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1976 WORLD AVOCADO PRODUCTION

Don Gustafson
Farm Advisor, Cooperative Extension Service, University of California, San Diego.

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INTRODUCTION

There is high interest around the world to develop avocado orchards. Acreage is increasing in presently planted commercial growing areas, and new commercial orchards are being planted in places where only native avocado trees once grew. Avocados have been known for many years, dating back to the year of 1519 or earlier. In that year, Hernando Cortez, Spanish soldier of fortune, set foot in Mexico City, the first white man to do so. Among the many significant events of that historic day was the discovery of the most versatile fruit of the New World, the avocado. In 1526, Oviedo, historian to the conquistadores, wrote the following description of the avocado and gave the first directions for eating it:

"In the center of the fruit is a seed like a peeled chestnut. And between this and the rind is the part which is eaten, which is abundant, and is a paste similar to butter and of very good taste." Oviedo speaks of the avocado of northern South America but the fruit seems to have originated in the lands to the north—in Central America and Mexico. Here the Aztecs named the fruit ahuacatl, and the avocado tree that flowers today in the United States was yesterday growing wild in the ruins of the Aztec and Mayan temples.

From Mexico the avocado spread into Peru, where in the pre-Incan city of Chanchan archaeologists have unearthed a double water jar in the shape of an avocado, dated around 900 A.D.

The fruit appears next in the West Indies, where new varieties developed. It was in these tropical islands that many travelers first encountered avocados, among them the young George Washington, who wrote in 1751 that "agovago pears" were abundant and popular in the Barbados.

We come now to the California avocado whose history goes back to Puebla, a city eighty miles from the Mexican capital. Puebla, which has been called the "Star of Christian Art in the Western Hemisphere," is reached from Mexico City via a beautiful road bordered by corn fields, and bright blazes of flowers. Here is a most appropriate place to celebrate the blending of Spanish and Indian cookery that produced the Mexican cuisine.

To Mexico City, Puebla, and Atlixco in 1911 came the twenty-one year-old American,

Carl Schmidt. Schmidt was employed by the West Indian Nursery in Altadena, California. His task was to search the Mexican marketplace for avocados of outstanding quality and to locate the trees from which they came. He cut budwood from the best trees, numbered each, and shipped them by Wells Fargo to Altadena. Many buds refused to adapt to the soil and climate of California; but number 15, which Schmidt cut from a tree in the garden of Alejandro Le Blanc, flourished. When it survived the great freeze of 1913, its strength was officially recognized and it was given the name 'Fuerte'—Spanish for vigorous and strong. The 'Fuerte' tree that Schmidt found in Atlixco became the mother tree for California's avocado industry.

It should be noted that the first planting of avocados in California was actually recorded in 1848, by Henry Dalton near what is now Azusa, a few miles east of Los Angeles. All evidence of this planting have long since disappeared. But trees set out in Santa Barbara by R. B. Ord in 1871 have thrived until recent years.

The first record of introduction into Florida was in 1833, when Henry Perrine sent trees from Mexico to his land grant near Miami.

The avocado tree is related to the laurel and is the fruit of the genus Persea—a bright green tree that grows from Mexico south to Columbia and Peru and north to Florida and California. The tree strains—Mexican, Guatemalan, and West Indian—were first catalogued in 1653 by a Spanish padre named Bernabé Cobo. These strains included hundreds of avocado varieties which come in sundry shapes— round, pyriform (pear-shaped), crooknecked (like a squash); skin colors—green, purple, maroon, and jet black; and skin textures— smooth to pebbly.

This fruit of the New World has been known by many names. In Chile, Peru, and Ecuador, it is called Palta, the name given to it by the Incas. In West Africa, it is called custard apple. In Spain it is known as abogado; in France, avocat. The latter two names, both of which mean lawyer, and the English word avocado have probably all derived from attempts to speak phonetically the Aztec name ahuacatl. (6)

AVOCADO PRODUCTION WORLDWIDE

The avocado is becoming popular in many countries. With an increased demand for the avocado by the consuming public, these countries see an opportunity to export the fruit and obtain revenue from yet another agricultural crop. Avocados are grown in climatic zones similar to where citrus is grown. Avocados are grown essentially in two. types of climate, tropical and subtropical, occurring, generally, from 40° south latitude to 40° north latitude. (See Table 2)

Avocado industries can be classified as: 1) commercially developed, 2) commercially developing, and 3) native plantings. In the first category are countries such as Mexico, United States, Israel, and South Africa. In the second category are countries such as Australia, New Zealand, Philippine Islands, Spain, Cyprus, Canary Islands, Chile, Brazil, Ecuador, Peru, Venezuela, Greece, and Caribbean Islands. Category three includes countries in North, West, and East Africa, some Central American and South American countries.

