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# An overview of the Mango industry in Puerto Rico

W. Colon-Guasp and A. Acosta-Rodríguez

USDA-ARS Tropical Research Station, P.O.Box 70, Mayaguez,  
Puerto Rico, 00709

Puerto Rico has been successfully exporting mangoes to the European market for the past three years. In 1986, 1407 tonnes were exported. Major producers/exporters are: Fruits Int'l Inc.; Huertos del Caribe Inc. and ISPRAC Inc.; with 200, 320 and 69 hectares respectively; each producer marketing their fruits independently. Extending the harvest period from late April to early September could be important, since several mango varieties are available. Management and production technologies vary in each particular case. The Mango industry is characterized by high investment, high level technology and high yields of excellent quality. At present the mango produced in Puerto Rico can enter European markets without restrictions except for Spain. However, they are not permitted to enter the mainland United States markets until an acceptable treatment for fruit fly control is validated under local conditions. During 1986 a shipment of irradiated mangoes from Puerto Rico was permitted to enter the United States at Miami, Florida. Consumer acceptance was monitored. American consumers reacted positively to the irradiated mangoes. The economic feasibility of mango irradiation has yet to be determined.

**Keywords:** Mango; Varieties; Export; Puerto Rico

## Introduction

The Mango (*Mangifera indica* L.), native to Southeastern Asia, was introduced to Puerto Rico about 1750 from Jamaica (Toro, 1987). In the early 1900's the Federal Experiment Station, now the Tropical Agriculture Research Station, initiated a collection of mango varieties (Kinman, 1918). The University of Puerto Rico, Agricultural Experiment Station (UPR-AES), also established a mango collection which was expanded in 1948 by introducing related varieties of large size and excellent quality fruit (Mattern et al., 1972). At present, a collection of 105 related mango varieties from all parts of the world is maintained at the Fortuna Substation of UPR-AES.

The first attempt to export mangoes occurred in 1952 with the shipment of local varieties "Mayaguezano" and "Pasote" to the continental United States, mainly to New York City (Spencer and Kennard, 1955). The next attempt to export better and more attractive mango varieties was made by the UPR-AES in 1970 (Mattern et al., 1972). Fruits were shipped to evaluate market acceptability and determine price fluctuations as affected by season of the year and consumer preferences. In their study, fruits were treated with ethylene-dibromide (EDB) in a sealed chamber for 2 hours. With this treatment, no deterioration or spoilage of fruits occurred. Fruit size, color and appearance, and the attractiveness of packaging were found to be important considerations. According to their results, fruits of large size demanded higher prices. Mango fruits in the U.S. market were reportedly scarce before May and after September. Such cultivars as "Springfels", "Irwin" and "Haden" were considered the best varieties based on criteria of size, early bearing and productivity.

In 1984, the Environmental Protection Agency (EPA) prohibited the use of EDB on mangoes shipped from Puerto Rico to the U.S. market. This decision forced local growers to seek markets outside the U.S. Since then, the production is mainly exported to Europe and some is marketed locally.

### Present status of the Mango industry

In 1986, the most important mango growers in Puerto Rico were Fruits International, Inc. (FII), Huertos del Caribe, Inc. (HDC) and ISPRAC, Inc., with 200, 320, and 69 ha, respectively. The three companies are located on the southern coast of Puerto Rico where annual rainfall is less than 150 mm. In addition, the region has a well developed infrastructure where irrigation facilities and deep, fertile calcareous soils are common. Furthermore there is abundant labor. All farms use drip irrigation, fertilizer injectors, intensive pest control and have packing facilities. The average investment amounts to US \$15,000-17,500/ha.

The implementation of this technology leads to high yields of excellent quality fruits. Since 1985, Puerto Rico has been exporting appreciable amounts of mango fruits to the European market from early, middle and late season cultivars (Table 1).

