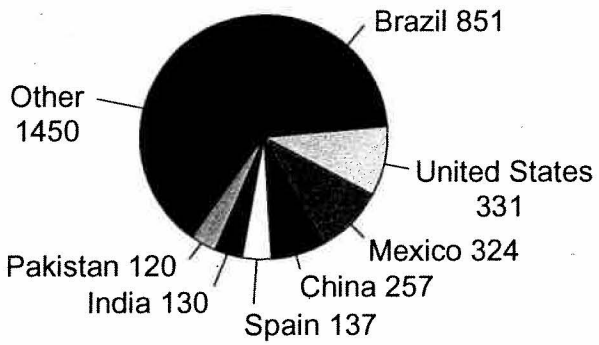
Oranges *Citrus sinensis*

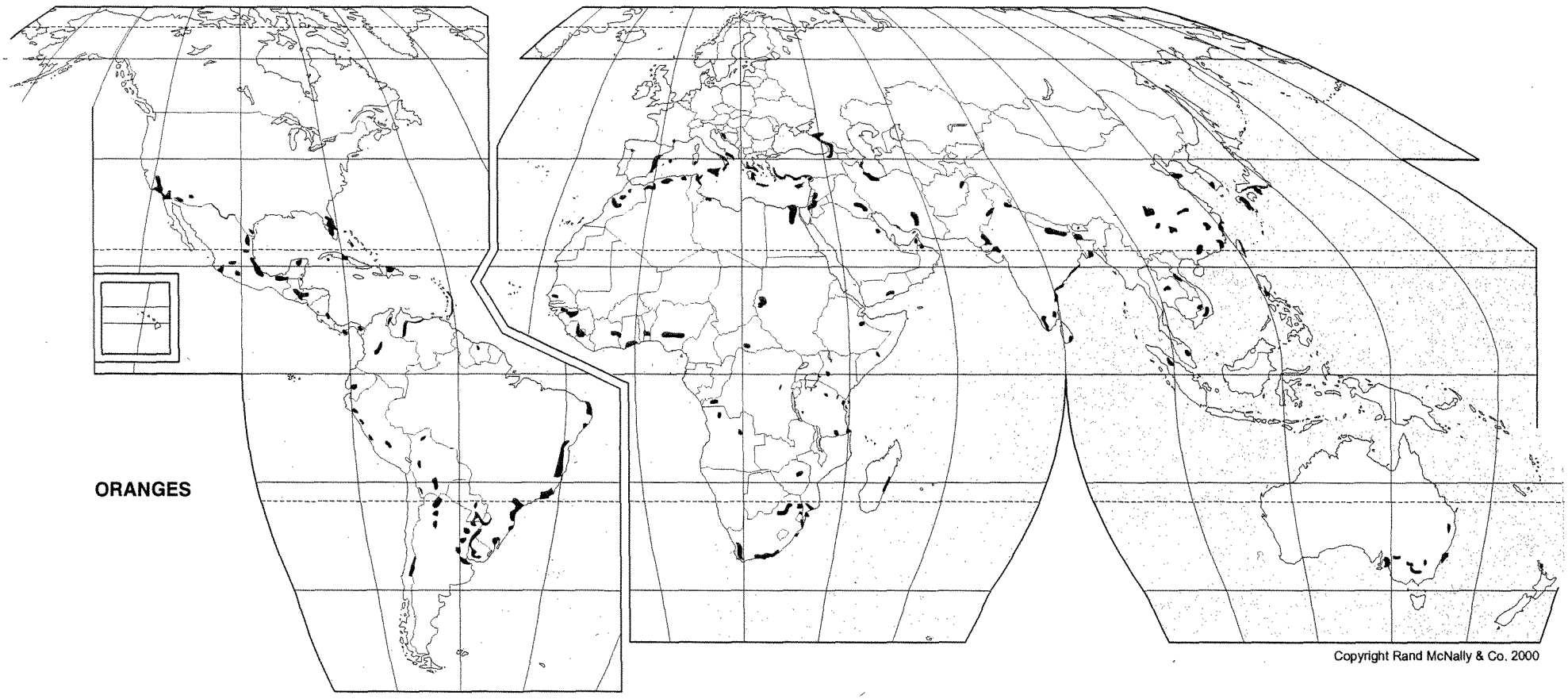
Production	
Area Under Cultivation	3.6 million ha
Global Production	62.4 million MT
Average Productivity	17,330 kg/ha
Producer Price	$219 per MT
Producer Production Value	$13,662 million
International Trade	
Share of World Production	13%
Exports	8.1 million MT
Average Price	$579 per MT
Value	$4,691 million
Principal Producing Countries/Blocs (by weight)	Brazil, United States, Mexico, India, China, Spain, Iran, Italy, Egypt, Pakistan
Principal Exporting Countries/Blocs	
Oranges	Spain, United States, South Africa, Morocco
Orange Juice (concentrated)	Brazil, United States, Spain, Costa Rica, Belize
Orange Juice (single-strength)	Germany, Belgium, United States, Netherlands
Principal Importing Countries/Blocs	
Oranges	Germany, France, Netherlands, United Kingdom, Russia, Saudi Arabia
Orange Juice (concentrated)	United States, Canada, France, Korea, Saudi Arabia
Orange Juice (single-strength)	France, Belgium, Netherlands, Germany, United Kingdom
Major Environmental Impacts	Conversion of habitat Use of agrochemicals Soil erosion and degradation Wastes from processing
Potential to Improve	High Planting occurs mostly on existing agricultural land BMPs are cost effective, reduce input use and increase production

Source: FAO 2002. All data for 2000.