Countries Where Avocados Grow

1. *U.S.A.*
   California, Florida, Hawaii, and Texas
2. *Mexico*

Michoacan, Jalisco, Vera Cruz, Puebla

3. *Central America*
   Costa Rica, Honduras, Guatemala, El Salvador, Nicaragua, Panama
4. *Caribbean Islands*
   Cuba, Puerto Rico, Dominican Republic, Guadeloupe, Haiti, Martinique, Jamaica, Trinidad, and Tobago
5. *South America*
   Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Venezuela
6. *Africa*

Morocco, Cameroon, Ghana, Ivory Coast, Kenya, South Africa, Zaire, Algeria, Egypt

7. *Australia*
   Queensland and New South Wales
8. *New Zealand*
9. *Cyprus*
10. *Spain*
11. *Sicily*
12. *Asia*
    Israel, Philippine Islands
13. *Greece*

VARIETIES GROWN

Varieties grown around the world fall into basically two categories, those grown under tropical climate conditions, and under subtropical climate conditions. Varieties grown in tropical areas are: 'Lulu, Collinson, Tonnage, Taylor, Choquette, Pollack, Booth 7, Booth 8, Hall, Walden, and Nabal.' (13) These are West Indian, Guatemalan, and hybrid types grown in areas such as Florida, east and west coasts of Mexico, Caribbean Islands, Cameroon, Ivory Coast, Argentina, Brazil, etc. In countries considered tropical, but where avocados are grown above 5,000 foot elevation, the varieties planted are the ones used in subtropical areas. Examples are: In Kenya, where avocados are grown at 6,500 feet, the varieties used are 'Fuerte, Nabal, and Hass.' These are the varieties grown in California, South Africa and Israel where the elevation ranges from sea level to 2200 feet. In Mexico a new and dynamic industry is developing at elevations of 6,000 to 8,000 feet, using California type varieties.

The varieties commonly grown commercially in subtropical areas are: 'Fuerte, Hass, Bacon, Zutano, Reed, Nabal, Ettinger (Israeli variety), Mexican seedlings, Sharwill' (Australian variety), and many selected trees being tested for future plantings. For instance, in California the 'Hass' has replaced the 'Fuerte' as the number one variety, while new varieties have been introduced and are being tested. The California Avocado Society has an active variety committee. A seven acre test plot on Rancho California, Riverside County, includes many new and old varieties. The newest introductions are 'Santana' ('Zutano' type),, 'Jim' (developed by Jim Bacon, who also developed the

'Bacon'), 'Pinkerton' (a Ventura County variety), and a patented variety 'Reed,' now considered commercial in California. It appears to *be* a 'Nabal X Anaheim' cross. The fruit resembles the 'Nabal' and the tree growth characteristics of the 'Anaheim.' (5)

All countries responding to the 1976 Worldwide Avocado Production Survey report extensive varietal testing being conducted. Varieties included were those introduced from other countries, plus the planting of native selections that look promising.

INDUSTRY PROBLEMS

The industry problems are divided into three main areas: cultural, harvesting and marketing.

Cultural

The cultural problems can best be described by reproducing the comments from the Survey. Different countries, and different areas within a country, have different problems, but it is interesting to observe the similarities between countries. (3) Here are the problems from the various countries:

Spain:

1. Spring leaf drop in 'Hass'
2. Alternating 'Fuerte' production
3. Potassium nutrition
4. Soil management
5. No good summer variety (July-September)
6. Limestone soils

Canary Islands:

1. Bad soil drainage
2. Salinity
3. Undetermined rootstocks
4. Avocado root rot *(Phytophthora c).*

Israel:

1. Non-dependable bearing of 'Fuerte'
2. Small size 'Hass' fruit
3. Short harvest season of 'Ettinger'
4. Absence of more uniform sources of rootstocks
5. Productivity not high enough
6. Salinity
7. Lime in soils
8. Proper irrigation methods

Cyprus:

1. Weeds
2. Winds
3. Salinity of water

Martinique, French West Indies:

1. Avocado root rot disease *(Phytophthora cinnamomi)*
2. Fruit disease *(Cercospora)*
3. Weeds

St. Lucia, West Indies:

1. Varieties (supply or suitable planting material needed)
2. Avocado root rot *(Phytophthora cinnamomi)*
3. Slugs
4. More information on fertilization requirements

Argentina:

1. *Anthracnose* disease
2. Avocado root rot *(Phytophthora cinnamomi)*
3. *Verticillium* disease

Chile:

1. Avocado root rot *(Phytophthora cinnamomi)*
2. Cost of fertilizers
3. Cost of labor
4. Alternating bearing habit of 'Fuerte'

Mexico:

1. Avocado root rot *(Phytophthora cinnamomi)*
2. Seed weevil
3. Need for excessive sprays to control fruit diseases and tree and fruit pests

Cameroon (West Africa)