**Table 1** Production (metric tons) and varieties exported to Europe by Mango producing companies, 1985-1987

Grower (Estimated)	Year			Varieties Used
	1985	1986	1987	
FII	45	878	1500	Irwin, Haden, Parvin, Davis, Haden, Keitt
HDC	25	448	600	Irwin, Haden, Osteen, Parvin, Springfels, Tommy Adkins, Keitt
ISPRAC	NA	79	714	Irwin, Haden, Springfels, Keitt

### Production Technology

**Recommended Varieties:** The commercial varieties grown in Puerto Rico extend the mango producing season from the end of April to the beginning of September. These varieties can be classified as follows:

<u>Early-season</u>	<u>Mid-season</u>	<u>Late-season</u>
Irwin Tommy Adkins Haden	Davis, Haden Springfels Parvin Osteen	Keitt

The fruit weight of these varieties ranged from 0.34 kg for "Irwin" to 0.68 kg for "Springfels" (Anon., 1985). Planting densities are 172, 400 and 335-1000 trees/ha at ISPRAC, FII, and HDC orchards, respectively. Plant populations depend on the growth habit of the varieties grown. "Irwin", which is a semi-dwarf tree, can be planted effectively at the rate of 400 trees/ha. A medium size tree such as "Osteen", "Tommy Adkins", "Davis" and "Haden" should be planted at a density of 350 trees/ha. Large trees, such as "Parvin", "Keitt" and "Springfels" should be planted at 175 trees/ha. Densities of over 400 trees/ha should be avoided.

**Intercropping:** Intercropping of mangoes with other economic cash crops such as plantains and papaya in order to provide wind breaks and a source of income during the first year is recommended. ISPRAC successfully intercropped their mangoes with plantains. The FII mango orchard was successfully intercropped with Solo papaya, cv. Sunrise.

**Irrigation:** Each tree is irrigated by drip lines. Two emitters are spaced one meter from the trunk of each tree, providing approximately 8 liters of water/hour. Each tree receives approximately 96 liters of water/week. At the FII farm, tensiometers are distributed uniformly throughout the orchard. Three tensiometers are located at each station at a depth of 0.33m, 0.66m and 1m. The tensiometers are used to monitor the distribution of the water in each section and not to program the water applications. However, at ISPRAC and HDC farms, water applications are made depending on the reading of the tensiometers located throughout the orchard.

At each farm, water applications are cut back preceding flowering. Apparently this practice helps induce a heavy bloom and reduces growth flushes on bearing mango trees. At that time, trees should be left without water for about one month.

**Fertilization:** The trees are fertilized through the irrigation system. The fertilizer solution is made up of very soluble salts, including potassium nitrate, ammonium sulfate and phosphoric acid. The amount of fertilizer applied depends on the age of the trees. Young, non-bearing trees receive 0.30 kg of N, 0.30 kg of P, and 0.25 kg of K per year. Application rates are doubled each year. Fertilizer applications, are cut off around October-November, depending on the variety. This is done to avoid excessive growth flush and a physiological disorder leading to softnose on the fruits. Fertilization is resumed as soon as all the fruits have been harvested.

**Flower Inducement:** In each mango orchard, trees are stimulated to flower uniformly by spraying with potassium nitrate. Two applications are made/year at a concentration that varies from 1 to 5%. Applications are made using a 500 gal stainless steel blower. Flower inducement has been shown to be most effective on 7-month old shoots (Raul and Fidel, 1981). For this reason mango growers try to avoid excessive growth flushes during the year.

**Pruning:** Huertos del Caribe, Inc. and ISPRAC, prune their trees manually, while FII uses a tractor mounted machine. Trees are heavily pruned after the harvesting season to facilitate spraying and picking operations. In the long run, better quality fruit is obtained by this practice.