Oranges

Area in Production (Mha)





Main areas of production - often interspersed with other citrus

Chapter 6

Orange Juice

Overview

For many consumers, orange juice is part of a complete breakfast. Orange juice is perceived as a very nutritious food, one that is particularly important to consume in the winter as a way to avoid colds (though in fact, there are far better and cheaper sources of vitamin C).

The orange is an evergreen tree originally native to Asia. It was brought across the Middle East and North Africa and introduced into Europe by the Moors in Spain. This is where the Seville orange came from. Oranges were first introduced into the New World in the early 1500s, but did not become a commercial crop for some 350 years. According to the Food and Agriculture Organization of the UN (FAO 2002), by the year 2000, citrus (which is mostly oranges) was the most-produced fruit in the world with a 22.5 percent share of all fruit produced. The most common oranges cultivated at this time, which provide most of the sweet oranges and juice sold in the world, are several different varieties of *Citrus sinensis.*

There has been a market for orange juice for about 100 years. While fresh oranges are produced throughout the world, it is really Florida growers who created the bulk orange juice market. This was done as a way to sell their product throughout the year in order to avoid glutting the market during the harvest. In the past, Southern California (e.g. Orange County) also produced a lot of oranges, but now real estate development and water shortages have reduced production there. In the 1970s severe frosts in Florida ruined harvests, and buyers began to look further afield to find sources of oranges for juice. At that time, significant production started in the states of São Paulo and Paraná in Brazil's Atlantic coastal forest area. Most of the lands that were ultimately planted with oranges had previously been used to grow coffee.

Overproduction of juice globally now characterizes the fresh and frozen orange juice markets and contributes to declining prices. However, diseases in Florida and Brazil are reducing production and increasing production costs, and production there is expected to decline by 25 percent within the next five to ten years. In all likelihood, this will stimulate a new wave of planting and production in other countries.

Producing Countries

The countries with the largest areas planted to orange trees include Brazil (850,875 ha), the United States (330,850 ha), Mexico (323,618 ha), China (257,200 ha), Spain (137,000 ha), India (130,000 ha), and Pakistan (120,000 ha). Brazil has about a quarter of all land worldwide planted to oranges and produces more than 28.8 percent of the 62.4 million

metric tons of oranges produced globally. The other six large producers have nearly 36 percent of the area planted to oranges globally and produce nearly 36 percent of all oranges annually (FAO 2002).

The data on orange production is somewhat complicated. For example, the primary fresh orange exporters in 2000 by volume were Spain, the United States, South Africa, and Morocco. The main orange juice concentrate exporters were Brazil, the United States, Spain, Costa Rica, and Belize. By contrast, Germany, Belgium, the United States, and the Netherlands are the largest exporters of single-strength, or non-concentrate orange juice.

Globally, Brazil and the United States dominate orange juice production, and combined they accounted for 87.3 percent of total frozen concentrate in 2000 (FAO 2002). Since the 1980s, however, Brazil has been the single largest producer. In 2000 Brazil produced 22.74 million metric tons of oranges, which amounted to 34.4 percent of global production. About three-quarters of all Brazilian oranges are crushed for juice. Brazil produces 47 percent of the world's frozen concentrated orange juice and accounts for more than 80 percent of global exports of frozen orange juice concentrate. Oranges represent 25 percent of total agricultural value in São Paulo state, and 5 percent of all Brazilian agricultural production (Neves et al. 2001).

The United States produced about half as many oranges as Brazil in 2000 (11.9 million metric tons) and accounted for about 18 percent of global production. Mexico, India, China, and Spain add another 6 percent to global production.

However, orange and orange juice production can dominate small countries' exports even if the amount exported is not significant globally. For example, oranges are the second most valuable export in American Samoa, Belize, and Dominica, and the third most valuable export in the Cook Islands, Cyprus, Morocco, and Swaziland (UNCTAD 1994).

In addition to frozen orange juice concentrate, most producers also export a number of other by-products. These include frozen orange juice (not concentrated), fresh oranges, pulp pellets (used mainly for animal feed), and essential oils (used as food flavorings and in personal care products and household cleaners). In the case of Brazil, the combined value of all these items is only 7 percent of the value of that country's frozen orange juice concentrate (Neves et al. 2001).

Consuming Countries

The main consumers of orange juice are the United States, Europe, Brazil, Canada, and Japan. The United States first developed the frozen orange juice market and dominated production until the 1980s. It still consumes half of the orange juice produced in the world but now must import an increasing proportion of its juice. Brazil supplies 90 percent of U.S. imports, or about 757 million liters (200 million gallons) per year. The European Union adds about a third of global imports, and Canada and Japan about 5 percent each.