1. Fungus diseases *(Cercospora* and *Diplodia)*
2. Cankers *(Phytophthora* sp.)
3. Difficult to find suitable land

Egypt:

1. Winds during flowering and fruit set period

2. Dryness at bearing stage

Australia:

1. Grafted trees difficult to obtain in quantity
2. Avocado root rot
3. Anthracnose rot on fruit
4. Sunblotch virus disease
5. Grass control
6. Soil drainage

Florida:

1. Weed control (vine type weeds)
2. Disease control (anthracnose, *cercospora,* scab)
3. Tree spacing-shaping

California:

1. Avocado root rot *(Phytophthora c.)*
2. Thinning crowded orchards
3. Clonal rootstocks needed
4. Saline water
5. Irrigation management
6. Soil management

South Africa:

1. Alternating bearing habit of 'Fuerte'
2. Avocado root rot *(Phytophthora c.)*
3. Weeds

From these reports a similarity of cultural problems exists in all avocado producing countries. Avocado root rot, caused by the *Phytophthora cinnamomi* fungus, appears to be the most serious problem. It was mentioned in almost every report. It is, undoubtedly, the most serious problem facing the avocado industry worldwide because of the wide range of host plants the fungus attacks or lives on, and how deadly the disease can be when it strikes an avocado orchard. (14)

Harvesting

Following are harvesting problems encountered by reporting countries. (3)

Spain

All avocados are planted on terraces. There are no harvesting problems at the present time except in orchards that are too small.

Canary Islands

Lack of harvesting criterion leads to incorrect time of harvest for most varieties.

Israel

Two main problems in harvesting avocados are the fullness of trees and a need for developing mechanical aids in harvesting. A dwarf tree would be an answer to the large tree problem.

Martinique, French West Indies

No special problems of harvesting in the West Indies islands. Trees are large and in some cases very tall. As in other avocado growing areas, the tall tree is an obstacle to efficient harvesting.

Argentina

The main problem is one of erratic bearing of the varieties which makes a consistent harvesting program difficult. This type of tree behaviour ties in very closely with the development of good markets.

Chile

Conventional harvesting is carried out with very little problem at the present time. As the industry is expanding, modern equipment can be introduced which will make harvesting efficient and economical.

Mexico

Harvesting is carried out in the usual method, with picking poles, hand clippers, picking sacks, and ladders. No mechanical equipment is used at this time. Harvesting fruit in this country ties in closely with market development, as well as proper cultural practices where pests and disease chemicals must be sprayed regularly so the fruit does not become damaged. In warm, moist, tropical conditions, fruit are more susceptible to fruit rots and increasing number of insect attacks. It is more difficult to maintain a biological control, and therefore sprays of chemicals are required. The main problem in harvesting is knowing when to get the fruit off to reduce the incidents of disease and pests damage.

Cameroon

The most serious problem connected with harvesting is the actual transportation of the fruit from the orchards to the market outlets. Since much of our fruit is exported, it includes the transportation on sea or by air, requiring proper refrigeration and efficient handling. If this is not done, the fruit upon arrival in Europe is not up to standard, and the growers lose money.

Egypt

Costs of harvesting are expensive. All of it is done manually and the rate of pay adds considerable cost to the product on its way to market. *Australia*

High labor costs and lack of equipment for harvesting high growing trees are two of the problems in their industry. Determining the correct stage of maturity and careful handling are additional problems.

Oil content is one of the methods used to ascertain the correct stage to harvest avocados. Oil content will vary depending on time of year, the varieties picked, and the geographic location.

Florida

There is a definite need for mechanical aids in harvesting. The other problem being one of too many varieties.

California

The most pressing problem is the harvesting of the fruit from steep hillside orchards. Plantings in California are on slopes from 35 to 70 percent. It presents a serious problem of how to keep the picker from falling down the hill while picking, much less how to set a ladder on steep sloping ground, or how to walk to field boxes and bins to empty full picking bags. Another problem is the oil content of varieties. A more refined method for determining maturity would provide better harvesting scheduling.

South Africa

One of the more important facets to harvesting avocados is the ultimate market which is in Europe. The long boat trip to market makes it extremely important that fruit be harvested at the proper time. Avocados must be transported over long distances, not only within the country before it reaches the dock, but on the long trip by boat from the southern tip of Africa to the main European markets. The fruit has to be handled carefully because any bruises, marks, etc., will only cause further breakdown of the fruit and reduce its market quality.

Marketing

Marketing is the last stage in getting the growers' fruit from his trees to the consumer. It encompasses many facets, such as: varieties, seasons, maturity, transportation, advertising, promotion, sales, etc. Following are some observations on this important part of the avocado industry. (3)

Spain

Although over half the avocados are marketed through cooperative organizations, there is no central body that has the power to set minimum standards, advertise the product, promote the product at the retail store level, and work on the most efficient and acceptable transportation.

