WALNUT PRODUCTION IN CHINA

A Report to the California Walnut Commission

December 15, 1989

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Summary and Conclusions.

The following summary and conclusions are from the report of the team sent to China by the California Walnut Commission from July 31, 1989 through August 16, 1989.

1. China's production of walnuts has increased significantly since 1981. A parallel increase has taken place in Chinese walnut exports.

From all of the evidence gathered and observed by the team, this production increase is likely to continue with most of it going into export channels. In fact, during the next ten years, if not before, China is likely to surpass California in the production of Walnuts when the currently estimated 30 to 40 percent of non-bearing trees come into production.

2. China is currently behind California in production technology. China has implemented long term (5 year) plans to improve production efficiency. Efforts are being focused on evaluation and selection of improved cultivars including an active breeding program and grafting nursery stock and older trees to improved cultivars. Experimentation is taking place with "hedgerow" and other types of intensive planting methods. Catkin removal is practiced to improve production.

3. Compared to California, Chinese farmers lack expertise and skills in modern horticultural practices and an understanding of basic physiology of a walnut tree as part of a production system. There was little evidence that plans are underway to improve this knowledge.

4. Harvest and post harvest practices currently result in nut quality problems. This situation coupled with difficulties in transportation pose significant problems in getting supplies of consistent quality to the market on a timely basis.

5. A significant question exists on how much further cooperation needs to be undertaken with the Chinese. Significant prospects for California include: access to germplasm to improve cultivars, improved pest management programs through discovery of parasitic enemies of California walnut pests, and improved practices such as male flower removal and drought stress management. The disadvantages are that cooperation may lead to Chinese improvements in management and technical deficiencies now posing a problem to their production efficiency.

6. The need for marketing programs by the California Walnut Commission and the Walnut Marketing Board, both domestically and internationally, must be continued and improved in order to continue to compete effectively with obvious increased Chinese production. These marketing programs can capitalize on the California strength of quality and consistency in delivery of walnuts.
WALNUTS IN CHINA
Report to the California Walnut Commission

This report summarizes findings of a team sent to China by the California Walnut Commission to observe walnut production. The team spent nearly three weeks in China from July 31, 1989 through August 16, 1989. The team was composed of Jerome Siebert, University of California Economist; G. Steven Sibbett, University of California Farm Advisor, Tulare County; Craig McNamara, walnut farmer and member of the California Walnut Commission; and Bob Merrill, Vice President (retired) Diamond Walnut. The team was assisted and accompanied in its travels by Jonathan Gressel, Agricultural Trade Officer, U.S. Embassy, Beijing. While in China, the team was hosted by the Ministry of Forestry which made all necessary travel and meeting accommodations. Mr. Yuan Haiying, an official of the Foreign Affairs Division, represented the Ministry of Forestry during the team's travels as well as serving as its official interpreter.

Background.

According to reports from the U.S.D.A. Foreign Agricultural Service (FAS), Chinese walnut production has expanded from 116.6 thousand tons in 1981 to 170.5 thousand tons in 1988.1/ (See Appendix A) The crop was projected to be down in 1989 due mainly to drought conditions, but the overall trend is definitely up. California production in 1988, by comparison, was 206 thousand tons with 210 thousand tons forecast for 1989. During the same period of time from 1981 to 1988 Chinese walnut exports have nearly doubled from 30 thousand tons to 58 thousand tons. California currently exports 75 thousand tons. China produces its walnut crop on nearly 120 million trees while California produces its crop on less than 10 million trees.

Purpose.

Because of the significant increase in production and exports in Chinese walnut production, it was important to determine what factors were responsible, current state of its production capability, and long term trends. The main purpose of the team's trip was to observe walnut production in China and report its findings back to the California Walnut Commission. Within this purpose, the team's objectives were to 1) observe the current status of walnut production, and 2) determine the future intent of Chinese walnut production from the standpoint of increasing plantings, its research base, standardization and quality of cultivars, and increased exports. A secondary objective was to determine horticultural opportunities available in China that would benefit California production.

Trip Structure.

China is an immense country that stretches over 3,400 miles from north to south and embraces the tropical, temperate, and frigid climate zones. The country measures 3,100 miles from east to west, and although it has only one time, in actuality it

1/ In this report, "tons" are equivalent to 2,000 lbs.
covers the equivalent of four time zones. Its total land area is 3.7 million square miles which makes it the third largest country in land mass in the world after the Soviet Union and Canada. Its travel infrastructure is not well developed, particularly its road system, which makes travel very difficult. Hence, even in a three week time period, it is impossible to see all but a small representative part of China’s walnut production area.