Germans consume an average of 45 liters of orange juice per person per year (Neves et al. 2001) while Americans consume 22 liters and Brazilians only 9 liters. After the United States, the main importers of orange juice are Germany and the rest of the European Union, Japan, Canada, and South Korea. India, Indonesia, Mexico, and a few other countries are also large consumers of orange juice, but because they do not import the juice and their domestic production is not exported they are underrepresented in most statistics.

In addition to being a large producer and consumer of orange juice, the United States is also a large importer of orange juice. In some cases, at least, the juice appears to be repackaged and exported as a U.S. product.

Production Systems

Orange juice is produced from monocrop plantations. In some parts of the world, natural habitat is cleared to plant orange trees. In most countries, such as Brazil, orange juice production comes from plantations that are instead planted on already-cleared lands formerly used for another crop.

The main varieties of oranges grown in Brazil are Pera, Hamlin, Parson Brown, and Natal. In Florida they are Temple, Parson Brown, Pineapple, Hamlin, and Valencia (similar to Pera). The harvest season in Brazil is from July through January; in Florida it is from November through June.

Orange seedlings are started in nurseries and then transplanted into grid planting systems in the field. Organic and/or synthetic fertilizers are applied during the planting. Heavy liming is required for the production of oranges in many areas as well. In some countries, other crops are planted between the rows before the trees grow to maturity. Once the trees begin to cover the area, these other crops are eliminated and grass or other ground cover is grown to prevent soil exposure and erosion. Leguminous ground cover is used in some areas.

Production begins in a few years, but more serious production occurs after five to seven years. Trees will produce for thirty or more years depending on how well they are maintained. Every year several activities must be undertaken to ensure both short and long-term production. Orange trees are pruned at least once per year to encourage proper spacing of branches and to maximize production. Oranges require direct exposure to sunlight for the fruit to ripen properly. Traditionally, several forms of agrochemicals are used to produce oranges. Fertilizers and lime are applied each year or as needed. In addition to these tasks, ground cover and irrigation systems must be maintained.

During periods of declining prices, producers often cut production costs by forgoing some of these expenses. As prices pick up, producers tend to pay more attention to their trees, but the productivity of untended orchards cannot be turned around overnight. As a consequence, production on untended estates tends to continue to fall even as prices rise. In other instances, producers with a longer-term view appear to be willing to cover their

marginal costs in bad years in the hopes of having a few good years. Unfortunately, generally declining prices have tended to squeeze producers' profit margins over time.

On a per-hectare basis the orange industry is one of the biggest users of pesticides. Trees are sprayed several times during the flowering and fruiting season to prevent insect damage. Chemical spraying is also undertaken to prevent mold, which can affect the leaves and the overall heath of the trees. In Brazil orange trees account for 6.5 percent of all pesticide use, but they account for the largest pesticide use per hectare of any agricultural crop (Neves et al. 2001).

Oranges are usually picked in the early morning or late afternoon in order to avoid having the picked fruit sit in the heat of the fields during midday. Oranges are picked by hand and consolidated first into wooden boxes and then into larger tractor-pulled trailers. Small producers tend to transport their production to elevated pickup points along major roads so that the trucks can pass underneath and gravity can be used to load the product. Trucks from a processing plant pass by the pickup point, or by the farm, to collect the fruit. Trap doors are opened in the storage bins so that gravity will allow the oranges to flow down into the larger trucks below.

Because heavier oranges produce more juice, the price paid to producers depends partly on the weight of the fruit. While farmers are paid according to the solid weight of their oranges, the standard unit of measure of oranges is a "box." Each box weighs more or less 40 kilograms (90 pounds) depending on the overall juice content. Farmers receive a premium or are penalized depending on the weight of the box, which gives an indication of the average weight of the oranges contained within.

Citrus groves are huge investments to establish. Costs have been estimated at U.S.$17,500 or more per hectare in developed countries (Barham 1992). It generally takes about five years for the trees to produce substantially and about ten years of operation to pay off the original investment. Discounted and averaged over the cost of the grove, initial capacity costs are approximately 50 percent of the annual grove operating costs (e.g. weeding, trimming, fertilizers, pesticides, and irrigation). Harvesting and transportation costs are generally equal to the annual operating costs (Barham 1992). The high cost of entering or leaving the market tends to discourage large fluctuations in area planted and output, other than those caused by freezes in Florida or drought in Brazil.

Producers are attracted to oranges because of the profits. In Brazil oranges produce 1.7 times the income per hectare as coffee, nearly 3.5 times that of sugar, more than 5 times that of soybeans, 6.5 times that of corn, and 9.5 times that of wheat (Neves et al. 2001).

In the 1980s Brazil and the United States accounted for 98 percent of the U.S. supply of frozen orange juice concentrate. Brazil's share rose rapidly from 10 percent in 1980 to 50 percent of the U.S. market in the late 1980s, which amounted to a third of the global market. Since then, other suppliers (such as Belize, with 1 percent of U.S. market share) have reduced Brazil's margin to the low 90 percent range (Barham 1992).