**Harvesting and Packing:** Mangoes are harvested manually at the three farms. Fruits are taken to the packing-house in bins. The fruits are cleaned, sorted and weighed mechanically. Hand labor is used to reject malformed or cracked fruits and to pack the fruits in boxes. Boxes can hold 6-18 mangoes each. Each box weighs approximately 10 lbs. FII does all the packing manually, since it lacks an automated packing-house. All companies stack the mango boxes on pallets, which are then placed into refrigerated containers. The temperature in the containers is maintained at 10-12°C (50-55°F), depending on the variety. The capacity of each container is approximately 15 metric tons. Mango production is considered seasonal, since it provides most employment from late April to early September. During the rest of the year, a small group of permanent employees carry out maintenance work on the orchard.

**Marketing:** Mangoes that are classified as Grade A are neither malformed nor exhibit any anthracnose damage. Grade B mangoes are malformed with anthracnose spots throughout the fruit. Grade C mangoes are those which are slightly over-ripe. Only grade A mangoes are exported to Europe. Shipping the refrigerated containers from Puerto Rico takes approximately 12 days. Once fruits arrive in Europe, brokers, who work on a commission basis, coordinate the distribution and marketing of mangoes throughout Europe, except Spain. This country does not permit mangoes to enter its market because of strict phytosanitary restrictions. From the actual selling price, brokers deduct all expenses including sea freight and commission. The difference is transferred back to the company. Grade B and Grade C mangoes are sold locally and in the US Virgin Islands. A small amount of Grade B and Grade C mangoes are sold to a food processing company for the preparation of fruit cocktail and mango slices. A limited amount is sold to make chutney.

Each company markets their fruit independently. FII markets its Grade A mango under "Pango Mango" brand and its Grade B mango under the "Coqui Mango" brand. HDC markets its mango under the "Mango Rico" brand. ISPRAC markets its mangoes under the "Tropic" brand. The price of mangoes varies in relation to a series of factors such as color, firmness, variety, and size of fruits. The demand for mangoes in the European market is usually high in April and mid-May. Price and demand are depressed by the entry of mexican mangoes in July. In August and September the market demand again increases. Prices obtained so far by FII in Europe range from US\$6.00-8.00/10 lbs box (Segal, 1987)

### Irradiation of Fruits

In September of 1986, 479 boxes of mangoes from FII were treated to 50 kilorads of gamma rays from a Cobalt-60 irradiation source. This treatment was carried out at Isomedix Inc., a company which sterilizes health care equipment. This company is located at Vega Alta, Puerto Rico. The mangoes were then sold at a produce market in North Miami at about US \$1.00/lb (New York Times, 1986). Consumers reacted favorably to the irradiated fruits. This venture provided a valid control of fruitflies, but the price of irradiating the mangoes was extremely high. For this reason the Mayor of Ponce, the largest city near the mango producing area has proposed building a fruit and vegetable irradiation plant. If this can be done at a low cost, Puerto Rico will probably be able to meet the growing demands of the American consumer for imported specialty and tropical fruits and vegetables.

## Research

The UPR-AES is currently conducting various research projects which will benefit the mango industry in Puerto Rico. These projects are:

- 1) Control of the Caribbean fruitfly (*Anastrepha suspensa*) and the West Indian fruitfly (*A. obliqua*) on mango by irradiation and hot water treatment.
- 2) Biology of the West Indian fruitfly (*A. obliqua*) related to larval population in 16 varieties of mangoes.
- 3) Evaluation of Bravo 500 fungicide for control of anthracnose (*Colletotrichum gloeosporioides* Penz)
- 4) Behavior of mango rootstocks to different pruning systems.
- 5) Effect of different water regimes, using drip irrigation on mango fruit production.
- 6) Inducement and retention of flowers in mango trees.

Numerous scientific papers on mangoes have been published in the Journal of Agriculture of the University of Puerto Rico over the last 40 years. In addition, Puerto Rico has an experienced cadre of highly qualified professionals involved in production, processing and marketing of mangoes and other tropical fruits. This can be an important resource in the Caribbean due to the demand for these fruits in U.S. and European markets and their potential as a source of foreign exchange.

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