STRATEGIES OF BREEDING AND PRODUCTION MANAGEMENT OF MANGO (*Mangifera indica* L.) ON FOCUS TO THE DYNAMIC OF MARKET

Alberto Carlos de Q. Pinto
Gilberto José N. e Silva
Luiz Eduardo C. S. Ferraz
<table>
<thead>
<tr>
<th>Country</th>
<th>Consumption (kg/hab/year)</th>
<th>Population (X 1000)</th>
<th>Consumption (total: t / year)</th>
<th>Production (total: t / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>11.29</td>
<td>1.210.000</td>
<td>13.7 millions</td>
<td>16.3 millions</td>
</tr>
<tr>
<td>China</td>
<td>2.57</td>
<td>1.347.000</td>
<td>3.5 millions</td>
<td>4.4 millions</td>
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<td>Thailand</td>
<td>21.89</td>
<td>66.000</td>
<td>1.4 million</td>
<td>2.6 millions</td>
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<tr>
<td>Mexico</td>
<td>4.62 *</td>
<td>110.000</td>
<td>508.200</td>
<td>1.6 million</td>
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<tr>
<td>Brazil</td>
<td>2.68</td>
<td>192.924</td>
<td>517.000</td>
<td>1.2 million</td>
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<td>France</td>
<td>0.29</td>
<td>65.400</td>
<td>19.000</td>
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<td>Germany</td>
<td>0.26</td>
<td>81.800</td>
<td>21.300</td>
<td>none</td>
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<td>Holand</td>
<td>1.72</td>
<td>16.558</td>
<td>28.500</td>
<td>none</td>
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<tr>
<td>England</td>
<td>0.37</td>
<td>62.000</td>
<td>23.000</td>
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</table>

Source: Adapted from Granço (2010) estimated population in 2011;  
* Camargo Filho et al. (2004)
## FIVE IMPORTANT COUNTRIES AS FRESH MANGO PRODUCERS AND EXPORTERS IN 2011

<table>
<thead>
<tr>
<th>Countries</th>
<th>Production (t)</th>
<th>Exportation (t)</th>
<th>Participation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>16,337.400</td>
<td>286.775</td>
<td>1.75</td>
</tr>
<tr>
<td>Mexico</td>
<td>1,632.650</td>
<td>232.643</td>
<td>14.24</td>
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<tr>
<td>Brazil</td>
<td>1,188.910</td>
<td>127,002 *</td>
<td>11.00</td>
</tr>
<tr>
<td>Peru **</td>
<td>130.000</td>
<td>101.060</td>
<td>77.00</td>
</tr>
<tr>
<td>Equador ***</td>
<td>76.774</td>
<td>46.065</td>
<td>60.00</td>
</tr>
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</table>

Sources: adapted from [www.mapsoftworld.com](http://www.mapsoftworld.com) (updated in jan/2013); * Secex, Brasilia, 2012; ** Promango, Piura, 2013; *** Fundación Mango, Guayaquil 2013
WHICH FACTORS MAY INFLUENCE MANGO PRODUCTION AND QUALITY?
INADEQUATED PRE-HARVEST MANAGEMENT

BLEMISHES FROM LATEX, PULP COLLAPSES (“SOFT-NOSE”), AND SEVERAL POSTHARVEST DISEASES RESULTS MOSTLY FROM USE OF NO IMPROVED CULTIVAR AND BAD PRODUCTION MANAGEMENT.
Adequate pre-harvest management leads to higher productivity and quality, coming mostly from the use of excellent cultivars and adequate pre-harvest management (including integrated pest and disease control) under favourable climate conditions.
MANGO PRODUCTION AND QUALITY
(Pre-Harvest Factors)

- **MANAGEABLE FACTORS**
  1. BREEDING
  2. PRODUCTION MANAGEMENT

- **DIFFICULT MANAGEABLE FACTORS**
  1. CLIMATE
     1.1. INFLUENCE ON FRUIT GROWTH AND GROUND COLOR
  2. PHYSIOLOGICAL ANOMALIES AND INNOVATIVE PRODUCTS (?)
MANGO BREEDING: TO WHOM A BREEDER SHOULD ATTEND?
...TO GROWERS?

...TO WHOLESALERS, RETAILERS AND TRANSPORTERS?

... TO PROCESSING INDUSTRY?