The largest orange juice producers in the world are Brazilian companies; Montecitrus is one example. These companies dominate the global market. Montecitrus and other large Brazilian companies are already producing certified organic orange juice and dominate that market as well. They expect to produce a combined 12 million boxes (45,000 metric tons, or more than 100 million pounds) of organic citrus per year. One trend of note is that by 2002 the cost of orange production had increased relative to price in Brazil and the United States. Both countries are expected to reduce production in the near future at least relative to international demand.

Citrus is an ideal crop for production on smaller plantations because, unlike large-scale producers, small producers can use their own labor to cover many of the expenses associated with establishing plantations. The major bottleneck for small producers, however, is the cost and volume of production required to run a processing facility. Given that such facilities now exist in many areas, perhaps it is time to contemplate a new form of either cooperative ownership or employee stock option plan (ESOP) for processing plants. Given the international interest in chain-of-custody issues, even juice manufacturers or grocery store conglomerates may decide that it would be wise to invest in such facilities as a way to ensure supply quantities and quality.

Processing

The orange processing industry is highly concentrated. Four Brazilian family-owned companies control more than 50 percent of global supply. Three factors account for this: the importance of market connections to the viability of processing plants, the substitutability of products produced in different countries, and the fact that there are few differences in processing throughout the world.

Oranges should be delivered to the central processing plant and processed within twenty-four hours of picking. Due to their overall volume, oranges are transported from the farms to central processing plants by large semitrailer trucks. In the case of very large estates or plantations, the central processing plant may be owned by the farm itself.

Oranges are pressed in such a way as to maximize the juice recovery and minimize the release of acid from the peel. The overall value of oranges is based on three factors: their total juice content (determined by weight per volume), juice color, and juice sweetness. Fruit juice sweetness is measured in units called "brix", which are an indication of the sugar content in the product. In general, heavier fruit with juice that has a good color and is high in sugar is the most valuable. In fact, in the United States, up to 10 percent of orange juice can come from tangerines to enhance the color.

Once processed, orange juice can be sold fresh, fresh frozen (e.g. not concentrated), pasteurized, or made into a concentrate that can also be sold fresh or frozen. Concentrate is produced by using evaporation to reduce the water content of the juice from 89 percent to 34 percent. (This leaves the soluble solid content of the product at about 66 brix for Brazilian juice; from the United States it tends to be a bit lower, at around 42 brix.) Most

juice that is traded internationally is concentrated and frozen, and most of it is blended from the juice of many producers selling into a central processing plant. In many cases, juice is also mixed in other countries as well, e.g. a certain percentage of orange juice from Brazil can be mixed with that produced in Florida and still sold as U.S. product.

Because the harvesting seasons in Brazil and the United States complement each other, there is, in effect, fresh fruit throughout the year. This means that frozen orange juice concentrate does not have to be stored for long periods of time. Freezing and transporting liquid are both energy intensive. Orange juice is one of the lower value agricultural commodities that is frozen and transported great distances. This is why the concentration method was developed, so that water was not being frozen, shipped, and stored around the world.

Substitutions

While juices from different fruits have very different flavor profiles and nutrients, almost any juice can be a substitute for any other juice. Through advertising and branding programs, even markets for the same juice can be differentiated. Branding and advertising, however, tend to reduce the portion of the juice dollar received by the producer and may reduce the absolute value to producers as well.

What is happening is that the overall consumption of juices, soft drinks, bottled water, and other liquids has skyrocketed. Orange juice consumption has continued to grow, but it is losing market share to many other beverages. In Brazil, which is the largest orange juice producer in the world, orange juice now represents only 4 percent of the total beverage market (Neves et al. 2001).

Overall, demand for orange juice has continued to grow. In fact, blends of orange juice with other fruits are increasingly common on the market. This has not resulted either in a decline in the consumption of orange juice or an increase in returns to producers.

Market Chain

The orange juice market chain is dominated by large international juice companies. Such companies tend to be heavily invested in costly processing plants in most major areas of production. In Brazil, some of the largest producers also own processing facilities and have been able to compete on international markets. Most of the big juice companies work directly with supermarket chains, retail food services and outlets, and institutional buyers. In some cases, joint ventures have been developed that involve the entire chain from producer to retailer.

There has also been increasing concentration of the orange juice industry at the processing level. The expansion of the Brazilian orange processing industry into Florida has been very calculating. Several of the largest processing plants have been purchased.

Initially, independent growers are paid higher prices for their product. Paying higher prices deprives smaller processors of supply, eventually forcing them out of business. Once the competition is eliminated the larger processors drop the prices paid to producers to rates that are lower than they had been prior to the initial purchase of the first processing plant.

Most recently, the juice companies have been subject to buyouts, as many grocery store chains are beginning to buy equity in some of their key suppliers as a way to guarantee supply and quality as well as potentially hamper their competitors. This, coupled with increasing concerns about product quality, may well change the overall market chain, concentrating power in a few key players while making the entire chain more vulnerable at the same time.

Market Trends

Orange juice consumption is increasing; in fact the consumption of juices in general is increasing. Consumption of frozen orange juice concentrate is expected to expand at only about 1.5 percent per year or less in the United States and Canada. However, growth in the rest of the world is expected to be about 4 percent per annum (J.F. Chaumont 2002).

