to come under increased regulatory pressure. The complexity of regulations will pose a particular challenge to walnut growers with small acreages who are accustomed to doing the work themselves. In the future, these growers may need to rely on pest control advisors and operators to comply with some of the regulatory aspects of growing walnuts.

Budgetary Pressures

In addition to increased regulation, the walnut industry also will be impacted by restrictions on the use of public funds. Funding for research, education, statistics, and market promotion could be jeopardized.

Research is important to the success of the California walnut industry. While the industry, through the Walnut Marketing Board, provides a significant amount of funds for research, an even greater amount comes from the University of California Experiment Station and the U.S.D.A. Agricultural Research Service. In addition, field research and education are carried out through an extensive farm advisor system. As public funds at the county, state and federal levels are restricted through budget reductions, the ability of these organizations to meet the research and technology transfer needs of the walnut industry may be constrained significantly.

Another program that is being reduced substantially at both the federal and state levels is public financing of agricul-
tural statistics. The walnut industry may well find that it will have to finance its own statistical collection and publication.

More pressure will be brought on marketing orders to support both existing programs and those formerly funded from public sources. Increased funding will be required for research and technological development; regulatory analysis and justification; market development and promotion; statistics; and government liaison. While increased funding through marketing orders may prove to be costly to the California walnut industry, these activities may be necessary in order to preserve the industry's competitive edge.

Market Promotion Program (MPP) funds have been instrumental in building export markets. These funds have been reduced during the past several years and increased pressure on them can be expected, since the program's purpose and overall payoff is being questioned. If MPP funds are significantly reduced or eliminated, the California walnut industry will face some difficult choices on how to replace them.

**Strategies for the Future**

Actions to maintain or improve the competitiveness of California's walnut industry may be taken by individual growers, by the industry collectively, by research institutions—or by any combination of the three.

For both regulatory and economic reasons, walnut growers will need to increase their overall efficiency, using both improved farm cultural practices and farm management skills such as planning and budget analysis, and computerized recordkeeping. Because of increasing urbanization as well as environmental reasons, they also will be under pressure to use practices with less overall environmental impact. Maintaining a profit under these conditions will require growers to:

- Use more integrated pest management.
- Irrigate and fertilize more efficiently.
- Find alternatives to burning orchard waste, such as chipping.
- Shift to lower maintenance varieties when possible.
- Where irrigation systems allow for no-till middles, use cover crops to reduce dust, add organic matter to the soil, shelter beneficial insects and reduce leaching of nitrate.
- Increase marketing skills.

Many walnut growers already use several of these practices or farming methods, or are in transition to them. Adopting many of these practices will be especially critical for growers who farm near subdivisions and for those with smaller walnut acreages that are part of rural residential developments.

For the walnut industry in general and its supporting institutions, there are a number of areas of possible action.

**Strategy: Protect the resource base.**

The walnut industry depends on continued availability of prime farmland, and a reliable water supply. Increasing competition for these resources is likely to have a cumulative impact on the industry. Much of the best orchard soil surrounding cities, especially in the Central Valley, is being developed for housing and industry—forcing some growers onto more marginal soils. In addition, many thousands of acres along the Sacramento River potentially could be converted into riparian habitat. Air quality is another endangered resource. Specific possible strategies are to:

- Encourage local government policies that strengthen and support agriculture in the long term.
- Support research trials on growing walnuts in less desirable soils, in order to determine long-term sustainability of orchards that may be planted there.
- Support research to determine the effects of ozone on walnuts, especially on predominant varieties.

**Strategy: Emphasize high-priority areas of technological development.**

Research and development needs include:

- Improved varieties. Much of the California walnut industry's competitive advantage has come from the UC walnut breeding program and its development of superior varieties. Breeding of walnuts is a long-term process, and it is important to have a broad and well characterized germplasm base in
order to tackle new problems as they arise. This requires both development of efficient evaluation methods and evaluation of a wide diversity of walnut types for response to pests and diseases, as well as traits such as leafing and harvesting dates. Specific needs are for (a) varieties with even better quality, increased yield and an earlier harvest, (b) a new variety adapted for both inshell and shelled uses, and (c) varieties and rootstocks that resist blight and other diseases.

- Development of alternatives to chemicals that are likely to lose their use registrations. Particularly pressing is the need to replace methyl bromide, since its loss would significantly affect post-harvest fumigation for marketing, soil fumigation, and production of clean (nematode-free) nursery trees. Possible strategies are to either (a) assume that methyl bromide will be unavailable around the year 2000 and emphasize research into alternatives or (b) gather more data to scientifically determine the ozone-depleting potential of methyl bromide, with the goal of at least allowing its continued use for very selective purposes, such as producing quality nursery trees.

- Development of more environmentally acceptable pest and disease control technologies and management practices. For years, most walnut growers have been monitoring for insects in order to better time sprays and reduce applications. They were readily adopting effective and economic alternative pest control methods. The question is: Can the industry survive the transition phase from known and productive farming systems to new, unproven ones, even if they eventually would be economically viable? Two things are needed: (a) public understanding of the time and cost involved to develop alternatives and (b) acceleration of UC and industry research efforts toward meeting the goals of reduced inputs while sustaining grower and processor profits. Also, since the federal IR-4 program for registration of pesticides for specialty crops is very important to the walnut industry, UC should continue to be involved in this program with funding from manufacturers and the industry. Another specific need is to support long-term trials using alternatives to fumigation for control of (1) nematodes and (2) replant problems in second and third-generation orchards.