In setting up the trip with the Ministry of Forestry, several considerations were requested: 1) Visits to a representative sample of different walnut growing provinces to include both old and new plantings, 2) visits to farms showing different and cultural and management systems, 3) visits to nurseries propagating trees for distribution to farmers, 4) consultations with research and extension personnel at experimental facilities, 5) discussions with appropriate government personnel responsible for planning production and marketing of walnuts, and 6) visits to areas that had unique pest and disease problems. Given the logistics of travelling in China, these requests were met by the Ministry of Forestry. (See Itinerary, Appendix B)

During 1988, walnut production was located in five different areas (Map, Appendix C) with 90 percent in nine provinces, summarized in the following table:

<table>
<thead>
<tr>
<th>Province</th>
<th>Production (1,000 tons)</th>
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<tbody>
<tr>
<td>Yunnan</td>
<td>39.6</td>
</tr>
<tr>
<td>Shanxi</td>
<td>25.3</td>
</tr>
<tr>
<td>Shaanxi</td>
<td>23.1</td>
</tr>
<tr>
<td>Hebei</td>
<td>15.4</td>
</tr>
<tr>
<td>Gansu</td>
<td>14.3</td>
</tr>
<tr>
<td>Sichuan</td>
<td>14.3</td>
</tr>
<tr>
<td>Henan</td>
<td>7.7</td>
</tr>
<tr>
<td>Guizhou</td>
<td>6.6</td>
</tr>
<tr>
<td>Xinjiang</td>
<td>5.5</td>
</tr>
<tr>
<td>Other</td>
<td>18.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>170.5</strong></td>
</tr>
</tbody>
</table>

Visits were scheduled for four provinces: Beijing, Shanxi, Shaanxi, and Liaoning. These four account for almost one-third of the 1988 production of walnuts. Of the four, Shanxi and Shaanxi represent major walnut growing areas, with both old and new plantings. Beijing was included because it is one of the older areas, has many other crops competing for the use of land, has a large urban area in close proximity to the walnut production areas, has a large concentration of scientific and research knowledge, and is the center of government. Liaoning was chosen because, while it has relatively little production (less than 100 tons), it is targeted as a new walnut growing area close to a seaport, Dalian, and Economic Development Zone, and it has the Economic Crops Research Institute which is conducting some interesting experiments with cultivars and cultural methods.
Yunnan, Hebei, Sichuan, and Xinjiang are major walnut areas not included because of distance to growing areas from easily accessible transportation and the difficulty of logistics for the team given the time available and additional contribution to the mission. For example, Yunnan is the largest growing area in China but the trees are two days drive from Kunming on the Burma border. Similarly, Sichuan is a major growing area but the location of the walnut production is more than a day's drive from Chengdu. The production area of Hebei province is easier to access but is similar to those visited in Beijing, Shanxi, and Shaanxi. The autonomous region of Xinjiang is a particularly interesting area in as many cultivars originated there. If future trips are arranged, the areas that weren't visited would be an interesting follow-up.

Activities by the team included briefings by provincial and county officials responsible for walnut production, Ministry of Forestry officials, and various researchers. Visits included both formal briefings where an exchange of information took place between various Chinese officials and the team, and on-site inspections of walnut plantings, nurseries, and research plots. The Chinese were open in their discussions (although some discussions were difficult because of the technical terms involved). The Chinese were very interested in finding out more about California production technology, and, at some future time will likely plan to travel to California. Some publications, including a walnut production manual and research reports, were brought back to California that will need translation. In turn, the team promised to send to the Chinese additional information relating to California production to be distributed through Jonathan Gressel.

At the end of its trip, the team exited through Hong Kong, which is a large buyer of Chinese walnuts. It was hoped that the team would be able to travel to Shenzhen, over the border from Hong Kong, to see a nut cracking facility using California equipment. However, travel restrictions prevented the trip from taking place. While in Hong Kong, the team did visit and interview some importers and were accompanied by Ms. Yeung Lai Yee, Agricultural Specialist with the American Consulate in Hong Kong.

Observations and Findings.