The only FAO-designated food category to increase in both area and total production faster than vegetable oils since 1960 is fruit production. Between 1961 and 2000 orange production increased by 193 percent, while the volume of oranges traded internationally increased by 198 percent. During the same period, the price of orange juice declined by 61 percent (FAO 2002).

Through the 1990s Brazil came to dominate more and more of the international market as an increasing amount of the orange juice produced in the United States was consumed in that country. There are signs, however, that orange productivity in both the United States and Brazil will decline. Since consumption is not likely to decline proportionately this will most likely be accompanied by a shift of production to other areas. If this new production takes place in natural habitat it will have substantial environmental impacts.

The price of orange juice is rather sensitive to changes in total production. For example a 10 percent increase in production will tend to reduce price by more than 10 percent at the wholesale level. Some projections suggest that aggregate global production will increase faster than demand for the next several years. This is happening because many younger trees are coming into full production.

One of the major trends is for Brazilian orange juice and concentrate to be blended with that produced in the United States and then sold domestically or even exported as an American product. Sources within the industry indicate that as much as 25 percent of the orange juice sold in the United States is actually produced in Brazil.

The United States currently has a tariff in place to protect the domestic orange juice industry from lower-cost Brazilian producers. This tariff currently amounts to about

$0.20 per gallon. If the tariff is eliminated, Florida growers will receive that much less for their orange juice. It is doubtful that, given their higher cost of production, they could still compete. However, producers in Belize, Costa Rica, and Mexico benefit from this tariff as well. If it is eliminated, then production in those countries will no longer be viable either.

At this time, the cost in Florida to produce the equivalent of a gallon of juice delivered to a processor is U.S.$0.99 per gallon. With the tariff in place, the cost of delivering a gallon of juice from Brazil is about U.S.$1.06. However, if the tariff were to be eliminated, the Brazilian industry could deliver juice to Florida at a cost of only $0.78. Under current regulations of the World Trade Organization, this tariff will have to be phased out. Such a phase-out would mean a significant shift in where oranges are produced globally. Such a shift in production would have environmental implications, not only due to the expansion of orange cultivation into areas of natural habitat in some areas but also because of contraction in others where producers could be forced to move into much more damaging annual crop production in order to make the same levels of income.

Five families in Brazil control the citrus industry. If the tariff in the United States is removed, they are expected to relatively quickly double their plantings, just as they did in the 1970s and 1980s after freezes destroyed orange production in north and central Florida. However, four of the five key Brazilian citrus-owning families also now own 40 percent of all processed production in Florida. It is not exactly clear where they stand on the tariff issue (Layden 2002).

Environmental Impacts of Production

The production of oranges has two negative environmental impacts—the conversion of natural habitat for the establishment of orange groves and the use of inappropriate production practices which have impacts for as long as production occurs. Significant changes in biodiversity and ecosystem functions result both from the conversion of natural habitat as well as the ongoing degradation of soil and the elimination of biodiversity within producing orange groves. The degradation of soil also makes it more difficult for producers to use inputs (e.g. fertilizers, pesticides, and water) efficiently and to control the levels and content of effluents coming from orange groves.

Habitat Conversion

The citrus industry in Belize illustrates some of the important environmental issues that arise from the orange juice industry. From 1984 to 1994 the industry expanded from an area of less than 12,000 hectares (30,000 acres) planted to oranges to some 23,000 hectares (57,000 acres), nearly doubling the total area in one decade. As the industry has expanded it has grown out of the better-suited river bottoms up the steeper slopes along both sides of river valleys and into forested areas of the watershed. Most of these lands had not been used for agricultural production. And even though oranges are a tree crop, the areas they are planted in are marginal, at best, for orange production. If such lands are

not managed very well there is likely to be significant soil erosion and downstream siltation, as well as little long-term orange production. And of course, conversion of natural habitat always brings a reduction in species diversity.

In one area of Belize, some 450 small farmers are involved in orange production. More than half of all the land planted on their holdings (average size of about 6.8 hectares or 17 acres) is planted to oranges. About a quarter of the farmers own their land, another quarter have short-term leases, and half have long-term leases from the government. These farmers clear an average of 2.2 hectares (5.4 acres) per year. It is estimated that as many as 240 hectares (or some 600 acres) of mature forests on hillsides are cleared by these farmers each year. Most producers are focused exclusively on orange juice production. As prices decline, focus is shifting to other products as well.

It is not clear that hillside plantings are sustainable either economically or environmentally in the long term. What is clear, however, is that hillside production requires greater inputs (e.g. fertilizer and labor) than in the lowlands. It is also clear that hillside production also causes greater environmental damage because the soils are more erodible. At current prices of U.S.$3 per box, it appears that hillside farms are viable only when farms are small enough (e.g. less than 2.5 hectares or 10 acres) that all the labor can be provided by the family.

Impacts of New Varieties

Another potential development in the orange and orange juice industry is the adoption of new, higher-priced varieties that have more significant environmental impacts. One example is the growth in demand of blood oranges that require cold periods to develop their deep red color. This plant could do very well on the steep highland areas of Latin America, Africa, and Asia and therefore must be viewed as a potential threat to such areas. Currently, some of this land is devoted to high quality shade-grown coffee. However, with the extremely low price of coffee, these areas might be converted to such a higher value crop. The potential range of blood oranges, however, goes even further since they actually require colder temperatures to produce the highest value fruit. Most of this land has not yet been converted for agricultural use. For now, however, blood orange demand is limited primarily to Europe and is supplied mostly by Spain.