- Development and adoption of technologies and management practices that conserve water supplies and protect quality of water and air resources.

**Strategy: Expand demand for walnuts in both domestic and export markets.**

Domestically, demand over the next 20 years will depend on the California walnut industry's ability to consistently provide a high-quality product and to be price-competitive with competing nuts—primarily pecans. In foreign markets, much will depend on the relative strength of the dollar, the development of economies that will enable consumers to upgrade their diets, and competing supplies.

If the world continues to strive toward a freer trading environment, California walnuts should continue to find lucrative foreign markets. It is likely, however, that continued investment by the California walnut producer community in market promotion will be required in order to continue to tell consumers at home and abroad about the advantages of California's high-quality walnuts.

Specific actions include:

- Continuing support of Walnut Marketing Board market research and promotion activities.

- Continuing support of California Walnut Commission programs to enhance market development activities, including strong consideration of replacing Market Promotion Program funds with grower funds if planned government reductions occur.

- Continuing programs that encourage high quality standards and consistent deliveries.

- Developing new uses and market outlets for walnuts.

- Continuing research into the health and nutrition benefits of walnuts.

- Continued activities which play a role in development of trade policies and negotiations. The industry will have to face the policy issue of what trade concessions might be made by the U.S. in dealing with developing economies. The industry has been adversely impacted in the past by arbitrary tariffs and trade restrictions which took much time and cost to resolve, including the preparation of analyses and documents for government officials. While a freer trading environment is hoped for, the California walnut industry should be prepared to
continue to fight political battles to preserve its markets and competitive ability.

**Strategy: Be prepared to document benefits of the industry’s marketing orders.**

Long term changes may take place in marketing order provisions and policies of both the state and federal governments. Public concern has developed due to some highly publicized perceptions of abuses, particularly regarding volume control. Congress may hold hearings into the purpose and function of marketing orders. This may lead to legislation that provides increased restrictions on what marketing orders can and cannot do. Thus, the industry needs to be prepared to document the public benefit of marketing orders. However, since the Walnut Marketing Board and California Walnut Commission programs are concerned primarily with activities other than supply control, they are less likely to be affected.

In addition to restrictions on supply control, there will likely be more public representation on marketing order boards and commissions. Many in the legislative arena believe that more public members will better serve the public benefit and reduce perceived abuses.

**Strategy: Promote the crucial linkage between research, extension of information, and the walnut industry.**

The two-way flow of information from grower to UC research faculty and vice versa via UC farm advisors and extension specialists must be maintained and enhanced to bring about quick adoption of new varieties, new pest management technologies, and other necessary changes. Even more emphasis on quality is essential to maintain the industry’s competitiveness. This will require not only research but extension programs aimed at both skilled commercial growers and at smaller operators—who produce a significant part of the total tonnage. Another concern is development of future expertise in pomology and other scientific disciplines essential to the industry.

In all this, allocation of increasingly limited UC resources is a crucial issue. The industry should be prepared to not only continue its support for research and extension programs but possibly to increase industry support in relation to public funding.

**Strategy: Strengthen information exchange and leadership development within the industry.**

Like other sectors of agriculture, the walnut industry would benefit from additional efforts to communicate effectively among growers, processors, handlers and other involved groups and agencies. More newsletters and similar communication methods would facilitate this process. One particular need is to reach the large number of small growers for whom walnuts may be a secondary economic interest—but who, collectively, would wield influence.

Another need is to develop future industry leadership potential among younger walnut growers.

**Strategy: Increase industry efforts to inform the public.**

Consumers need to understand the importance of agriculture to their quality of life and to the economy of California. Public understanding also is urgently needed to prevent regulations resulting from concerns about pesticides, air and water quality, and wildlife—particularly at the orchard/urban interface—from becoming unnecessarily restrictive. The industry needs to point out to the public (1) the fact that current farming systems are highly regulated and relatively safe and (2) the contribution of walnut growing to communities in the form of economic benefits and quality of life. Specific possible actions include:

- A UC study to determine the number of jobs and economic benefit provided directly and indirectly to California by the walnut industry, with results communicated to the public.
- Continued support of public information efforts such as those through the education system.

**Conclusion**

The California walnut industry has become a world leader through a combination of factors, including a climate and natural resources well suited for walnut production—conditions found only in a few places elsewhere in the world. What is unique about California, however, is a combination of industry structure, leadership, technology, management, and supporting institutions that is unduplicated anywhere else in
the world, and is unlikely to be in the near future.

These are the industry's strengths. Its challenges include increasing pressure on land, water and air resources; increasing regulatory pressures from an urbanized and consumer-oriented society; and potentially increasing competition in global markets.

Despite these constraints and uncertainties, the California walnut industry remains economically strong and with substantial competitive advantages. The industry is in a sound position to make the decisions and the changes that the future will require. However, it must be prepared to make the necessary investments, financial and otherwise, to maintain its leadership.
GLOSSARY

ARMILLARIA ROOT ROT. The soilborne fungus causing this disease lives in old roots and infects living roots upon contact.

BLACKLINE. A virus disease that eventually kills trees grafted on black or Paradox rootstock. Trees on English rootstock survive but can serve as disease carriers for the life of the orchard.