Farm and Industry Structure. All land in China is owned by the government. However, the latest economic reforms encourage entrepreneurship; land is being leased to individuals on a long term basis (up to 15 years) with an active market in buying and selling leases. Walnut production in China is divided between individual farms and village or township farms. The percentage between individually farmed and village or township farmed units is not known, but from observation it appears that the bulk of the farming is on individual units. On individually farmed pieces of land, each farmer has about 1.1 Mou (about 1/6 acre) which may have up to 3 to 4 walnut trees that are intercropped with other crops such as corn, beans, etc. (four trees per mou would be equivalent to about 24 trees per acre if parcels were contiguous)
In this pattern of ownership, walnuts are not the main crop but provide a supplement to other crop income. However, walnuts are a good source of cash income to farmers of these individually owned plots of land.

Under village or township cultivation, crops are usually more intensively farmed, including walnuts. Under this form of farming, families specialize in farming certain crops and receive incentives in the form of extra shares of the crop income for doing so. Profits, unlike with individual farmers, are split among various members of the village or township. In addition to farming, many villages and townships have other non-agricultural enterprises. Hence, people are divided into work units with specialization occurring in the various production enterprises. Walnut production, in villages or townships, involves less intercropping and more intensive plantings. Selected families specialize in caring for the orchard.

If individual farms predominate walnut production, the problem of planning and coordinating production, quality control, gathering information, and marketing the walnut crop is greatly increased for the Chinese, especially given the inadequacies of their communications and transportation networks.

Economics. While walnuts are produced in many areas in China, the more commercial areas are rural, away from population centers. The major reason is the competition for land in China. The closer the farm is located to an urban area, the more alternatives for high value, cash crops exist. For example, walnuts do not do well in competition with other crops around Beijing because the demand for fresh fruits and vegetables by urban consumers is high. As a result, the land, which is a scarce commodity in China because of population pressures, is used for higher paying fruit and vegetable crops.

The more rural areas grow more basic crops such as rice, wheat, corn, beans, cotton, etc. In these areas, walnuts are grown in conjunction with some other crop and provide a favorable cash supplement to a farm family's income. This income will depend on number of trees on a farm, yield, and price received. If, for example, there are three walnut trees per farm which yield 50Kg apiece and the farmer receives 2.5 Yuan per Kg, total income would be 375 Yuan or a little over $100 at the current exchange rate of 3.71 Yuan per dollar. This amount is significant income in China.

Prices paid to farmers vary by location and quality. According to the 1988 U.S.D.A. Foreign Agricultural Service Walnut Report, and verified during the team's visit, farmers in Shanxi Province received about 30 cents per pound for Grade 1 walnuts (walnuts are graded according to type and nut size). In addition, premiums are paid for more desirable varieties and larger size. For example, in Shanxi Province, a new variety which is larger and has a higher oil content has a premium of 1.2 to 2.5 cents per pound. The price spread between the smallest and
largest nuts is usually about 1.5 to 1.7 cents per pound. A farmer is also paid an additional .5 to .75 cents per pound for shelled walnuts.

Production Capability. Walnut production in China has increased more than 20 percent in the past five years. Production in 1988 was 170.5 thousand tons. Chinese walnut exports during this same period of time increased even more by over 55 percent to 58 thousand tons. These exports are increasingly dominated by shelled walnuts, which were 72 percent of exports in 1987. The walnut team discussed the future direction of Chinese production. All discussions clearly indicated their future plans included increased walnut production with most directed towards export because of a favorable price structure and needed "hard currency" in foreign exchange.

Significant increases in nonbearing acreages and young trees coming into bearing were observed by the team. In the two provinces of Shanxi and Shaanxi provinces, nonbearing trees accounted for over 45 percent of the 53 million trees planted. It is important to note these two provinces accounted for 48.4 thousand tons of production in during 1988. Hence, these two alone could account for at least another 50 thousand tons of production under the most conservative calculations. It is not known if conditions in Shanxi and Shaanxi provinces represent other commercial growing areas, but contemplation of projected figures throughout the walnut growing areas of China can result in some impressive potential problems for California walnut exports. The team's best estimate is that other provinces such as Yunnan, Sichuan, and Hebei are similar in terms of long term potential growth. Hence, it is quite possible during the next ten years, and perhaps before, that China will surpass California in walnut production, with exports as a significant component of their market.

