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# Expanding Mango Consumption Phase 1: Mango (*Mangifera indica*) Cultivar Evaluation for the National Mango Board

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**Growing, producing, and marketing the right cultivar or cultivars has a critical impact establishing, maintaining, and expanding the fresh fruit business in the western hemisphere. The international fresh mango fruit business is no different. Although the major cultivars in the trade, i.e., 'Tommy Atkins', 'Keitt', 'Kent', 'Haden' 'Madame Francis' and 'Ataulfo' possess many of the attributes of successful commercial cultivars, they all have their drawbacks. The fresh fruit mango trade in the western hemisphere is expanding and the market seems poised to accept new peel colors, shapes, sizes, and flavors. However, establishing sufficient production and marketing of new cultivars can be a daunting task. There are major considerations such as production, handling–postharvest, transport, and marketing, which need to be worked out as much as possible if a new cultivar is to be successfully introduced. An initial step is for the mango industry to review a range of potential cultivars that have the attributes necessary for commercialization. The purpose of this report is to offer the results of a panel of nine international mango experts assembled as a part of a National Mango Board sponsored project to identify mango cultivars with potential for commercialization to enhance the international mango industry on this continent.**

Worldwide fresh mango production has increased about 44% during the past 20 years from 24.7 million metric tons in 2000 to 57.4 million metric tons in 2021 (FAO-STAT, 2021). Fresh mango imports to the U.S. have risen from 1.1 billion pounds in 2017 to over 1.2 billion pounds (lb) in 2020 valued at $493.0 million (USDA-ERS, 2021). U.S. per capita mango consumption has increased from 1.75 lb in 2000 to 3.21 lb by 2019 (Statista, 2021).

The National Mango Board (NMB) is a national promotion and research organization formed in 2004 under U.S. federal marketing order legislation and is under the auspices of the USDA–Agricultural Marketing Service (CFR, 2003). The board's mission is to increase U.S. consumption of fresh mango through marketing and promotion, research, and industry development. The NMB is funded through assessments on imported and domestic whole fresh mango fruit. The board is composed of fresh mango importers, handlers (an entity which handles or markets mangos), and domestic and foreign producers. The NMB develops and executes strategic promotion, research, and industry development plans to further the best interests of the mango industry and ensure funds are invested wisely.

Currently in the Western Hemisphere export trade, six mango cultivars predominate: 'Tommy Atkins', 'Keitt', 'Kent', 'Ataulfo' ('Honey'), 'Haden', and 'Madame Francis' ('Francis'). While all these cultivars have many positive attributes, the industry is actively investigating alternative cultivars to expand the pallet of mangos for consumers and producers. The NMB is searching for mango cultivars with excellent handling characteristics, superior pulp flavors and textures, peel colors, shapes, and seasons of availability.

Stemming from the NMB mission and vision, a first step was to evaluate potential mango cultivars for wider commercialization. This paper reports primarily on Phase-1 of this effort. The Mango Cultivar Evaluation Project—Phase-1 was designed to garner the expert advice of numerous mango researchers who were intimately familiar with mango cultivars, their performance and fruit quality characteristics. The purpose of this report is to offer the results from a panel of scientists intimately familiar with mango cultivars and mango growing and handling to further develop the international mango industry of this continent.

The criteria for a successful mango cultivar vary somewhat by which part of the mango business is considered. Producers require that cultivars come into bearing fruit as soon as possible and have reliable crop yields, moderate to excellent resistance to diseases, insects, and pests, possess acceptable fruit quality, and can tolerate postharvest handling and shipping. In contrast, packers and handlers are more interested in cultivars that tolerate picking and postharvest quarantine treatments, sorting and packing, storage, and shipping. Marketers require a year-round fruit supply of blemish-free fruit of acceptable internal and external color, taste, and texture, that ship and store well and that ripen to acceptable eating quality.

The project began in 2017. The first step in this process was to form a panel of experts (Table 1) from Australia, Brazil, Israel, Mexico, Peru, South Africa, Spain, Central America, and the United States. Many on the panel were previously or are currently active in mango cultivar selection for their national industries.