Canary Islands

Most avocados are consumed in the islands. Very little is exported to Europe, so the local market is limited. There is a need for expanding the market in Europe and Scandinavia. This requires planting the most acceptable market varieties and to concentrate on quality and high yields.

Israel

The main problems in marketing avocados are: 1) size of fruit, either too large or too

small, 2) the shelf life, which is usually not long enough because of the long distance to European markets, and 3) the quality of the fruit produced. There is a strong need to promote avocados in the large markets of Europe. An educational program is needed on varieties, such as the difference between the eating quality of a green-skinned 'Fuerte' and the black-skinned 'Hass.' As most avocado growers have learned, black skin on avocados connotes over-ripeness and/or spoilage to the consumer. This is a logical conclusion when you see the green-skinned varieties turning black as they become over mature, or when certain fungus diseases have attacked the fruit.

Cyprus

The industry is too young at the present time to have any marketing experience and problems since most of the fruit is consumed at home. *Martinique, French West Indies*

The local market is not highly developed, so most fruit is exported to France. There is a need to produce more varieties so the marketing season can be extended. Better quality of fruit for market is required since there is a demand in the European market for good avocados.

St. Lucia, West Indies

There is no contact with export markets at the present time. The industry is young and most fruit is consumed locally.

Dominican Republic

An increase in exports is anticipated from these islands to the U.S.A. Declining Puerto Rican production and better prices in the foreign market than in the local market are reasons for increasing production and increasing exports from the Dominican Republic. It is anticipated that increased exports to the U.S.A. will increase in coming years due to larger production as well as the better price in the U.S.A.

Argentina

Small sizes and disease damaged fruit is given poor reception in the market. There is good demand in local markets for good fruit. Certain varieties produced in various times of the year will bring good or bad returns, depending on the quality of the fruit. Better varieties and better cultural practices resulting in improved market acceptance of the fruit are necessary.

Chile

Most fruit is marketed locally. The problems are connected with the cultural and harvesting practices. Better varieties, better cultural practices, better harvesting techniques would probably result in better fruit for market and better acceptance.

Mexico

The avocado industry in this country is developing along more commercial lines than it has in the past. Tremendous yields of fruit are reported from various states where avocados are grown. The avocado is a staple item in the diet of the Mexican. Most fruit is consumed in the domestic market. Increased plantings of improved varieties and increased yields will cause a marketing problem in the future. The government is working on a program with avocado growers to establish quality standards for avocados

and by-products. A series of promotional studies and technical and industrial assistance to further utilize the avocado is carried out by the government.

Cameroon

Once again, in a tropical country, the problem is of producing a good marketable fruit. The high incidence of fruit rots requires frequent and consistent insecticidal and fungicidal sprays. The local market is well supplied with fruit, so most fruit is destined for export. Transportation, from the avocado producing areas within the country to the ports where the long trip by ship to Europe begins, takes its toll on fruit quality. To get the best possible fruit to market will require selection of the best variety, using the best cultural practices to grow that variety, careful harvesting techniques, and the most up-to-date transportation techniques, including refrigeration, storage, packing, and handling.

Egypt

The avocados produced are for export almost entirely. The local market has not accepted the avocado, therefore, very little of it is marketed at home.

Australia

There are three main problems in marketing avocados: 1) There are no maturity standards, so any large city or heavily populated area becomes a dumping ground for poor quality and immature fruit. 2) Consumers are ignorant of the avocado, and, therefore, education and advertising are necessary. 3) There is a break in the supply of fruit to market in that 'Hass' harvest is finished in November and December, while the 'Fuerte' is not available until April. There are no suitable varieties yet developed for the January to April market. Since there are no standards or procedures for determining maturity, there is much immature fruit on the market. This only causes further rejection by the consumer. There is a definite need for more careful handling of the fruit from harvest time, through the packing house and during transportation. The industry is just getting started, so most of the fruit is marketed in the country.

Florida

There is a need for greater consumer awareness of the avocado. An educational and advertising program has been started. There are too many varieties which increases the problem of marketing and promoting the avocado. Some varieties have a very short shelf life. There is a need for evaluation of the present varieties and a program to find more suitable varieties for the market.