CODLING MOTH. A major insect pest causing economic losses mainly in the early season varieties. Early infestation causes nutlet drop, and nuts damaged by the second and third generation stay on the tree but are unmarketable from feeding damage. Damaged nuts serve as breeding sites for navel orangeworm. Current management is based on a monitoring program and timely insecticide sprays if needed.

CROWN GALL. This disease, caused by a bacterium in the soil, infects the crown and roots of trees that have been wounded in the nursery during digging, during planting or by hoeing, sucker pruning and cultivation. The resulting outgrowths called galls eventually can girdle a tree. Paradox is much more susceptible than is NC black rootstock. The disease is best managed by avoiding wounding and using a protective biological control treatment in the nursery and before planting.

DEEP BARK CANKER. This bacterial disease is primarily a problem in Hartley trees that are under stress from poor soil, drought, crowding or poor management. The first symptoms can appear in young bearing trees. Eventually trees are weakened by deep bark canker and often die from other diseases that affect stressed trees.

NAVEL ORANGEWORM. This insect damages sound nuts only at hull split. It overwinters in mummy nuts and builds up over the summer in blighted, codling moth infested and sunburned nuts. It is best managed through orchard sanitation, blight and codling moth control, sunburn prevention and early harvesting.

NEMATODES. Microscopic worms that feed on roots and decrease vigor and yield in both young and old orchards, especially those on light, sandy soils.

NORTHERN CALIFORNIA BLACK ROOTSTOCK (NC black). Juglans hindsii, the walnut native to northern California, frequently used as rootstock.

PARADOX ROOTSTOCK. A hybrid between NC black and English walnut. Seed for Paradox rootstock are usually collected from NC black trees which have been naturally pollinated with English walnut pollen.

PHYTOPHTHORA CROWN AND ROOT ROT. This fungal disease, caused by several species of Phytophthora, affects the crown and/or roots and leads to eventual tree death. It is favored by saturated soil conditions. The causal fungi have been found in virtually all of California's major surface water sources, but not in well water.

PISTILLATE FLOWER ABSICSSION (PFA). The drop of small female flowers due to the presence of too much pollen. It is primarily a problem in the Serr variety. The source of excess pollen can be Serr itself or the pollinator variety.

PM 10. An air pollutant. Fine particulate matter with an aerodynamic diameter smaller than or equal to a nominal 10 microns.

REPLANT PROBLEM. In most areas, nematodes are considered a major component of what is called the replant problem—a diminishing of growth when walnuts are replanted following walnuts. Preplant fumigation usually overcomes this problem but not always completely.

RIPARIAN HABITAT. An area along a river or stream naturally suited for populations of plants and wildlife.

SOIL. "Sphere of influence," the likely growth area of an incorporated city, taking account of its future population increase and service delivery capacity.

URBAN LIMIT LINE (sometimes called "greenline"). In local land-use policymaking, a line beyond which the policy intends no additional development.

WALNUT BLIGHT. This disease, caused by a bacterium that needs rain or other moisture to spread and infect nutlets, is usually not considered a major problem in late blooming varieties. However, in rainy years it can be a problem on any variety.

WALNUT HUSK FLY. This insect feeds in the husk which causes staining of the shell. It is mainly a problem in Hartley, Eureka, and Franquette. Control is based on monitoring and well timed sprays.

WETLANDS. Defined in Section 204 of the Clean Water Act as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Vernal pools are seasonal wetlands and are also regulated. Certain wetlands that are unregulated include stock ponds, irrigation ditches, settling basins, and rice fields.
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APPENDIX A

ACKNOWLEDGMENTS

Butte County:
Paula Leasure, Assistant Director of Planning
William H. Olson, UC Farm Advisor
Richard B. Price, Agricultural Commissioner

Colusa County:
John Edstrom, UC Farm Advisor
Harry Krug, Agricultural Commissioner
Stanley M. Walker, Director of Planning & Building

Contra Costa County:
Dennis M. Barry, Deputy Director, Community Development
Janet Caprile, UC Farm Advisor
John H. deFreers, Agricultural Commissioner

Fresno County:
Bruce Clayton, Supervising Agricultural/Standards Specialist
Mark Freeman, UC Farm Advisor
Carolina Jimenez-Hogg, Assistant Director, Public Works & Development
Dennis C. Plann, Deputy Agricultural Commissioner/Sealer
Jeff Tweedie, Program Manager, Planning Projects

Glenn County:
William Duckworth, Jr., Assistant Agricultural Commissioner
William H. Knueger, UC Farm Advisor
Christy Leighton, Senior Planner
Ed Roman, Agricultural Commissioner

Kern County:
Ted Davis, Agricultural Commissioner
Ted James, Director, Planning & Development Services
William Turpin, Executive Officer, Local Agency Formation Commission
Mario Viveros, UC Farm Advisor

Kings County:
Bob Beede, UC Farm Advisor
Charles Gardner, Director of Planning
Susan L. Johnson, Deputy Agricultural Commissioner

Lake County:
Rachel B. Elkins, UC Farm Advisor
Mark T. Lockhart, Agricultural Commissioner
Mark Phillips, Principal Planner
Robert Reynolds, Air Pollution Control Officer
Cherie R. Seely, Air Quality Specialist

Madera County:
Leonard Garupa, Planning Director
Robert J. Roper, Assistant Agricultural Commissioner
Ron Vargas, UC Farm Advisor