Climate, Soils, and Water. In walnut growing areas, winters are very cold (temperatures as low as -5 degrees F); summers are hot and humid (temperatures up to 98 degrees F). Rainfall varies from 18 inches to 32 inches, depending on location with a substantial portion (50 to 60 percent) during the summer. In the observed areas (except for Liaoning), soils were deep, wind deposited or alluvial with deep, silty textures. Generally Chinese walnut soils were very fertile and salt free with high water holding capacity. Chinese walnuts are generally not irrigated; rainfall is relied upon as the sole source of water. It should be noted, however, that in Liaoning Province, a new area, irrigation is being used because their soils are shallow and rocky with low water holding capacity and fertility. Generally, walnuts are grown on hills and in mountain valleys throughout China.

Cultivars. Most older walnut trees grown in China are English (J. Regia) seedlings from a nonselected parent probably coming from original native walnut forests. These seedling trees are highly variable in production, quality, pest and disease resistance, and drought tolerance. Such seedling
variability suggests (and were observed) individual trees may have pest and disease resistance which could be exploited in a U.S. breeding program involving that germplasm. Cursory observation by the team indicated resistance occurring.

The Chinese have an active program in each province to plant new orchards of trees from selected local parents. The Chinese refer to trees selected for this program as "super varieties". Traits desired and selected include: 1) high kernel oil content (65%) to enhance flavor, 2) early leafing and harvest to accommodate their short growing season and expeditious marketing, 3) thin shell, 4) pest and disease resistance, 5) drought resistance, 6) high kernel percentage, and 7) precocity (early bearing). Such traits are also desired by the U.S. walnut industry. The process of identifying and selecting good quality and productive cultivars is left to spot observation. Better attention to a uniform, quantitative selection system and then pruning to produce abundant graft wood from "mother" trees would greatly increase the efficiency of this program. There is an active program to clonally propagate such trees and establish them in the provinces. Many selected "super" cultivars are exported from one province to another for testing and eventual propagation. Distribution of these new "supervarieties" is occurring, as is topworking of existing trees (20 years and younger) using the improved scion wood. This latter situation is a fundamental long term goal in walnut production.

The Chinese are grafting seedlings and topworking existing J. Regia seedling trees to superior varieties. Rootstock research in Beijing includes testing usefulness of J. Hindsii (No. Cal. Black) and Paradox (J. Regia X J. Hindsii). Other species, e.g. Microcarpa, are also under test as potential rootstocks. Eventual rootstock selection will allow more uniform nursery trees and productive orchards. Currently, J. Regia nursery trees are quite variable due to seed source and seedling variation in China.

While grafting selected walnut cultivars is in its initial stages in China, several nurseries in the provinces were observed utilizing such practices. One such nursery in Fengyang county, Shanxi Province, had 160,000 two-year old grafted trees to be distributed to Chinese growers within a year.

Nursery trees are supplied to walnut farmers by the provincial governments at very low cost. Nurseries are essentially government supported research stations and would like to make a profit on the sale of walnut trees to farmers to support expanded research activities. Obviously, the farmers would like to secure the trees for free. The government policy is to provide walnut trees at a cost that will provide incentives for farmers to plant them and not generate monies for funding research activities.

Scions of improved cultivars are also being provided to farmers by provincial governments to topwork existing trees. A provincial goal is to topwork seedling trees 20 years and younger. This program currently appears to be less successful than the grafted seedling program, as the grafting techniques
and timing are not optimal. Improvements in grafting skills would increase efficiency of the topworking program. The team was informed that Chinese farmers have the skill to do their own grafting.

Walnut cultivar trials are included on Chinese research stations including both U.S. and European cultivars (It should be noted that Sunland, Chandler, Howard, and U.C. Patent cultivars are not in China). Although performance data for current U.S. cultivars were not yet complete or available (they will be sent to the team at a later date), U.S. cultivars are said to be too late leafing and harvesting for Chinese use. Most promising cultivars are Chinese and come from Xinjiang province. Cultivar evaluations will be important to future walnut plantings and productivity in China. The California walnut industry will benefit from results of the various Chinese cultivar trials; some may be used to develop cultivars for California conditions.

Cultural Management. Orchard planning, design, and management are currently minimal and affect the onset of bearing and maximum production. With the common practice of intercropping walnuts, more attention is currently given to the intercrop than to walnuts. The generally excellent soils and summer rainfalls minimize effects of poor management, but does not eliminate it. Evidence indicates that the typical manager has little understanding of walnut bearing habit or tree growth which is influencing their ability to manipulate the trees to maximum productivity. The Chinese will direct their attention to more efficient walnut culture with increased walnut planting to maximize precocity and ultimately production.