California

Problems of marketing and distribution are being worked upon by various packing and marketing organizations, as well as federal, state, and county governmental agencies, including the University of California. The California Avocado Advisory Board, voted in by the avocado growers in 1959, with the Board activity starting in 1961, has done much to improve the returns to the grower through intensive and high quality advertising and sales promotion. This is a self-help program where growers contribute 4.7 percent of the value of their crop at the packing house door. This money is used for advertising, sales promotion, and production research. Only two-tenths of a percent is used for production

research, and this is devoted almost a hundred percent to solving the avocado root rot problem. The problems that face the industry in the marketing field are not as serious as it was a number of years ago before the Board was established. The problems at that time were: 1) education of the consumer about the avocado and how to use it, 2) identification of suitable and market acceptable varieties, and 3) market expansion. This resulted in elimination of many poor varieties. At the present time there are five major varieties being marketed, plus smaller amounts of minor varieties still being grown. A cooperative effort by the Advisory Board, avocado packers, marketing organizations, and growers has resulted in the expansion of markets. No one or two markets will be flooded with fruit when a large industry crop is harvested and marketed, depressing the price returns to growers. Another important facet is the investigation and exploration by various organizations within the industry to find new markets, whether domestic or foreign. Even though there are still problems in the marketing phase of the industry, efforts are being made to correct these problems.

South Africa

One of the most important problems in the marketing of fruit is transportation. There are long routes to travel, both land and sea, between producing areas and the ports where fruit is loaded on ships destined for Europe. Domestic market takes a certain amount of avocados, but a large portion goes to Europe.

Summarizing reports from the avocado producing countries, there is a similarity of problems regardless of the climatic conditions under which trees are grown; and they are: 1) there is a need for better varieties and more varieties to provide fruit for market twelve months of the year. 2) There is need for better harvesting, packing, and transportation methods and techniques. Top quality fruit is of prime importance if there is to be repeated buys by the consumer. The growers' fruit is not sold until it has passed through the checkout stand at the retail store. 3) There is a need to know the best way to store and handle fruit on its journey to market. To countries dependent on export markets, the storage, refrigeration, and transportation techniques take on more significance because of the long distances the fruit must travel to reach markets. How to get large volumes of fruit transported by ship, under refrigerated conditions, and in just the right combination to assure good fruit to the markets of the world are formidable problems. Solving these problems is a tremendous challenge for researchers, marketers, and growers.

CULTURAL PRACTICES

Growing avocados requires using proper and good cultural practices. These include fertilization, irrigation, disease and pest control, weed control, tree pruning, and orchard thinning.

Fertilization

The use of inorganic sources of fertilizer materials is consistent throughout all avocado growing countries. Materials used are: urea, ammonium nitrate, ammonium sulfate, calcium nitrate, potassium nitrate, potassium sulfate, supersulfate, zinc sulfate, iron

chelate, and various mixed fertilizer compounds. In some countries the mixed fertilizer material includes nitrogen, phosphorous, potassium, and magnesium. In most cases, however, nitrogen and potassium are the main materials used. Zinc, iron, and phosphate are increasing in use as more becomes known about fertilizing avocado trees.

Amounts of nitrogen used per tree or per acre vary with age of tree, variety planted, and the type of fertilizer used. For young trees the range is from half-a-pound to a pound of nitrogen. For mature trees, the range is from one pound upward to four pounds of actual nitrogen. In California the 'Hass' variety requires twice as much nitrogen for its growth and production as for other varieties such as the 'Fuerte, Bacon, Zutano, and Reed.' Nitrogen is the most needed element. Many countries report regular use of mixed fertilizers, which include nitrogen, phosphorus, and potassium. Most growers use nitrogen consistently year after year since this is the limiting element in soils. Only one or two countries reported the use of manures.

Summarizing the avocado fertilizer program as practiced around the world, it can be stated that fertilizer materials are used consistently. Growers are selective in what they use. There is a wide choice of materials from which to select. According to production figures, the fertilizer program is satisfactory in most cases. Obtaining fertilizer materials does not seem to be a problem. The price of fertilizers has increased, but the extra return growers receive in the marketplace does not discourage the use of higher priced fertilizer materials. (2 & 3)

Irrigation

Irrigation practices vary from country to country. In tropical areas, irrigation water is used as a supplement applied during the dry season. In those areas the problem becomes one of too much water during a short period of time. However, there are months when trees are growing using only the water stored in soils from rainfall. More and more growers realize the importance of irrigation. They are beginning to provide an irrigation system for supplemental irrigation. In the subtropical and more arid areas, irrigation is a way of life and any rainfall during the year is just a bonus. Irrigation programs are built on a rainfall pattern of usually less than ten inches per year. Also, the ten inches comes within a short period of time, sometimes as short as a two-month period, but in most cases, during a five to six-month period.

Good water quality and sufficient quantity are absolutely required in growing avocados. Very few places around the world have ideal water for growing of avocados. Many countries report a shortage of water, and what water is available, is high in chlorides, sodium, and other salts.