Merced County:
Gary Caseri, Assistant Agricultural Commissioner
Lonnie Hendricks, UC Farm Advisor
Robert E. Smith, Planning Director

Placer County:
Loren Clark, Senior Planner
Garth Veerkamp, UC Farm Advisor
Griffith Yamamoto, Agricultural Commissioner

San Benito County:
William W. Coates, UC Farm Advisor
Rob Mendiola, Director of Planning
Mary Paxton, Planning
Mark A. Tognazzini, Agricultural Commissioner

San Joaquin County:
Joseph Grant, UC Farm Advisor
Scott Hudson, Deputy Agricultural Commissioner
Lorre Islas, Senior Planner

San Luis Obispo County:
Mary Bianchi, UC Farm Advisor
Richard D. Greek, Agricultural Commissioner
Frank Heinsohn, Planner
Robert L. Hopkins, Deputy Agricultural Commissioner
Brenda W. Ouwerk, Deputy Agricultural Commissioner

Santa Clara County:
Eric Carruthers, Principal Planner
Kevin O'Day, Supervising Agricultural Biologist
Greg Van Wassenhove, Agricultural Commissioner
Craig Kolodge, UC Farm Advisor
Shasta County:
Kit L. Cassaday, Agricultural Commissioner
Mark Radabaugh, Senior Planner

Solano County:
Susan Cohen, Agricultural Commissioner
Harry Englebright, Principal Planner
Jeff Erwin, Supervising Agricultural Biologist
Lawrence Lew, Senior Planner

Stanislaus County:
Leslie Hopper, Associate Planner
Kathleen Kelley, UC Farm Advisor
Don Shephard, Deputy Agricultural Commissioner

Sutter County:
Stacy Carlson, Agricultural Commissioner
Dale Rollas, Associate Planner
Michael Harrold, Planning Director
Dave Wilson, Deputy Agricultural Commissioner

Tehama County:
Richard P. Buchner, UC Farm Advisor (also in Shasta County)
Heidi Walker Hill, Agricultural Commissioner
George W. Robson, Planning Director

Tulare County:
John K. Akana, Agricultural and Standards Inspector
B. J. Culliton, Supervising Agricultural and Standards Inspector
Gary W. Kunkel, Chief Deputy Agricultural Commissioner
Jennifer Murri, Planner
Andrew Remus, Planner
Steve Sibbett, UC Farm Advisor

Yolo County:
Elizabeth Castro Kemper, Executive Officer, Local Agency Formation Commission
Raymond J. Perkins, Agricultural Commissioner
Wilbur Reil, UC Farm Advisor (also in Solano County)

Yuba County:
Larry Brooks, Planning and Building Services Director
Bernie Engle, Agricultural Commissioner
Jim Manning, Deputy Director of Planning

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G. I. Bergquist, Associate Land and Water Use Analyst, Southern District
Charles Ferchaud, Chief, Land and Water Use Section, Northern District
Ed Morris, Senior Land and Water Use Analyst, Central District
Frederick E. Stumpf, Chief, Land Use and Water Conservation Section, San Joaquin District

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Appendix B

Notes Regarding Statistical Sources

Department of Water Resources (DWR) Mapping Procedure:

Detailed land use surveys are conducted each year in different parts of the state to determine urban and agricultural water needs as part of the DWR's Land Resource and Use Program. The base maps for all land use surveys are U.S. Geological Survey 7'1/2 minute quadrangle maps, scale 1:24,000. Agricultural and urban land uses are identified on these maps using standard DWR cartographic procedures. DWR aerial 35mm color slides, taken immediately before the survey, are used as the main reference for field boundaries and sometimes to help identify crop type. The transfer of information from slides to quads is done by photo-interpretation. Delineations made on the quads are all verified in the field for both irrigated and non-irrigated crops. A final mylar overlay is made from the quad to measure the delineation.

Land use acreage for the given land use categories is either digitized or is obtained by the cut-and-weigh method which is easy to use but is slow because of the precision and care required in handling the tremendous number of paper cuttings. Acreage of the designated units is obtained from a known weight-to-area ratio (acres given for each USGS quad). Acreage includes farm roads, irrigation ditches, etc. For net acres in a particular crop, take 95 percent of the total acres. Eventually, DWR plans to digitize all maps with a computer which will allow maps to be integrated into a geographic information system.

Source: DWR 1990 Survey of Sutter County

County Agricultural Commissioners 100 percent Pesticide Permit Reporting Database:

Any grower applying a spray must obtain a permit. This database will show the majority of growers but miss those acreages with new plantings that have not yet been sprayed, some organic orchards that were not sprayed or other orchards not sprayed because they were waiting to be removed or for some other reason. In some cases, there may be some duplication where an orchard changes owners because of a lag time before it will show in the permit process.

Source: Personal communication with Agricultural Commissioners and their statisticians

County Agricultural Crop Reports:

Agricultural Commissioners and their staff use a number of sources depending on the county to determine crop acreage and value. Of the 23 counties reported on in this study, 74 percent use mail surveys, 65 percent use industry groups/processors, 57 percent use their pesticide permit computer program, 44 percent use the state crop statistics, 30 percent use personal contacts, 17 percent use UC farm advisors. One county uses the assessor and another uses aerial photographs.