Walnut trees benefit from the intercropping management, especially use of fertilizer. The farmer's first priority is to manage the intercrop. Both "nightsoil" and commercial fertilizers are used. Commercial fertilizers are in short supply and the government provides them to the farmer for crops other than walnuts at a subsidized cost. Hence, when commercial fertilizers are applied, walnuts inadvertently benefit.

Supplemental irrigation is not generally practiced; rainfall is usually plentiful and relied upon during the summer months. Lack of irrigation limits walnut production to those areas where rainfall is plentiful. Reliance on natural rainfall introduces variability into production cycles; for example, China is experiencing a drought in 1989 which will both lower current yields and affect production in 1990. However, irrigation is being recommended where hedgerow plantings are being experimented and contemplated.

The Chinese are experimenting with hedgerow plantings of local selected cultivars as observed by the team in Shanxi and Liaoning Provinces. Trees in these plots appear to be quite vigorous, and the research will provide interesting results as data and production are evaluated. The Chinese currently lack the knowledge to manage hedgerow plantings to insure precocity while maintaining tree size and productivity for the various cultivars being tested.
Most walnut trees in China are seedlings rather than grafted trees. As new, grafted nursery trees become available and are distributed, earlier bearing can be expected than the usual 6 to 8 years. Precocity is a major goal of the selection program of improved cultivars. It should be noted that onset of bearing may be affected as much by initial tree management as by cultivar, including pruning, training, fertilization, pest control, and irrigation. These factors were observed to be minimal by California standards. Improvement in orchard management techniques will increase walnut productivity considerably.

In mature tree situations, some Chinese practice catkin removal at bloom to improve fruit set. On several occasions this practice was mentioned to the team and was said to improve production by up to one-third. Explanation and further not of such practices may prove useful to the California walnut industry.

Pest and Disease Control. A number of major pests of walnuts were noted in China that do not occur in California. Two examples include: a hull feeding moth that stains the shell, infests the kernel before shell hardening, and causes dark kernels (according to samples submitted to the California Department of Food and Agriculture that the team brought back, this pest is a species of Cydia, the codling moth genus); another was a leaf feeding, "long horned" beetle that causes substantial leaf damage and defoliation. Codling moth was not observed or said to occur in walnuts, but was said to occur in closeby apples (further investigation of this relationship by entomologists is suggested). A number of minor pests were observed including the "two spotted mite" (red spider), several leaf feeding, skeletonizing caterpillars, unknown armored and soft scales, and walnut aphid. None except spider mites and aphids have been seen by the team in California.

Chemicals used for pest control are provided by the government. Pesticides are applied by backpack sprayer which limits coverage of larger trees. Thorough knowledge of pests, monitoring techniques, and insecticide use including timing and application are lacking by the Chinese. Such lack of knowledge results in minimal control of the target pest.

Walnut blight was observed only in Liaoning Province. Although other walnut growing provinces have climatic conditions suitable to blight, none was observed. In Liaoning, coppers are used to control blight, but are applied one month after bloom demonstrating a lack of knowledge of blight control. A bark canker was observed in Beijing, but no positive identification could be made. The team recommends U.S. pathologists visit China to further examine walnut diseases to factually determine existence or non-existence of diseases and probable reasons. E.g., given the ideal conditions for blight in China and its noticeable presence in Liaoning but lack elsewhere, there is need for further study to determine if resistance truly occurs. It should be noted that a blight resistant cultivar was selected in Liaoning Province.
Harvest and Post Harvest Handling. All harvest and post harvest operations are performed by hand. The nuts are knocked down with long poles once 30 percent of the hulls split. They are picked up by hand and generally placed in a pile two to three feet deep and covered with leaves for six to seven days in an enclosed room to enhance hulling of the remainder of the nuts. The nuts are then hulled by hand or beaten with sticks to loosen them and dried in the sun for about seven days. These harvest practices result in poor quality, i.e., dark kernels.