Irrigation methods vary from country to country. There are basically four types of irrigation systems: basin, furrows (also flooding), sprinklers, and drip/trickle. Irrigation is by far the most important cultural practice for the growing of avocados. (8)

Diseases

The number one disease is Avocado Root Rot, caused by *Phytophthora cinnamomi* fungus. The only country where this disease has not been reported is Israel. In Florida, the trees appear to be able to live with the fungus because of the nature of the porous rock type soil in which trees grow. However, in all countries there is the knowledge that before their industry can really increase in size and production, there is a need for finding a control for root rot. Other diseases reported are Sunblotch—the only known virus disease of avocados— Anthracnose, Dothiorella, Verticillium wilt, Cerospora, Scab, and Diplodia. The diseases attack all parts of the tree—roots, bark, trunk, limbs, fruit, and, in some cases, the leaves. Control measures are required. In the case of Cercospora, a fruit rot occurring in tropical humid areas, consistent and frequent sprays with fungicides are needed if fruit quality is to be maintained. There is no cure at the present time for Avocado Root Rot, nor is there a treatment for Sunblotch. Fruit rot fungi can be controlled by the use of fungicidal sprays. In most countries, where humidity and high rainfall is a factor, fungicidal sprays, such as Benlate®, Bordeaux®, etc., are used in disease control (3, 14, 15)

Pests

Pest control varies mainly in areas with different rainfall patterns, and high or low humidity. In California, for instance, there is no spraying of pesticides or insecticides on avocados because the industry enjoys complete biological control of all pests. There are periodic pest flare-ups to the extent that considerable damage is done to trees. It has been the experience in California that these cycles are usually on a three to five year period. Some of the common pests in California are brown mite, omnivorous looper, and latania scale. (9) Other countries with similar climate to California, such as Chile, high elevations of South America, Cyprus, Israel, and other Mediterranean countries indicate that pests are a minor problem. Most of them report mites, thrips, mealybugs, and certain type beetles to be an occasional pest. Generally, the pest situation is in good control. However, in the more tropical areas with humid climate, this not the case. Growers have to spray every two or three weeks for pest control. For instance, in Mexico, one of the most devastating pest is the seed weevil. Eight to twelve sprays a year is required to keep this pest under control. (3)

Weed Control

Weeds are a major problem in most avocado growing areas. The higher the rainfall and humidity, the greater amount of weed control is required. The types of weed control materials, commonly called herbicides, can be divided into three groups: Contact killers or contact herbicides, systemic herbicides, and soil active, or residual herbicides. Examples of contact herbicides are weed oil and Paraquat®. For systemic herbicides there are materials such as MSMA®, Dalapon®, 2,4D®, and the new glyphosate called Roundup®. Soil active, or residual herbicides, applied directly to the soil for pre-emergence control of weeds, are Simazine (Princep®), Diuron (Karmex®), Terbacil (Sinbar®), and Bromacil (Hyvar X®). (4) A material with the trade name of Gramoxone is used in many foreign countries.

Weed control practices vary from country to country, depending on cost and availability of chemicals and labor to carry out the control practice. Weed control is accomplished by hand removal, or in combination with mowing, and by chemicals. Steep hillside plantings present a problem for good weed control practices. A certain amount of native weed growth and/or ground cover should be maintained to prevent erosion of the hillside soil. Machinery is difficult to operate on steep hillsides, so weed control is usually by hand. Where weed oil and Paraquat® are available, the material can be sprayed on by the use of a ground spray rig. In California, only three materials are licensed for use in the control of weeds in avocado groves. They are weed oil and Paraquat® as contact killers and Simazine (Princep®) for a pre-emergence soil application.

Weed control is an important part of good orchard management. Weeds compete with the trees for soil moisture and nutrients. Rodent damage is more severe in weed infested orchards. Operations, such as irrigation, spraying, harvesting, and fertilizing, are more efficient in weed free orchards.

Orchard Thinning—Topping and Pruning

In countries where avocados have been grown for a number of years, one of the more perplexing problems is that of the crowded orchard. Avocados are usually planted on deep, well drained soil and the climatic conditions are such that plants respond very well and grow large. Because of the soil and climatic conditions favorable to plant growth, the avocado tree usually grows large and tall. The problem results from planting trees too close in order to realize greater yields per acre during the first few years of production. As the trees become older, the sides and lower branches of the tree are shaded out, resulting in decreasing production. If the orchard is not thinned out early, four-fifths of the producing area is destroyed. Fruit is produced mainly in the tops of the trees, which increases the harvesting costs.

Solutions to the crowding problem have been worked upon by many people. Orchard thinning is a standard method and appears to be the only feasible and practical answer to this problem. Orchard thinning is the actual removal of every other row on the diagonal in a squarely planted orchard. Pruning or topping the trees during the early life of the orchard is a possible way of training trees so shading does not take place as early as it would were the trees permitted to grow without this operation. Wider planting distances could also be the answer, but experience in California shows that production is not as high on widely spaced trees as those planted closer together. Undoubtedly, this reduced yield is the result of poor cross pollination.