Source: Personal communication with Agricultural or Deputy Agricultural Commissioners

California Agricultural Statistics Service

The state has a database, which was set up many years ago, with all fruit and nut trees listed in parcels with what is grown there. It is updated yearly with information from the county agricultural commissioners, with changes noted during the walnut objective survey if any were seen, and periodically with grower surveys. They survey the grape growers yearly, but many other commodities do not want to be surveyed as frequently. The walnut, almond and prune industries will pay the state to do a grower questionnaire in 1994. The database is updated throughout the year as new numbers become available, but a summary is run only once, in the spring. That is why listed planted acreage for a particular year may be reported differently from year to year.

Source: Personal communication, Tom McNair, Agricultural Statistician

The table on the following page gives walnut acreages and other data from five sources, illustrating the degree of variation among the sources.
## Acreage Comparison from Five Sources

<table>
<thead>
<tr>
<th>County</th>
<th>State Non-Bearing</th>
<th>Total Non-Bearing</th>
<th>County Non-Bearing</th>
<th>Total County</th>
<th>DWR Maps</th>
<th>May</th>
<th>Pesticide Report</th>
<th>Number of Growers</th>
<th>1987 Census</th>
<th>Census Number of Farms</th>
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<td>1,484</td>
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<td>663</td>
<td>32,795</td>
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<td>1988</td>
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<td>Madera</td>
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<td>24,534</td>
<td>24,285</td>
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<td>143</td>
<td>1,449</td>
<td>1,449</td>
<td>1,449</td>
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<td>40</td>
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<td>1,110</td>
<td>1,110</td>
<td>1985</td>
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<tr>
<td>San Benito</td>
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<td>3,976</td>
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<td>3,976</td>
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<td>3,016</td>
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<td>Subtotal:</td>
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<td>13,153</td>
<td>190,463</td>
<td>179,084</td>
<td>206,668</td>
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<td>191</td>
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<td>4,315</td>
<td>4,315</td>
<td>1987</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes

### Assumptions
- The specific volume of English walnut trees planted in this 1993 study are
- Water cost for irrigation is a blend of district and pumped water. Price per acre foot water.
- The specific volume of English walnut trees planted in this 1993 study are
- Water cost for irrigation is a blend of district and pumped water. Price per acre foot water.
- The specific volume of English walnut trees planted in this 1993 study are
- Water cost for irrigation is a blend of district and pumped water. Price per acre foot water.
- The specific volume of English walnut trees planted in this 1993 study are
- Water cost for irrigation is a blend of district and pumped water. Price per acre foot water.

### Appendix C: Sample Costs to Produce English Walnuts

<table>
<thead>
<tr>
<th>County</th>
<th>Total Annual Costs</th>
<th>Total Operating Costs</th>
<th>Total Harvest Costs</th>
<th>Total Operating costs @ 8%</th>
<th>Total Operating costs @ 9%</th>
<th>Total Operating costs @ 10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tulare County</td>
<td>$204,714</td>
<td>$174,632</td>
<td>$29,642</td>
<td>$14,774</td>
<td>$16,444</td>
<td>$18,114</td>
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</table>

The orchard is established on a well-drained, well-drained, and either a class II or III soil. The orchard site allows for a gravity (furrow) irrigation system.
APPENDIX E

POTENTIAL WALNUT ACRES
LOST TO URBANIZATION OR RIPARIAN CONVERSION

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>POPULATION GROWTH % CHG. 1991-92</th>
<th>POPULATION GROWTH % CHG. 1992-93</th>
<th>TOTAL ACRES IN SOIL AND COUNTY GROWTH</th>
<th>RIPARIAN CONVERSION % OF TOTAL DWR ACREAGE ALL LOSSES</th>
<th>TOTAL POTENTIAL TONS LOST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shasta</td>
<td>2.5</td>
<td>2.3</td>
<td>737</td>
<td>61%</td>
<td>653</td>
</tr>
<tr>
<td>Tehama</td>
<td>2.5</td>
<td>3.1</td>
<td>504</td>
<td>8%</td>
<td>950</td>
</tr>
<tr>
<td>Glenn</td>
<td>2.0</td>
<td>1.7</td>
<td>82</td>
<td>6%</td>
<td>553</td>
</tr>
<tr>
<td>Butte</td>
<td>2.8</td>
<td>2.7</td>
<td>742</td>
<td>5%</td>
<td>1,282</td>
</tr>
<tr>
<td>Colusa</td>
<td>2.4</td>
<td>1.8</td>
<td>872</td>
<td>15%</td>
<td>752</td>
</tr>
<tr>
<td>Sutter</td>
<td>4.0</td>
<td>3.5</td>
<td>1,856</td>
<td>10%</td>
<td>1,874</td>
</tr>
<tr>
<td>Yuba</td>
<td>2.5</td>
<td>2.3</td>
<td>1,963</td>
<td>27%</td>
<td>3,067</td>
</tr>
<tr>
<td>Yolo</td>
<td>2.1</td>
<td>1.2</td>
<td>158</td>
<td>2%</td>
<td>195</td>
</tr>
<tr>
<td>Suttero</td>
<td>2.5</td>
<td>2.2</td>
<td>410</td>
<td>6%</td>
<td>324</td>
</tr>
<tr>
<td>Placer</td>
<td>4.3</td>
<td>3.8</td>
<td>95</td>
<td>0.5%</td>
<td>10</td>
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<tr>
<td>San Joaquin</td>
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</tr>
<tr>
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<td>2.7</td>
<td>2,194</td>
<td>8%</td>
<td>3,092</td>
</tr>
<tr>
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<td>1.8</td>
<td>2.7</td>
<td>261</td>
<td>3%</td>
<td>318</td>
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<tr>
<td>Madera</td>
<td>5.8</td>
<td>5.8</td>
<td>85</td>
<td>6%</td>
<td>140</td>
</tr>
<tr>
<td>Fresno</td>
<td>3.4</td>
<td>3.1</td>
<td>329</td>
<td>9%</td>
<td>440</td>
</tr>
<tr>
<td>Tulare</td>
<td>2.7</td>
<td>2.6</td>
<td>5,147</td>
<td>17%</td>
<td>5,763</td>
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<tr>
<td>Kings</td>
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<td>3.2</td>
<td>1,133</td>
<td>16%</td>
<td>1,748</td>
</tr>
<tr>
<td>Kern</td>
<td>3.6</td>
<td>2.7</td>
<td>57</td>
<td>3%</td>
<td>69</td>
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<tr>
<td>Lake</td>
<td>3.4</td>
<td>2.6</td>
<td>4,721</td>
<td>43%</td>
<td>1,733</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>2.4</td>
<td>2.1</td>
<td>623</td>
<td>26%</td>
<td>287</td>
</tr>
<tr>
<td>Santa Clara</td>
<td>1.6</td>
<td>1.7</td>
<td>1,052</td>
<td>86%</td>
<td>965</td>
</tr>
<tr>
<td>San Benito</td>
<td>5.1</td>
<td>4.3</td>
<td>278</td>
<td>5%</td>
<td>200</td>
</tr>
<tr>
<td>San Luis Obispo</td>
<td>2.0</td>
<td>1.9</td>
<td>172</td>
<td>4%</td>
<td>41</td>
</tr>
</tbody>
</table>