Once dried, the walnuts are transported to either a local market for local consumption or to a central collection point for sale to the Ministry of Commerce. If sold to the Ministry of Commerce, the walnuts are destined for domestic consumption in other Chinese markets or exported. Usually, the walnuts are transported from farm to market "inshell"; however, the percentage of the crop that is shelled is increasing. The nuts can be shelled by either the farmer or collective or by the Ministry of Commerce. In reality, little shelling apparently goes on at the farm level, even though the farmer or collective can obtain a premium for shelled walnuts. Shelling is done mostly by hand, although the Chinese do have some locally produced, inefficient shelling machines. It was reported to the team that California supplied cracking equipment had been imported to the Shenzhen Free Trade Zone outside of Hong Kong. Limitations in the travel schedule prevented a visit to this facility, but any future trips should attempt to do so.

Travel is difficult. Many walnut producing areas in China are in remote rural areas, with poor roads jammed with all imaginable types of vehicles. Methods of inshell walnut transportation vary from "foot" to motorized vehicle. Because many of the varieties grown are thin shelled, they do not stand rough handling of long transport: breakage will occur, particularly on rough roads in the rural areas of China. Another major difficulty is getting harvested walnuts to market for sale at profitable times. For example, it has been reported that often there are not enough walnuts to satisfy local demand during the "Moon Festival" in October. Further, there have been reported delays in filling orders for the Christmas season in Europe, the most profitable marketing period. Adequate transportation is a major obstacle to increased profitability of the Chinese walnut industry.

Walnuts are stored shelled or in-shell in non-refrigerated facilities. Such storage further aggravates a decline in kernel quality with added problems of rancidity and insect infestation (walnut kernels shipped to Hong Kong had substantial insect contamination). Poor storage also affects the ability of the Chinese to deliver a quality nut on a year round basis so sale and delivery of their crop needs to take place as soon after harvest as possible, which is difficult at best with poor transportation.
In summary, harvest and post harvest procedures are major factors contributing to poor quality and expeditious marketing. These are relatively easy to improve through the implementation of existing technologies and appropriate management techniques. While the Chinese seem to have no difficulty in producing a crop, their largest disadvantage, particularly in serving an export market that is quality conscious, is in the area of harvest, post harvest, and transportation technology and management. At the current time, California has a distinct advantage in markets requiring quality. However, some markets are sensitive only to price, such as Hong Kong and England, and Chinese walnuts will continue to make inroads against California walnuts.

Research and Extension. Walnut research activities are carried out by the Ministry of Forestry as well as provincial and county governments. Most walnut research is in the horticultural discipline. Other research, such as that for pests and diseases, is carried out in a separate ministry. Any future visits or collaboration should investigate this activity.

An active breeding, screening, and selection program for walnuts is going on in China. Ms. Xi Sheng Ke is the leader in China's breeding program and is located in Beijing at the Chinese Academy of Forestry Research Station. Tissue culture was observed (close to state of the art) and is being used to clonally propagate selected cultivars for fruiting and rootstock purposes. It is of interest to note that one "paradox" has been selected that is easy to root and transplant. Controlled "crosses" are also being made and resulting seedlings are being grown.

A cultivar collection of Chinese and foreign material has been established and maintained in Beijing. The cultivars are being evaluated for production and quality performance and are being used for breeding purposes. Among the U.S. cultivars being tested in Beijing are Franquette, Ashley, Amigo, Chico, Gustine, Tehama, Pedro, Serr, Vina, and Hartley. As noted earlier, the U.C. patented cultivars Chandler, Howard, and Sunland are not in China. Similar cultivar test plots have also been established in several walnut growing provinces in China and performance data are being collected by Ms. Xi. Large demonstration orchards are planned by the Chinese Academy of Forestry, designed to demonstrate cultivar performance and cultural technology to farmers. This research is state of the art and new technology will develop from it.

Applied research is also taking place at various research centers in walnut growing provinces. Objectives of that research include improvement of production efficiency and nut quality, pest and disease resistance, and putting results in place among the farmers.

Extension services exist at the county level in the provinces, usually in conjunction with a research station. They provide workshops in cultural techniques, grafting, cultivar performance, and pest and disease management. They also provide improved cultivar nursery materials (trees and scion wood) to the
farmers free or at minimal cost. Extension technicians that met
with the team did not have a good command of horticulture and
utilize provincial researchers in some teaching activities.

Chinese farmers are quick to adopt new methods when they can
readily see how production can be improved. The Chinese have
recognized their weaknesses in walnut culture and are attempting
to change them on a large scale in the major producing areas.
Major improvements will take place once improved skills and
knowledge in basic technologies of production are learned by the
farmer. New plantings of improved cultivars grafted on to
rootstocks, topworking of existing trees to improved cultivars,
more intensive management of existing trees, and planting high
density orchards will result in significant improvements in
production and quality. The Chinese have developed the necessary
research programs to provide basic knowledge and materials for
improving their production; the major obstacle is transfer of
such technology to the farmer.