Even for conventional oranges, however, there is a general consensus after decades of production that quality citrus with its unique, deep orange colored juice does not develop in tropical areas. Such color is the result of low temperatures that trigger the orange coloration, and these temperatures are not found in typical tropical areas. Therefore, expansion of citrus for both juice and fresh fruit is expected to continue only in areas with a consistent period of cold temperatures as is found in Southern Brazil and for which even parts of Belize are also known. In the future, however, it should be easy to plot out those tropical areas that have the appropriate temperature and rainfall and that might be targeted for expansion, particularly if diseases known to be affecting production in Brazil cannot be brought under control.

Even Honduras, which sits next to Belize, has been unsuccessful in its attempts to produce export-quality orange juice and other citrus. The industry has simply not been able to compete in producing the quality product that is required for premium prices. Honduran citrus projects have ended up supplying local markets. The country's exports to the United States are limited to lower-grade backup juice or periods when there is a freeze in the main producing areas either of the United States or Brazil.

Use of Pesticides and Inorganic Fertilizers

Orange production requires more intensive use of a wide range of pesticides than any other major commodity including bananas. Only horticultural crops have higher input use per hectare than oranges. However, oranges produced for juice require far fewer pesticides than those sold as fresh fruit.

In Belize a number of pesticides are used in the cultivation and production of oranges for juice. In 1994 most commercial orange cultivators in Belize reported the frequent use of the following pesticides: paraquat, fosetyl-al, 2,4-D, glyphosate, aldicarb, diuron, propiconazole, ethoprop, ethion, malathion, phoxim, terbufos, and chlorpirifos. Paraquat, diuron, and glyphosate are broad-spectrum herbicides that kill all types of vegetation; the use of these three chemicals suggests that the technical recommendations to producers have been to maintain clean fields of monoculture crops with the possible exception of species planted for ground cover. Clean production systems have tremendous impacts on biodiversity (both resident and mobile, both in the soil as well as on it) as well as soil erosion and the overall need for chemical inputs.

The application of inorganic fertilizer, coupled with a clean fields approach to cultivation, has had perhaps the single largest impact on the environment. Orange production on clean fields results in ever decreasing levels of soil carbon. As a consequence, any chemicals applied to the soil are more likely to be washed off as effluents before they can be utilized by plants. Even the application of foliar fertilizers, while meeting the needs of the trees, may result in the degradation of soil so that it has diminished ability to utilize and take up the fertilizers. In addition, chemicals subsequently leach into waterways and lagoons.

Processing Waste

Considerable waste is generated by orange juice production. While the weight of the waste is less than that of the juice, the volume is far greater. Such wastes have become very large disposal and environmental issues in many countries. In fact, most processing plants have mountains of peels and pulp that begin to smell. Waste also can become vectors for the breeding of insects that can cause diseases.

Better Management Practices

Given that orange production is likely to expand to many parts of the world as production declines in the United States and Brazil, it will be important to work with producers and governments in those areas to minimize the overall environmental impacts of production. Areas of steep slope should not be converted from natural habitat to orange production. In several of the major producing countries (e.g. the United States, Brazil, and Spain) production areas are mostly gently rolling or flat. In these countries, orange groves are rarely planted in areas with more diverse features such as steep slopes. In the past, in fact, orange production has taken the place of other crops. However, as demand expands, some countries may be tempted to encourage citrus production in suboptimal areas that are homes to a wider range of biodiversity that should be protected.

In addition to the adoption of better practices during orchard establishment, they should also be employed during on-going management. For example, ground cover should be maintained at all times and every effort should be made to utilize cover crops that increase both nutrients and organic matter in the soil and that reduce soil erosion. The adoption of many, if not all better practices is driven by efforts to cut costs in an increasingly competitive industry. Innovation is driven by economics, not ethics. There is little or no room for error in many markets.

Nowhere is this more obvious than with water. Given the shortage of water in many orange producing areas, the reduction of overall water use will also be an issue for many orange producers. In Florida, for example, orange producers are required to install and use drip irrigation. All the water used on one Florida farm is recycled and reused. No surface water is allowed to enter the environment directly. In other farms, the goal of water management is to ensure that the quality of water leaving the farm is better than what is coming in and effluents are currently measured for levels of phosphorus, nitrogen, suspended solids, and key pesticides.

Reduce Use of Agrochemicals

One strategy used by many citrus growers to reduce their dependence on and use of chemical pesticides has been to incorporate new varieties of oranges that are more disease resistant. They also graft more productive varieties onto hardy rootstock. These strategies are viable options for those who want to control some of the more difficult citrus diseases.