TOTALS: 24,881 1,398 26,869

3/ Department of Water Resources (DWR) Land Use Maps (except Yuba County - source Agricultural Commissioner's aerial photographs) and sphere of influence (SOI) boundary maps for all the cities in listed counties.
4/ These numbers are based on acres that have been acquired or are proposed acquisitions as of 1993 by the USFWS. Potentially, there are thousands of walnut acres that could be acquired and converted to riparian habitat in Tehama, Glenn, Butte and Colusa counties over the next 20 years. Therefore, the percentages (in the next to the last column) for these four counties are conservative.
5/ Based on an average of 1991-1992 total tons (only 1991 Lake County) from county agricultural crop reports.
[a] Does not include walnut acreage in SOI that is inside the Feather River levees.
[c] Rural residential growth outside of SOI could have a moderate impact on walnut plantings.

(continued)
When interpreting the table on the previous page, these points should be considered:

- Many cities are or will be proposing to expand their SOI boundaries in the near future, in some cases by several thousand acres; but only a few cities are considering reducing their SOI boundaries.

- SOI boundaries of some cities are expected to fill within the next 5 to 10 years whereas others are very large and believed to have enough growth capacity for well beyond 20 years. Therefore, some county acreage numbers will err on the conservative side and others on the liberal side—equalizing out, it is hoped, in the total.

- In several of the counties, it is more difficult to quantify the potential loss or parcelization of walnut acreage outside the cities through rural residential or higher density urban development (e.g. new towns) or growth of unincorporated towns, except for planned growth around some unincorporated towns.

- DWR land use maps were updated between 1984-1990 (except for Lake County’s 1980) with the average being 1988. Thus, some of the mapped acreage in the SOI has already been urbanized in some counties; however, new plantings, are not accounted for either. Since they were mapped, only nine walnut-producing counties have reported acreage changes either lost or gained of over 500 acres.

APPENDIX F

PLANTINGS RATING SCALE

This is the rating scale used for prioritizing in Table 3, Current and Potential Expansion and Loss of Walnut Plantings.

Land availability:
- 3 - Over 5,000 acres available
- 2 - About 1,000 - 5,000 acres available
- 1 - Less than 1,000 acres available

Soil quality:
- 3 - Potential land available (bare, as a result of crop shifts or replanting) is mostly class 1 soil.
- 2 - Potential land available is a mix of class 1 and 2 soils (fine textured heavier soils.)
- 1 - Potential land available is mainly class 2 or 3 or lower in rating.

Water availability:
- 3 - None to little limitations/restrictions.
- 2 - Some limitations/restrictions.
- 1 - Severe limitations/restrictions.

Water quality:
- 3 - Mainly good water quality for walnut growth.
- 2 - A mix or certain areas within county with sodium, chloride, boron or bicarbonates.
- 1 - Severe problems with salts throughout county.

Urban/Riparian Conversion* Impact:
- 3 - Low impact on walnuts expected from urbanization, including rural residential growth, during next 20 years. (1-5 percent of acreage.)
- 2 - Moderate impact on walnuts expected from urbanization during next 20 years (6-20 percent of acreage); moderate impact from riparian conversion over next 20 years.
- 1 - Severe urban encroachment potential over next 20 years (over 20 percent of acreage).