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Table 1. Mango Cultivar Expert Panel members for the National Mango Board project to identify mango cultivars with potential for commercialization.

| Country | Name and title | Institution |
|---|---|---|
| Australia | Ian S.E. Bally, Horticulturist/Breeder | Dept. of Primary Industries, Queensland |
| Israel | Yuval Cohen, Plant Breeder | The Volcani Institute, Bet-Dagan |
| United States | Jonathan H. Crane, Tropical Fruit Crop Specialist | Tropical Research and Education Center, Univ. of Florida, IFAS, Homestead, FL |
| Honduras and Perú | Dr. Odilo Duarte, Prof. | PanAmerican School of the Americas, (retired), currently, Consultator en Agronegocios |
| Mexico | Samuel Salazar-Garcia, Dir., | INIFAP (Instituto Nacional de Investigaciones Forestales, Agricolas y Pecurarias), Tepic-Mazatlan |
| United States | Noris Ledesma, Curator | Tropical Fruit Program, Fairchild Tropical Botanical Garden, Miami, FL |
| Brazil | Francisco Pinheiro, National Leader | Mango Breeding Program, Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) |
| South Africa | Johann du Preez, Manager/Horticulturist | Bavaria Estate, Westfalia, So. Africa |
| Spain | Victor Galán Saúco, Research Prof. (retired) | Instituto Canario de Investgaciones Agrarias, Canary Islands, Spain |

Jonathan Crane was the Panel Coordinator. The experts agreed to participate by offering their input and assessment of a very wide range of mango cultivars. The assessment was conducted through an extensive survey where each expert was asked to list, based on their data and expertise, their top five to ten cultivars. For each cultivar evaluated, background information on the origin, location of the evaluation, germplasm availability, current commercial status, environmental adaptability (e.g., climate, soil types, cold and salinity tolerance), tree growth habit (e.g., tree vigor, canopy structure), production attributes (e.g., kg fruit produced/tree and season), disease tolerance (e.g., mango malformation and anthracnose), and detailed fruit characteristics (e.g., dimensions, weight, peel and pulp color, pulp texture) was recorded. Additional information requested was intended market (e.g., fresh and fresh-cut), postharvest handling characteristics (e.g., sap burn, chilling injury, and internal breakdown), and tolerance to quarantine treatments and cooling (e.g., hydrocooling and forced-air cooling).

## Summary of the Mango Cultivar Panel Findings

Panel members (PM) recommended 37 cultivars. Previously mentioned criteria were used to select the top cultivars for further evaluation (Table 2). Part of these criteria included the most frequently selected cultivar by PM and fruit and tree characteristics described from the cultivar surveys. We asked the PM to provide their "best" selections. This information was tallied and used as the criteria for further evaluation. The author then compiled the information and ranked each cultivar by the number of experts naming a specific cultivar in their top mango cultivar list. In some cases, PM top selections were not readily available for further evaluation or there was too little data to form the basis for further evaluation at this time. Based on the PM survey information, cultivar ranking and available literature, the Panel Coordinator selected the top six cultivars for further recommendation. These six were 'Agam', 'Angie', 'Calypso', 'Mallika', 'Rapoza', and 'Shelly'. Others for further consideration included 'Cogshall', 'Maha Chinook', 'Noa' and 'Osteen' (Table 3).

Table 2. List of mango cultivars recommended by the panel members.

| Cultivar | Cultivar |
|---|---|
| Agam | NMBP1243 |
| Ah Ping | NMBP4069 |
| Angie | NMBP1201 |
| Ataulfo Diamante | Noa |
| Ataulfo Zafiro | Omer |
| Calypso | Orli |
| Cavallini | Osteen |
| Cogshall | Otts |
| Duncan | Papo de Peru |
| Edward | R2E2 |
| Espada Ouro | Rapoza |
| Favo de Mel | Rosa 2 |
| Gouveia | Rosigold |
| Harders | Shelly |
| Isis | Southern Blush |
| Kensington Pride | Tali |
| Maha Chanook | Valencia Pride |
| Mallika | Young |
| Nam Doc Mai | |

The next step in the NMB mango cultivar evaluation process (Phase 2) is underway. Phase 2 consists of evaluating these top cultivars and other selected candidates for postharvest and quarantine treatment handling characteristics. This will provide further evidence of commercial suitability for export and import markets. This project is currently underway by the postharvest lab (Jeffrey Brecht) in the Horticultural Sciences Department at the University of Florida/IFAS in Gainesville, FL. Once Phase 2 is complete, an evaluation of the top cultivars from Phases 1 and 2 may be planted in replicated trials in selected mango producing regions to collect in-field tree performance, fruit production and

Table 3. Brief description of selected mango cultivars for further evaluation and potential commercial expansion.