Several systems of orchard thinning have been used. They can be described as follows: progressive thinning, stumping tree by blocks, stumping trees by rows, stumping and topworking by blocks or alternate diagonal rows, and thinning to hedgerows. (10)

LIMITING FACTORS

The factors limiting avocado development and production are soils, water, and climate. The avocado tree is a sensitive plant and will do best under ideal conditions of soils that

are well drained, water that is of high quality, and climatic conditions that are not too hot and not too cold.

Reports from the various countries indicate that the avocado is in trouble if these three factors are not as good as they can possibly be.

Soils

The avocado requires a well drained soil with good depth. This means a sandy loam to a fine sandy loam soil. A depth of from three to six feet above a porous subsoil is most conducive to good root development and subsequently tree development and fruit production. The better drained soils result in less risk of root rot. The report from Florida said that even though the cinnamomi fungus is present in the avocado groves of that state, the trees are able to live with it because the porous rocky structure of the soil prevents the establishment or spread of the disease. In some countries, avocado trees grow in areas where rainfall amounts to 200 to 400 inches of rain a year. Most of this water comes in a relatively short period of time, usually two to four months. If the soil is not well drained, the life of the avocado tree will be relatively short because of the disease factor which always occurs in conjunction with heavy moisture in a soil.

Water

Water quantity, water distribution, and water quality are three factors causing trouble for farmers around the world. The avocado is sensitive to too much water in the root zone, sensitive to too much salt around the roots; and in areas where artificial irrigation systems have not been installed, distribution of water is poor. In areas where growers depend on natural rainfall, the year's total amount is sufficient but insufficient in its distribution pattern throughout the growing season. Another factor that makes it imperative for growers to become more efficient in the art of irrigation is the high cost of water. Some reports indicate a shortage of water, and the development of a water supply is of prime importance to them. California could be an example of how water was developed to cause the desert to actually bloom. The rainfall pattern in Southern California is such that growers cannot depend on it for irrigation. The amount of rain received is insufficient to sustain a viable agricultural industry. Water had to be developed and it was imported hundreds of miles over the desert from a river. As a result the cost of the water is very high. The newest additional water development is from within the state itself, bringing Northern California surplus waters to the deficient water area of Southern California. Water in the San Diego area costs avocado growers from $85 to $150 an acre foot. Once the new California water is received, the cost will be even higher.

Climate

The avocado does not do well in the extreme high temperatures, of the desert nor in the below freezing temperatures of the more temperate climates. Certain varieties of avocados vary as to their susceptibility or tolerance to low temperatures. It is important

for growers to experiment with varieties to determine which are the most productive for a particular climatic zone. In reports from the various growing areas of the world, it appears that not only heat and cold are factors, but wind is another climatic condition that is troublesome. Chilling winds during blossom period will have harmful effects on the setting of fruit.

SUMMARY

In summarizing the worldwide production survey questionnaires, the following subjects caused the most concern to the growers: Varieties, cultural practices, marketing, and what the anticipated future will be. Within each of these categories the problems were constantly pointed out. Before the industry can advance, the problems must be solved. Much work is going on, both at the laboratory and field research level.

Varieties

The ideal variety is not only one that is a high producer for the grower, but it must be tied in with "how does that variety standup under adverse climatic conditions, under pests infestation and disease infections, and the amount of handling the fruit can take on its way to market; and, finally, how does the consumer accept it as a satisfactory product." There may not be one fruit that satisfies all the requirements laid down by the grower, the packer, the retailer, and the consumer. It may mean that four, five, or ten varieties are necessary; but fewer the number, the better job the retailer can do in getting the product to the homemaker. Another important facet of varieties is that in the near future avocados must be in good supply twelve months of the year. This may mean the utilization of avocados from different growing areas moving into similar markets so the volume going to market will be consistent and that a good market development can take place. California, at the present time, has the ability to put fruit into the domestic market twelve months a year. There are months which have a heavier supply of fruit than others. However, each month there is some type of avocado on the produce stand in the markets of the United States. The volume, however, is not great enough yet, even with the combination of Florida and California's crop, to be on every fruit stand in every city, town, and village in the United States. It is estimated that a fifteen to twenty percent potential market is all that is being reached at the present time.

Cultural Practices

Avocado root rot disease is by far the number one problem. Other fungus and virus diseases, likewise, take their toll; but in most cases these diseases can be controlled with persistent and timely treatments. Water is another serious problem and it has to do with quality, quantity, distribution, and cost. Most of the other cultural practices are employed with not too much problem. Fertilizer materials are obtainable. The use of fertilizer is fairly well known even though tests are continuing to determine the best method of application, the best materials to use, and how much materials to apply.

Marketing

High producing orchards mean absolutely nothing unless market development goes hand-in-hand with production. Regardless of how much fruit a grower produces, he gets nothing from it until the homemaker buys it. This means for every effort that goes into improving the yields and the fruit quality at the grower's level, a comparable effort will have to be put into improved fruit handling, which includes harvesting, boxing, transportation to the packing house, the packing operation, including refrigeration and storage, and the final disposition of the fruit through transportation to market, and how it is handled at the retail outlets. The avocado is a fruit that very few people put on a shopping list; therefore, the consumer has to be pre-sold and this is done through good persistent, effective advertising and sales promotion.