*Acres listed for riparian conversion are those that have been acquired or are proposed acquisitions by the USFWS. Potentially many thousand more acres could be converted to riparian habitat in the future. Therefore, the rating for those counties involved (Tehama, Butte, Glenn, Colusa) may be on the liberal side.
APPENDIX G

WATER SUPPLY SOURCES FOR WALNUT ACREAGE BY COUNTY

<table>
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<td>0</td>
<td>1,804</td>
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<tr>
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<td>14</td>
<td>47</td>
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<tr>
<td>Glenn</td>
<td>18</td>
<td>70</td>
<td>12</td>
<td>0</td>
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<td>100</td>
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<td>0</td>
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<td>36</td>
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<td>0</td>
<td>94</td>
<td>0</td>
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</table>

1/ Percentages based on Department of Water Resources (DWR) Land Use Quad County Summaries except for Stanislaus, Merced, Fresno, Tulare, Kings, Kern and San Benito counties. Sources in those counties were UC Farm advisors and DWR San Joaquin District personal communication.

2/ Acreage includes farm roads, irrigation ditches, etc. For net acres in walnuts, take 95 percent of total acres.

[b] Subtracted 314 acres that were urbanized since DWR map of 1990.
[c] Percentages based on DWR data and UC farm advisor.
[d] Percentages based on DWR data and UC farm advisor.
[e] Percentages based on DWR data and UC farm advisor.
[f] Percentages based on DWR data and UC farm advisor.
[g] Percentages based on DWR data and UC farm advisor.
[h] Subtracted 1,300 acres that have been lost since DWR map of 1985.

APPENDIX H

LOCATION OF SALINIZATION PROBLEMS

Salinization impacts walnuts on the west side of the Northern San Joaquin region to varying degrees, farther south in Fresno County to some extent. (There are no walnuts on the west sides of Kings or Kern Counties.) In this area, many wells have poor water quality, high in chloride or boron. This problem is likely to continue or worsen in the future as more water is diverted for urban and environmental uses. In Kern County, districts where walnuts are currently grown have good quality water, but wells with high chloride could limit potential new areas for expansion.

In the Sacramento Valley, Glenn and Sutter Counties have some wells with bicarbonates and a few alkali areas; Sutter County also has chloride in a few wells. The potential west side walnut expansion area in Colusa County has sodium and chloride problems, so drainage and water availability will be critical. Yolo County has some high boron and a limited area where sodium chloride is a problem. However, most of the new walnut plantings in this county are avoiding problem areas.

In the coastal region, Lake County has boron in wells and in the lake. If levels get too high, growers cease irrigating. Boron and sodium bicarbonate occur in well water in San Luis Obispo County. Walnuts are traditionally dryland farmed, but new plantings are being irrigated. In San Benito County, wells are high in total salts and boron, although this is not a limiting problem where growers have federal surface water.

Counties not mentioned generally have good water quality.
# APPENDIX I


<table>
<thead>
<tr>
<th>COUNTY</th>
<th>1989</th>
<th>1990</th>
<th>1991</th>
<th>AVERAGE</th>
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<td>11</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Tehama</td>
<td>7</td>
<td>4</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Glenn</td>
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<td>5</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Butte</td>
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<td>13</td>
<td>24</td>
<td>17</td>
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<tr>
<td>Colusa</td>
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<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Sutter</td>
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<td>16</td>
<td>22</td>
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<td>Yolo</td>
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<td>6</td>
<td>12</td>
<td>8</td>
</tr>
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<td>Fresno</td>
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<td>Tulare</td>
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<td>Kings</td>
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<tr>
<td>Kern</td>
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<td>San Luis Obispo</td>
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## APPENDIX J

## PEST AND DISEASE PROBLEMS

The most important pest and disease problems affecting the California walnut industry are listed here:

- **Blackline** is currently considered a major problem in parts of the northern San Joaquin Valley and some of the coastal counties. It is expected to spread slowly but not have a major impact on overall California walnut production before new resistant varieties are available in about 20 years. In areas where blackline is epidemic, growers are expected to favor English walnut rootstock over black or Paradox. If the rootstock and scion are free of the causal virus at planting this change should not have an important impact on spread of the disease. Since one of the recommendations for disease control is tree removal and replanting, the problems associated with replanting should be considered in assessing the impact of this disease.

- **Walnut blight** is a major problem in most of the Sacramento Valley counties and a moderate to minor problem in the San Joaquin Valley and coastal region. The overall significance of blight is expected to diminish as the old susceptible varieties like Payne and Ashley are replaced by later blooming varieties like Chandler. However, the occurrence of blight bacteria resistant to the copper sprays used to control it, coupled with the remaining early blooming varieties, suggests that blight will continue to have a major impact on production in the northern counties over the next 20 years.

- **Nematodes** are considered a moderate to major problem in almost all of the counties in all of the growing regions. They are expected to become an increasingly important problem in the future as more second- and third-generation orchards are replanted and preplant fumigation, the standard control, becomes less available. Genetic engineering for nematode resistance could be an ideal solution because the appropriate gene would be in the rootstock rather than the edible or reproductive part of the tree, and if resistance to the gene were to develop in the nematodes it would not spread to other nematode populations. Other new technologies such as laser technology are being developed and may be available for nematode control in the future.

- The replant problem, as with nematodes, is expected to increase in the future in those counties where older walnut blocks are likely to be replanted. The problem will not be as severe in those counties where expansion will occur mainly on soil not previously planted in walnuts.

- **Crown gall** is a disease considered to be a moderate problem in most counties but will become increasingly important since Paradox is now the rootstock of choice. Disease prevention through biological control and cultural practices will
become very important. Resistant rootstocks are a possibility but the basic research is needed first to determine feasibility.