In Japan, one of the most capital-intensive citrus production systems has been developed for satsumas (also called Mandarin oranges). Many satsuma farms are covered entirely by greenhouses. Even the drain water is collected and pumped back onto the crops. Very few pesticides are used. Since the greenhouses are intermixed with citrus grown in open, existing groves, one barely notices them. In short, every effort has been made to close the production system and this has resulted in a very clean, low-input production system that recycles most of its waste and by-products. While such a system could not be imported whole cloth into many orange producing areas producing bulk juice, it is likely that many specific practices may. For example, catching and recycling water in a water scarce world

will make increasing sense. Likewise, capturing agro-chemical inputs in water runoff for reuse makes sense.

In Florida, one orchard has reduced spraying from an average of 22 to 24 times per crop to 10. Orchard managers use IPM, the breeding and release of ladybugs, and the incorporation of hursatelia to reduce chemical interventions. Most of these approaches require that producers anticipate and prevent problems rather than following a strategy of trying to catch up with them later. Consequently, producers must monitor their fields and anticipate issues by paying close attention to warning signals. Increasingly, such farms employ professional scouters to undertake this work. The company reports that professional scouters are more attentive to details and changes than regular employees who are responsible for a number of different activities. Scouters are kept on retainer and their sole purpose is to visit fields and observe which pests are becoming problems in which areas of the groves. One farm manager reports that through better timing and targeting, he has reduced spray costs by 20 to 25 percent with scouting.

A Florida producer suggests that the reduction of pesticide use has resulted from a fundamental change in attitude. Most producers have found that even if they are producing only oranges, they need to be creating polycultures. What this means is that in addition to growing oranges, producers have to create or maintain conditions for beneficial organisms as well as problematic ones. For this reason, whenever producers are forced to use chemicals such as copper and sulphur compounds, they kill the beneficials, too. The goal is to provide conditions where both beneficial and problematic organisms can exist but in balance. Spraying is an indication that the proper balance has not been maintained.

In order to monitor pests and treat them more effectively, producers need information that allows them to make more precise analyses and interventions. One 1,600 hectare (4,000 acre) Florida orange farm, for example, is divided into lots, the smallest of which are 110 acres. These lots allow managers to trace problems and input use to specific areas and even specific workers. Managers now realize that they need to keep records for even smaller areas so that they can make informed production decisions. With better, targeted data they can see that some areas require more inputs and efforts than their yields justify, and they are beginning to cut down trees in such areas.

Producers prune and manipulate trees to increase production or to reduce the overall cost of production. For example, trees are trimmed around the edges and the top to make picking easier. In addition, many producers "skirt" trees, a process that consists of trimming the lower branches so that the lowest branches are half a meter from the ground. This allows air to flow into the tree branches which in turn reduces fungus and mold and the necessity to spray to eradicate it. One negative side effect, however, is that the increased space lets in more sunlight and as a consequence more weeds grow under the trees which are then killed with herbicides. The lesson here is that there are tradeoffs between BMPs and the question becomes which practices are less harmful than others. In this case, which types of sprays are less toxic, fungicides or herbicides.

Reduce Soil Erosion and Degradation

Regardless of the terrain on which orange trees are planted, grass lanes are recommended as a way to minimize erosion and to contain chemical-laden runoff. One recommendation is to keep only a small ring of cleared area under each tree that can serve both for fertilization and for harvesting.

Deliver Better Information and Incentives to Producers

In the global market, Costa Rica is a small producer of orange juice. The country experimented with organic orange juice, but it was not an overwhelming success. In the past, the strategy of the main orange juice company and the farmers producing for it had been to focus on processing and marketing their product rather than to work to improve the production base—the trees. Over time production declined, increasing numbers of trees became diseased and died, and the cost of production increased while overall production declined. Many producers were forced to abandon the businesses altogether.

Tico Fruit, the most successful juice processor in Costa Rica, has taken a slightly different path. The lessons that can be drawn from its experiences could be significant for producers in other parts of the world. Costa Rica has 14,000 hectares of oranges planted on more than 1,000 farms. Tico Fruit accounts for 75 percent of all orange juice produced in the country. While it owns only 25 percent of all land planted to oranges, it produces 50 percent of the country's juice from its own production. It buys oranges from other producers to produce an additional 25 percent of all production in the country.

Tico Fruit has come to two important realizations. First, it cannot produce all the fruit that it can process. And, second, healthy trees require very few chemical inputs. As a result of these realizations, the company has begun outreach programs with the farmers that sell to it. The company knows that the best way to increase its output of juice is to help all of its suppliers increase their production of oranges as well as their net profits from orange juice production.

Toward this end, the company has its buyers provide technical assistance to each farmer in order to help them improve production. This assistance takes three forms—plantation diagnostics, recommendations of specific technical packages or plans of action to address the problems, and support during implementation. The company's assistance is undertaken on a farm-by-farm basis. Tico Fruit buys all the materials required by all farmers in bulk and then extends them in the form of credit to local producers. In this way, the company is assured an increasing supply of fruit, and producers benefit from the lower prices that result from buying in bulk. As a result of the company's efforts, Tico Fruit producers have increased their net income to U.S.$4.20 per tree, as compared with a net income of $1.01 for other producers, as shown in Table 6.1.

In general terms, the health of trees is achieved by making nutrients available to them. For this reason, the company's approach is to feed and maintain the soils in such a way that the nutrients are released for the trees to use. The main inputs are lime and chicken

manure. These inputs, when applied correctly, encourage soil microorganisms that are important to healthy soil and trees.