...OR TO CONSUMERS?
SEVERAL AND DIFFERENT OPTIONS AND INTERESTS OF A SAME PRODUCT
SEVERAL AND DIFERENT OPTIONS AND INTERESTS ON A SAME SPECIE
SOMEONE HAS ALREADY RELEASED AN IDEAL MANGO?
SOME MANGO BREEDING STRATEGIES AND DECISIONS
A BREEDER MUST ESTABLISH A GOAL, IDENTIFY THE RESTRICTIVE FACTORS THEN DESIGN A STRATEGIC PROGRAM!
ENRICHMENT OF THE GENETIC BASE

Mangifera pajang, easy peeling as if were a banana

Variety Madame Francis, about 400 g, sweet and juicy flesh

Cultivar Osteen, Haden seedling, about 600 g, sweet and firm flesh

Kesar variety (India), about 300 g, very sweet, juicy and firm flesh
SELECTION OF PARENTS BY USING MOLECULAR MARKERS;

MULTIVARIATE ANALYSIS SHOWED THAT THE FLORIDIAN PARENTAL GROUP (1, 2, 3, 4 e 5) IS GENETICALLY FAR FROM INDIAN CULTIVARS MALLIKA AND AMRAPALI (7 e 8) LARGER NUMBER OF PROGENIES
EXCELLENT PARENTAL SELECTIONS

VARIETIES FROM INDIA

VARIETY FROM FLORIDA
IMPROVEMENT OF INDIAN HAND POLLINATION METHOD WITH USE OF PERFORATED PLASTIC BAG, BETTER PROPORTION ANther : STIGMA, WATER SPRAY ON THE YOUNG FRUITS AND PROTECTED BAG WITH LABEL, INCREASED THE SUCCESS FROM 1,47% TO 9,0% OF FRUIT SET.
OPEN POLLINATION STRATEGY

Selected parental cultivars established in the field as latin square design may also facilitate the progeny control.

EMBRAPA SEMI-ARID´S NEW STUDY - SELECTED MONOEMBRYONIC PARENTALS UNDER OPEN CROSSES IN THE FIELD OR INTO CAGES WITH IRRIGATION + PBZ APLICATION THEN PROGENY IDENTIFICATION BY MICROSATELLITE ANALYZES FACILITATES THE OBTAINMENT OF A LARGER NUMBER OF PROGENIES.
DWARF IS AN IMPORTANT TRAIT USED ON SEVERAL MANGO BREEDING PROGRAM; WITH THE ADVENT OF PRUNING, AS AN ALMOST OBLIGATORY TECHNIQUE FOR A GOOD COMMERCIAL MANGO CANOPY ARCHITECTURE, THIS BREEDING GOAL SEEMS TO HAVE LESS IMPORTANCE TODAY.
PRODUCTIVITY AND QUALITY TRAITS

SEVERAL EXPORTING GROWERS DO NOT ACCEPT PRODUCTIVITY LOWER THAN 30 t/ha WITH CROP DENSITY OF 476 PLANTS/ha, at 7 YEARS OLD.

FRUIT GROUND COLOR, TASTE AND SANITY, FLESH COLOR, JUICY, AND FIRMNESS ARE ALL EXCELLENT TRAITS
RESISTANCE TO PEST AND DISEASE

‘ALFA’ - BESIDES THE GOOD FRUIT QUALITY, ITS HIGH RESISTANCE TO FRUIT FLY AND ANTRACNOSIS AND TO TURNED IT INTO AN OUTSTANDING IMPROVED MANGO CULTIVAR.
THE PERCENTAGE OF INFESTED FRUITS OF 5 MANGO CULTIVARS IN THE FIELD, DURING 3 YEARS, VOTUPORANGA - SÃO PAULO (Dr. Rossetto´s study)

<table>
<thead>
<tr>
<th>CULTIVAR</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>AVERAGE</th>
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<tbody>
<tr>
<td>Espada Stahl</td>
<td>5,0</td>
<td>0,0</td>
<td>1,3</td>
<td>2,1 a</td>
</tr>
<tr>
<td>IAC 111</td>
<td>3,3</td>
<td>13,3</td>
<td>2,5</td>
<td>6,36 a</td>
</tr>
<tr>
<td>Alfa</td>
<td>10,0</td>
<td>7,1</td>
<td>5,0</td>
<td>7,37 a</td>
</tr>
<tr>
<td>Tommy Atkins</td>
<td>56,7</td>
<td>43,3</td>
<td>28,8</td>
<td>42,93 b</td>
</tr>
<tr>
<td>Sensation (F1)</td>
<td>96,7</td>
<td>100,0</td>
<td>100,0</td>
<td>98,90 c</td>
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</tbody>
</table>