* Phytophthora crown and root rot. This disease is considered a major problem in one-third of the walnut growing counties and a moderate problem in half of the counties. It is expected to become a bigger problem in those counties where particularly virulent species of the fungus have been found or where orchards will be planted on marginal (less well drained) soils. In the Northern San Joaquin Valley where it is considered to be a major problem now, the increasing use of Paradox rootstock and low volume irrigation systems should help in the management of this disease.

* Deep bark canker is a major problem in counties where Hartley is an important variety such as portions of the Sacramento Valley and the Southern San Joaquin Valley. It is expected to be a decreasing problem as old Hartley blocks are removed. However, deep bark canker has been identified in a few Chandler trees in Tulare and Kings counties. At this time, it is unknown whether the disease will develop into a problem comparable to that on Hartley, remain an infrequent and insignificant problem as it is on all other varieties. If current studies determine that the causal bacteria are spread by grafting, this may stimulate the desire to certify scion wood.

* Armillaria root rot. In many counties this disease has not been observed in walnuts. It is considered a major problem in Yolo and Solano counties and a moderate problem in Sutter, Yuba, Contra Costa and San Luis Obispo Counties. It is projected to get worse in Contra Costa County if English rootstock is planted in infested areas.

* Codling moth is a major insect problem in three-quarters of the counties. Only in Lake and Contra Costa Counties is it no problem or only a minor one. Intensive research at both the basic and applied level on biological controls and other alternatives such as pheromone mating disruption are ongoing. They are not effective or economic as yet, but show promise. The future significance of the codling moth problem depends on whether the pest eventually adapts to later-season varieties such as Chandler, and on the development of effective and economic alternative controls.

* Walnut husk fly. This insect pest is currently a major problem in most of the coastal region and Sutter and Yuba Counties and a moderate or sporadic problem in seven other counties. It is a minor problem in the Southern San Joaquin Valley and parts of the Sacramento Valley. The future significance of husk fly is an unsure one. There is current research underway to understand what triggers the flies to lay eggs in the husk; this knowledge would help in better spray timing and in finding alternative control methods. However, in the short term and possibly the long term, the loss of sprays could cause this pest to increase substantially. Husk fly has been found in Chandler in San Benito and Contra Costa counties and in the Tulare variety in the Central Valley, so we know these varieties, too, are susceptible.

Another factor is that it often occurs in backyard walnuts or on small acreage homesites, so as more walnut acreage is converted to, or planted in rural residential zoning, this pest could increase.

* Navel orangeworm is a major problem in parts of the San Joaquin Valley while in 60 percent of the counties it is considered a minor or sporadic problem. How important this pest is in the future will to a large extent depend on how well codling moth and blight are controlled. An increase in smaller acreages could favor this pest as these growers have to rely on custom harvesters and often are unable to harvest early enough to avoid worm damage.

* Other insects. Secondary insect pests such as mites are usually considered minor problems except in Tulare and Kings Counties. With less disruptive sprays or alternative treatments for codling moth and if growers have a reliable water source, this problem could decrease in the future. Likewise, the severity of walnut aphid is usually related to codling moth sprays that destroy the aphid parasite.

* Pistillate flower abscission. This has been a statewide problem with Serr although there are locations in the southern San Joaquin Valley and San Benito County where it has been less severe. Several factors suggest that this problem will decline in importance. The most sensitive variety, Serr, is not being recommended for new plantings and the cause of the problem, excess pollen, has been identified. Also, many problem Serr orchards have been removed or topworked to other varieties. The degree to which other varieties exhibit FPA when exposed to excess pollen should be investigated.
# APPENDIX K

## THREATENED AND ENDANGERED SPECIES

THAT COULD IMPACT RIPARIAN WALNUT ORCHARDS

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>STATUS</th>
<th>HABITAT NEEDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>California hibiscus</td>
<td>California Candidate (C2)</td>
<td>Freshwater marshes and swamps.</td>
</tr>
<tr>
<td><em>Hibiscus californicus</em></td>
<td>CNPS Code 1B (2-2-3)</td>
<td></td>
</tr>
<tr>
<td>Swainson's hawk</td>
<td>California Threatened</td>
<td>Riparian woodlands with large adjacent grasslands</td>
</tr>
<tr>
<td><em>Buteo swainsoni</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western yellow-billed cuckoo</td>
<td>California Endangered</td>
<td>Riparian woodlands.</td>
</tr>
<tr>
<td><em>Coccyzus americanus occidentalis</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bank swallow</td>
<td>California Threatened</td>
<td>Nests along streams in silty banks.</td>
</tr>
<tr>
<td><em>Riparia riparia</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bald eagle</td>
<td>California Endangered</td>
<td>Wide ranging; for nesting requires tall trees close to lakes and reservoirs</td>
</tr>
<tr>
<td><em>Haliaeetus leucocephalus</em></td>
<td>Federal Endangered</td>
<td></td>
</tr>
<tr>
<td>Winter-run chinook salmon</td>
<td>California Endangered</td>
<td>Ocean-going; returns to the Sacramento River to spawn.</td>
</tr>
<tr>
<td><em>Oncorhyncus tshawytscha</em></td>
<td>Federal Endangered</td>
<td></td>
</tr>
<tr>
<td>Valley elderberry longhorn beetle</td>
<td>Federal Threatened</td>
<td>Breeds on elderberry shrubs along streams.</td>
</tr>
<tr>
<td><em>Desmocerus californicus dimorphus</em></td>
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