Potential for Collaborative Research Efforts. The Chinese
are very aware and interested in California walnut technology.
Significant increases in their production could take place
through simple application of existing technologies and informa-
tion. However, application of existing technology is more dif-
ficult than it appears. It is dependent on both the infrastruc-
ture in place to transfer technology and economic incentives to
the farmer. It should be noted that it is unlikely "cutting
edge" research collaboration of importance to the California wal-
nut industry and U.C. will find its way into practical applica-
tion in China for many years. In any event, the Chinese
will press for closer collaboration in research and scientific ex-
change. At the very minimum, a Chinese team will likely request
a similar tour of California walnut growing areas in the near fu-
ture.

The advantages of collaboration with the Chinese to the
California walnut industry are many. The Chinese have sources of
germ plasm useful to California breeding programs, particularly
pest and disease resistance and nut quality improvements. In
this regard, it has been noted that a blight resistant cultivar
has been selected and quality characteristics of 65%+ kernel
percentage, high oil content kernels, and thin shelled cultivars
are common. In addition, there may exist natural parasites to
combat California pests such as codling moth. Finally, new cul-
tural practices and horticultural methods may be learned to as-
sist California walnut growers.

Concerns regarding collaboration with the Chinese center on
a quicker learning and adoption of basic skills and techniques by
them, such as pruning, training, pest management, harvest, and
post harvest handling that will overcome some of the more notice-
able problems with China's production. In addition, there is a
remote possibility an inadvertent importation of pests and dis-
ees could occur. This event should not be a problem if proper
quarantine measures are imposed.
In summary, the team feels substantial benefits can accrue to the California walnut industry through an active collaborative effort with the Chinese. Care should be taken to minimize direct exchange of basic technology except as it is acquired through other exchange efforts.
Chinese Walnut Production

Source: FAS, 1988 est
Chinese Walnut Exports

Source: FAS, China prod yrbook, 1988 est
APPENDIX B: California Walnut Commission Team China Itinerary.

Monday, July 31
Arrive Beijing

Tuesday, August 1
AM: Ministry of Commerce, Beijing
   Ministry of Forestry, Beijing
PM: Forestry Science Academy, Beijing

Wednesday, August 2
Field visit to Huairou County, Beijing Province

Thursday, August 3
Field visit to Mentougou County, Beijing Province

Friday, August 4
AM: Depart Hotel for Taiyuan, Shanxi Province
PM: Arrive Taiyuan
   Meet with Ministry of Forestry and Province Officials

Saturday, August 5
AM: Travel to Fengyang County
PM: Meet with County Officials
   Field Visit

Sunday, August 6
AM: Field Visit, Research Station and Nursery
PM: Return to Taiyuan
   Depart for Xi'an, Shaanxi Province via night train

Monday, August 7
AM: Arrive Xi'an, Shaanxi Province
PM: Meet with Ministry of Forestry and Province Officials
Tuesday, August 8
AM: Travel to Luonan County, Shaanxi Province via van
PM: Field Visit, Luonan County

Wednesday, August 9
AM: Field Visit, Luonan County
PM: Travel to Xi'an via van

Thursday, August 10
PM: Travel to Shenyang, Liaoning Province via CAAC air
Meet with Ministry of Forestry and Province Officials

Friday, August 11
AM: Meet with Liaoning Province and Academy of Forestry Officials

Saturday, August 12
AM: Travel to Dalian, Liaoning Province via train

Sunday, August 13
AM: Field Visit, Xinxian County, Liaoning Province
PM: Return to Dalian

Monday, August 14
AM: Economic Crops Research Institute, Dalian
PM: Visit to Dalian Economic Free Trade Zone

Tuesday, August 15
AM: Seminar with Provincial and Economic Crops Research Institute Officials
PM: Meet with Native Produce and Animal By Products Import Export Corporation (TUSHU) Official
Depart for Beijing

Wednesday, August 16
AM: Depart Beijing for Hong Kong
Thursday, August 17

AM: Meet with U.S. Consulate Officials, Hong Kong
Visit and meet with Hong Kong walnut importers

Friday, August 18

AM: Depart Hong Kong for United States