Table 6.1 Orange Juice Production and Costs per Tree in Costa Rica
(in U.S. dollars)

	Tico Fruit Producers	Other Producers
Cost per tree to establish plantation	3.00	1.00
Production (boxes/tree)	4	1.3
Average weight per box (kilograms)	2.3	2
Solid weight per tree (kilograms)	9.1	2.7
Price per solid weight	.50	.50
Gross revenues per tree	10.00	3.00
Harvesting cost per tree	.70	.70
Total net income per tree	4.20	1.01

Source: Interview with Tico Fruit staff 2001.

Company employees/extension workers explain to the farmers that the more synthetic fertilizers they use, the more they will have to use over time as they reduce both the nutrients created in the soil as well as their trees' ability to absorb them. Use of highly concentrated, synthetic fertilizers causes imbalances in nutrients, overall nutrient availability, and microbes in the soil. To be corrected quickly, the imbalances are treated with other fertilizers and producers lurch from one application to another. A better long-term strategy is for producers to find a better balance between tree needs and soil dynamics so that the soil and the tree can work together to meet the tree's needs.

Tico Fruit wants the producers to supply the company with increasing amounts of fruit. For this reason the company is cautious about converting to organic production methods. Company officials are not convinced that organic production is sustainable either environmentally or financially. A recent study supported by the FAO comparing organic and conventional orange production in Spain suggests that net returns from organic production are considerably lower for producers because many costs are higher and overall production declines over time from organic orange production systems (Igual and Izquierdo 2001). As it is, the company claims that it has helped its suppliers reduce their overall use of agrochemicals by 75 percent or more, which contributes to the overall increase in their profits. The timely application of limited amounts of agrochemicals appears to be essential to this success.

The Tico Fruit program to reduce the use of agrochemicals and their impacts within the orange juice industry is an excellent example of how a buyer can work with its producers to improve their production practices. Such partnerships can result in reduced environmental impacts, and both producers and buyers can increase their profits. Other companies, large or small, should travel to Costa Rica to see this program and adapt the

lessons learned to their own circumstances. Such industry-to-industry exchanges are often the most effective way to explain how and why a program works as well as the financial implications.

Reduce Processing Wastes

In the United States and Brazil, methods have been devised to grind the waste from orange juice production so that it can be incorporated into animal feeds. It is, in fact, for this reason alone that Florida has long been one of the states with the most beef cattle finished in feeder lot operations in the United States.

Such waste processing programs are not limited to the United States, however. The Tico Fruit processing plant in Costa Rica is the most advanced in all of Latin America. It produces feed pellets from its orange waste that are sold to the cattle industry. What was a potential waste problem and a disposal cost is instead a stream of income for the company and a useful product for neighboring farmers. The operation, in fact, produces a net revenue stream for the business and has a positive impact on the bottom line. In Belize, by contrast, peels from orange juice production are still a major waste problem.

Aside from converting pulp to animal feed or using it as organic fertilizer amendments, it can also be used as a source for essential oils that have high commercial value as fragrances and flavorings. Pectin, which is important in commercial production of jams and jellies, can also be extracted from the pulp. The orange juice industry also produces seeds that contain antibacterial and fungicidal properties and so can be used to manufacture innovative new pesticides for many crops. The isolation and production of these valuable by-products is now an increasing part of the industry and is integrated into the processing system in such producing countries as the United States and Brazil. Unfortunately, the production of some of these by-products requires significant investments and/or scales to be profitable. This could tend to make larger processing companies more financially viable than small ones. Still, as all these ways suggest, organic waste can be minimized.

Outlook

The production and consumption of orange juice globally is relatively stable. If anything, orange juice is only just holding its own in the market as the number of other juices available in fresh, frozen, and concentrated form has increased dramatically. However, with diseases and lower production in Brazil and the United States it is likely that production may well shift to other parts of the world. In Brazil, orange juice expansion took place at the expense of other crops, such as coffee. This does not pose a serious threat to the environment. In other places it might expand at the expense of natural habitat, and this would be a more serious issue.

It is still too early to determine whether the expansion of the blood orange will pose significant environmental risks. While that fruit is quite valuable, it is not clear that it can be produced easily in areas that are linked to international markets.

Finally, some of the preliminary work in Florida, Brazil, and Costa Rica suggests that orange juice production can be undertaken with far fewer impacts and far greater net profits if relatively simple and inexpensive better management practices are adopted. These can easily be supported by processing plants whose owners also have a self-interest in a long-term, stable supply of product from growers.

Resources

Web Resources

www.agmrc.org/fruits/citrusmain.html
www.infoagro.com/citricos/eng.asp
www.pesticideinfo.org/PCW/DS.jsp?sk='2006'
www.agmrc.org/fruits/info/califoranges.pdf
www.ams.usda.gov/standards/fzorange.pdf
www.ultimatecitrus.com/fssource/index.html#Braddock
www.njpa.com/
www.fred.ifas.ufl.edu/citrus/data/index.htm
www.lal.ufl.edu/ISC_Citrus_homepage.htm
www.citrus.usda.gov/
www.fao.org/DOCREP/003/AC117E/ac117e04.htm

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