Future Outlook

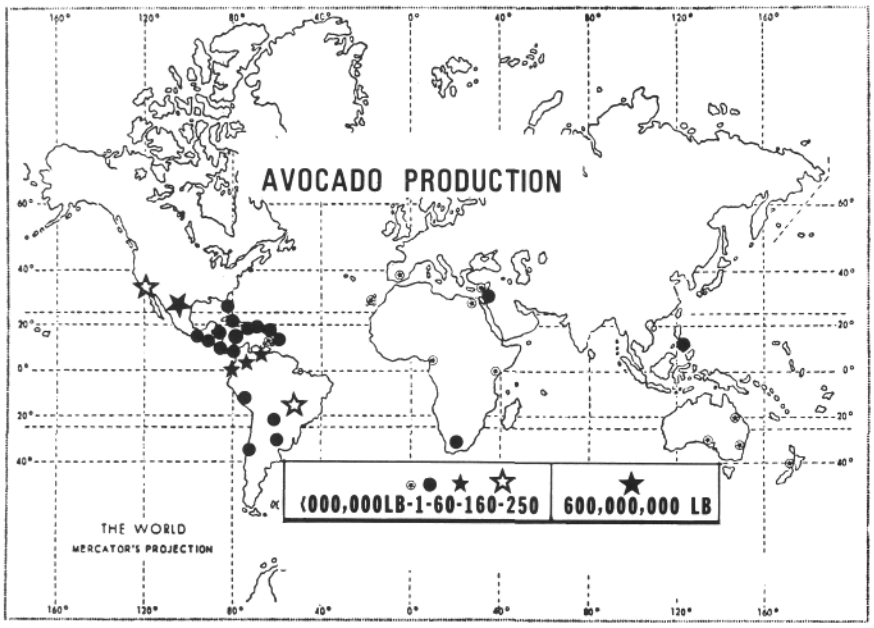
The outlook for the future of the avocado is bright. The number of people in the world using avocados is small. The potential market is fantastic. There is room for more production, but only of the best varieties that can be produced. The varieties should be as few as possible with production occurring every month of the year. (11)

The consumer must become more aware of the avocado—what it is, how it is used, where and when it can be purchased—and this is accomplished through consistent, informative, and effective advertising and sales promotion. This requires great cooperation among growers, marketers, governmental agencies, researchers, and countries producing this unique, delicious, and highly nutritious fruit.

TABLE 1. AVOCADO GROWING BY COUNTRY, ACRES AND PRODUCTION (1, 3, 12)

Country	Acres			Production
	Bearing	Non-Bearing	Total	(Pounds)
North America				
California	25,705	12,954	38,659	200,000,000
Florida	5,600	2,281	7,881	60,000,000
Hawaii	—	—	—	—
Texas	—	—	—	—
South America				
Argentina	1,500	1,500	3,000	9,000,000
Brazil	—	—	42,500	220,000,000
Chile	10,000	4,000	14,000	44,000,000
Colombia	—	—	—	154,000,000
Ecuador	—	—	13,120	66,000,000
Paraguay	—	—	—	44,000,000
Peru	8,750	750	9,500	57,000,000
Venezuela	—	—	18,360	130,000,000
Central America and Caribbean Islands				
Costa Rica	—	—	—	44,000,000
Cuba	—	—	—	44,000,000
Dominican Rep.	—	—	—	44,000,000
El Salvador	—	—	—	60,000,000
Guatemala	—	—	—	46,000,000
Haiti	—	—	—	20,000,000
Honduras	—	—	—	13,000,000
Jamaica	—	—	—	7,000,000
Martinique	1,750	3,750	5,500	9,000,000
Mexico	95,000	35,000	130,000	600,000,000
Panama	—	—	—	4,000,000
Puerto Rico	—	—	—	11,000,000
St. Lucia, W.I.	175	130	305	687,000
Africa				
Cameroon	—	—	325	800,000
Egypt	50	50	100	400,000
Kenya	—	—	100	700,000
South Africa	11,387	7,000	18,837	34,000,000
Zaire	—	—	—	22,000,000
Mediterranean				
Canary Islands	250	100	—	2,000,000
Cyprus	10	80	90	2,500
Israel	5,000	4,500	9,500	52,000,000
Spain	150	600	750	660,000
Australia				
South Australia	10	32	42	55,000
New South Wales	500	400	900	—
Queensland	525	310	835	925,000
New Zealand	—	—	100	—
Philippine Islands	—	—	7,810	44,000,000

TABLE 2. AVOCADO PRODUCTION



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