Mean avg column with same letter do not differ statistically – Tukey test 5%
CULTIVAR EVALUATION AT LAB CONDITIONS

TO STUDY RESISTANCE OF 4 MANGO CULTIVARS BY KEEPING THEM IN AN ACRYLIC BOX WITH ADULT FEMALE FRUIT FLIES OF ANASTREPHA OBLIQUA FOR 2 HOURS.
Mean of attempt of *Anastrepha obliqua* oviposition and number of pupa developed into 4 mango cultivars at acrilic box condition.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Attempts of Oviposition</th>
<th>Number of Pupas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfa</td>
<td>4,62 a</td>
<td>5,75 a</td>
</tr>
<tr>
<td>IAC 111</td>
<td>34,87 b</td>
<td>24,87 b</td>
</tr>
<tr>
<td>Espada Stahl</td>
<td>37.00 b</td>
<td>53,00 b</td>
</tr>
<tr>
<td>Tommy Atkins</td>
<td>34,50 b</td>
<td>40,37 b</td>
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</tbody>
</table>

Mean in the column with same letter do not differ statistically – Tukey test 5%
DOUBLE PURPOSE: PROMISING HYBRID SELECTIONS

GROUND COLORS, EXCELLENT TASTE, COLOR AND COMPACTNESS OF THE PULP OF THESE HYBRID SELECTIONS HAVE BEEN HIGHLY ACCEPTABLE BY CONSUMER AND FAMILY PROCESSING INDUSTRY.
SOME PRODUCTION MANAGEMENT STRATEGIES AND DECISIONS
COMMERCIALIZATION OF BRAZILIAN MANGO *

- ABOUT 80% FOR FRESH CONSUMPTION
- ABOUT 20% FOR PROCESSED PRODUCTS
- AS NUTRI-PHARMACEUTICS AND FUNCTIONAL FOOD, AN INSIGNIFICANT PERCENTAGE (ALTHOUGH A PROMISING FUTURE !)

* Estimation based on total production, population, fresh consumption, fruit loss (30%) and exportation.
IMPORTANT DECISION

CAMPOSOL FARM, A PERUVIAN & NORWEGIAN GROUP EXPORTS 60% OF ITS 400 Ha OF KENT AS FRESH FRUIT (EXCELLENT QUALITY) AND 40% AS FROZEN MANGO CUBES TO SCANDINAVIAN COUNTRIES.
MANGO INTEGRATED PRODUCTION

MONITORING PEST AND DISEASES

STRONG CONTROL OF PESTICIDE SPRAYING

SAFE AND EATABLE FRUIT

NO PESTICIDE RESIDUES IN THE FRUIT

TO RESPECT THE HUMAN BEING AND ENVIRONMENT; REDUCTION OR ELIMINATION OF PESTICIDE USE (SUSTAINABILITY) WITH REDUCTION OF COST OF PRODUCTION; HIGH FRUIT QUALITY; IDENTIFICATION OF THE PRODUCT FROM FIELD UNTIL MARKET (TRACEABILITY).
OBS: NOWADAYS, UNICONAZOLE HAS BEEN EVALUATED WITH CHEAPER AND SIMILAR RESULTS ON MANGO PRODUCTION.
IMPROVEMENT OF MANGO CALIBER

✓ EUROPEAN MARKET PREFERENCES FRUIT CALIBERS BETWEEN 8 and 10; CALIBERS 12 AND ABOVE ARE SOLD TO INTERNAL MARKET;
✓ Silva’s study: THREE FERTIGATIONS (BEFORE AND AT FULL FLOWERING THEN 35 DAYS BEFORE HARVEST), WITH FULVIC ACID + ADDITIONAL POTASSIUM SULPHATE (T1) COMPARED WITH TRADITIONAL FERTILIZATION TOMMY ATKINS MANGO (T2) USED IN PETROLINA, PERNAMBUCO STATE.