**Agam**

Medium- to large sized fruit (330-520 g; average 450 g), roundish (broad-shaped) with a dark red to scarlet color and numerous yellow dots (lenticels). The pulp is dark orange, firm texture with very low fiber. The fruit has a pleasant aroma and a rich sweet flavor with good to excellent eating quality. Anthracnose tolerance unknown. Tolerant to postharvest handling but unknown tolerance to postharvest quarantined treatment (e.g., hot water treatment). Trees harvested early season.
*Photo credit: Volcani Research Center.*

**Angie**

Medium size fruit (350-480 g), oval to oblong-shaped fruit with a yellow pink to reddish blush that turns yellow at ripening. The pulp is yellow to orange colored with very low fiber, has a pleasant aroma, is sweet (18-22°Brix) with excellent eating quality. Generally harvested in late spring (May in U.S.).
*Photo credit: Noris Ledesma.*

**Calypso**

Medium- to large sized fruit (350-570 g), elliptic to round shape with a slight beak; a yellow-pink peel. The pulp is orange, firm with medium-low fiber, and has a sweet rich flavor and mild aroma, good eating quality. Mid- to late season harvest period.
*Photo credit: https://twitter.com/calypsomangoes.*

**Cogshall**

Medium size fruit (280-500 g), 11-14 cm long, 6.2-8.5 cm dia., oblong with rounded base, yellow-to-yellow-orange peel with crimson blush. The pulp is yellow-orange, low in fiber, with a pleasant aroma and spicy, sweet rich flavor, with good to excellent eating quality. 'Cogshall' is an early to midseason cultivar.
*Photo credit: J.H. Crane.*

**Maha Chinook**

Small to medium sized fruit (262-435 g), ellipsoid shaped with a slight beak and a yellow-pink peel. The pulp is light orange, firm with very low fiber, and has a sweet distinct flavor and mild aroma; very good eating quality.
*Photo credit: Ian Bally.*

**Mallika**

Medium size fruit (280-510 g), oblong-sigmoid shaped fruit with a bright yellow-to-yellow-orange peel. The pulp is orange colored with very low fiber, has a pleasant strong aroma, and is sweet (20-22°Brix) with excellent eating quality. Harvest season June-July (Florida)
*Photo credit: Ian Maguire.*

**Noa**

Large fruit (483-812 g; average 650 g), 13-14 cm long, 9-10 cm dia., broad elliptic-oval shaped with a yellow ground color and large-area with a blend of red, orange, yellow and green color blush, numerous small yellow dots (lenticels). The pulp is medium-orange, firm with low fiber. The fruit has a pleasant aroma, and a rich sweet flavor with good eating quality.
*Photo credit: Volcani Research Center.*

Table 3. (Continued)

**Osteen**

Large fruit (500-760 g), 12-15.5 cm long, 8.5-10.5 cm dia., oblong shaped with yellow-orange color and purple or lavender blush with numerous small white dots (lenticels). The pulp is yellow colored with low fiber, firm, has a mild pleasant aroma, and is sweet with good eating quality. Harvested July to early September (Florida).
*Photo credit: Mark Nickum.*

**Rapoza**

Large fruit (650-800 g), oblong shaped with a red blush extending over half the fruit peel. The pulp is yellow, yellow orange colored with very low fiber, has a pleasant aroma, and is sweet (19-21°Brix) with excellent eating quality. Harvested July-August (Florida).
*Photo credit: J.H. Crane.*

**Shelly**

Medium sized fruit (300-700 g), roundish (apple-like) shaped with a yellow ground color and large-area red blush, numerous small yellow dots (lenticels). The pulp is medium to deep yellow, yellow orange, very firm with low fiber. The fruit has a mild, pleasant aroma, and is sweet with good eating quality. Harvest mid- to late season.
*Photo credit: The Volcani Research Institute.*

quality information along with further harvest and postharvest handling characteristics.

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