SOME EXPORT FARMERS TOOK A BAD DECISION – THEY THREW OUT (BURY) THOSE MANGO FRUITS WITHOUT APPROPRIATE CALIBER TO EXPORT;
FIELD TRIAL TO IMPROVE MANGO CALIBER

FULVIC ACID + K SULPHATE (T1) INCREASED MANGO SIZE AND...
FIELD TRIAL TO IMPROVE MANGO CALIBER

... IMPROVED FRUIT WEIGHT ABOUT 21% BESIDES...
MANGO PRODUCTION AND QUALITY

PROMOTING A BETTER MANGO UNIFORMITY AT HARVEST
THUS IMPROVING PRODUCTION AND QUALITY.
Mango Pulp Collapse has high frequency in acid soil of Cerrados Ecosystem; a 7 years study of Pinto and colleagues on cv T. Atkins using gypsum (290 g/m2 at planting) in the recommended mango fertilization then monitoring the ratio of Ca:N at leaves; a minimum of 2:2 Ca:1 N promoted a reduction from 60% to 3% of mango pulp collapse – HIGHER AND BETTER MANGO SUPPLY IN THE MARKET!
THE LATEX EJECTION DEPENDS ON THE TIME OF HARVEST AND THE LENGTH OF THE PEDUNCLE; CUT ABOUT 1.5 cm ABOVE PEDICEL.

HARVEST AID - IN AUSTRALIA, MANGO IS PULLED FROM THE TREE OR DE-STEMMED IN FIELD AND THROWN ON TO THE TARPAULIN COVERED WITH WATER AND DETERGENT (Ian Bally´s photo)
Common Mango Picker: about 60% of the harvested mango presented latex in the skin;

NEW MANGO HAND PICKER: LESS THAN 10% OF THE FRUITS PRESENTED LATEX IN THE SKIN
CLIMATE MAY INFLUENCE MANGO QUALITY AND DYNAMIC OF MARKET
GENOTYPE AND ENVIRONMENT INTERACTION

INTENSE SUN RAY + REFLECTION FROM SANDY SOIL + HIGH IRON CONTENTS IN LEAVES (50-75 ppm in Petrolina vs 104 ppm in Piura) = BETTER GROUND AND PULP COLOR
INFLUENCE OF MANGO GROUND COLOR

SOUTH AFRICAN ‘KENT´ MANGO AT SUBTROPICAL CLIMATE

´KENT´ MANGO FROM PIURA, PERU AT TROPICAL CLIMATE
HADEN FRUIT S CASE

‘HADEN’ HAS A BETTER ACCEPTANCE IN THE WHOLESALE MARKET IN SÃO PAULO (R$ 4,33/Kg in May 03/2013); ‘PALMER’ (R$ 2,90/Kg) AND ‘TOMMY ATKINS’ (R$ 2,61/Kg).

TEMPERATURE ABOVE 30ºC DURING FRUIT GROWTH IN NORTHEASTERN BRAZIL PROMOTES HIGH PERCENTAGE OF STENOSPERMOCARPY AND MORE THAN 20% OF FRUITS DO NOT REACH ITS NORMAL SIZE OF THE VARIETY THUS INFLUENCING ITS COMMERCIALIZATION.
DUE TO THE SMALL AND SUPPOSELY UNSAILABLE FRUIT, SEVERAL GROWERS (at 90’s DECADE) CHANGED MANGO CANOPY FROM ‘HADEN’ TO ‘TOMMY ATKINS’ OR ‘PALMER’ THUS INFLUENCING DYNAMICS OF MARKET.
LIKE “THE VERY LITTLE MÔNICA APPLE” (Mini-Apple; left) WITH GOOD ACCEPTANCE IN THE MARKET, ‘MINI-HADEN’ FRUIT WAS SIMILARLY RELEASED (by Mr. Zé Pires) IN THE MARKET OF RECIFE CITY, WHICH GOT AN EXCELLENT PRICE THUS CHANGING THE DYNAMIC OF MANGO MARKET.
INNOVATIVE PRODUCTS?

A MUTANT PURPLE SKINNED SUGAR APPLE

SQUARE WATER MELON BY KEEPING GROWING FRUIT INTO AN ACRYLIC BOX

SQUARE MANGO? WHY NOT?
CURIOSITY: WHAT ABOUT HORN MANGO?

THIS PHENOMENON WAS FOUND AT AREA OF ‘TOMMY ATKINS’ JOIN WITH ‘HADEN’ IN PARAGOMINAS, PARÁ STATE; HIGH TEMPERATURE AND HUMIDITY AT FLOWERING AND FRUIT GROWTH PERIODS; A HIGH PRICE GIFT (R$ 15,00/fruit) PAYED BY THOSE WHO WANT TO MAKE JOKE WITH “FRIENDS”.

HYPOTHESIS: ABNORMAL GROWTH OF SYNERGID CELLS?
“Love begins when a person feels another person’s need to be as important as his own”
Harry S. Sullivan