Mango Flower Induction Technology

Dr. Ramon C. Barba

National Scientist
National Academy of Science and Technology (NAST)
Department of Science and Technology (DOST)

The Beginning

❑ 1957, Start of Interest on Mango Flower Induction

- BSA student, with thesis adviser
  * Dr. Leon G. Gonzales*, first to study "*smudging of mango trees* (1923)"

- Pioneering book,
  "*Auxins and Plant Growth (1955)*"
  by *Dr. Aldo Carl Leopold*

The Beginning (Cont.)

- 1958-1960, sustained interest on mango flower induction

- Assistant Instructor
  Fruit Crops Section, Dept of Agronomy,
  UP College of Agriculture (UPCA)

- Immediate supervisor, thesis adviser, * Dr. Leon G. Gonzales*, first to study "*smudging of mango trees* (1923)"

The Beginning (Cont.)

- 1960-1967, postgraduate studies

- gained more knowledge & ideas on flowering

- ✓ from publications, experiments & interactions with professors & fellow students

The Beginning (Cont.)

- 1960-1967, postgraduate studies

- 1962, M.Sc. University of Georgia, USA (Adviser: Dr. Franlin Pokorny)

  - Flowering of azalea using GA & KNO3

  - New ideas on mechanism of flowering

The Beginning (Cont.)

- 1960-1967, postgraduate studies

- 1967, Ph.D. University of Hawaii, USA

- Dr. Toshio Murashige, Adviser (famous for MS tissue culture medium)

- RC Barba, 1st Ph.D. advisee

- Modified the technique in sugarcane single cell isolation

The Beginning (Cont.)

- 1960-1967, postgraduate studies

Dr. Toshio Murashige, RC Barba's adviser moved to University of California Riverside (UCR)

However, RC Barba did not go with Dr. Murashige to UCR

The Beginning (Cont.)

- 1960-1967, postgraduate studies

  - Dr. Roman Romanowski, new adviser endorsed by Dr. Murashige

  - Ph.D. thesis, mechanism of action of herbicide ametrine in banana

The Beginning (Cont.)

- 1960-1967, postgraduate studies

❖During Ph.D. at University of Hawaii, a favorite author of book on *"growth regulators"* taught *advance course in "Plant Physiology"*

Dr. Aldo Carl Leopold, Professor

The Beginning (Cont.)

- 1967, Warner & Leopold patented "*Ethrel*"

- *Ethrel* (2-chloroethylphosponic acid

- Growth regulator that produces ethylene when sprayed to plant

- RC Barba brought back to UPLB *1 liter of Ethrel*

The Beginning (Cont.)

- 1967-'68, Assistant Physiologist, Hawaiian Sugar Planters' Ass'n (HSPA), Honolulu, Hawaii

  - Pioneered in plantlet regeneration in tissue culture of sugarcane with "Dr. L. G. Nickell"

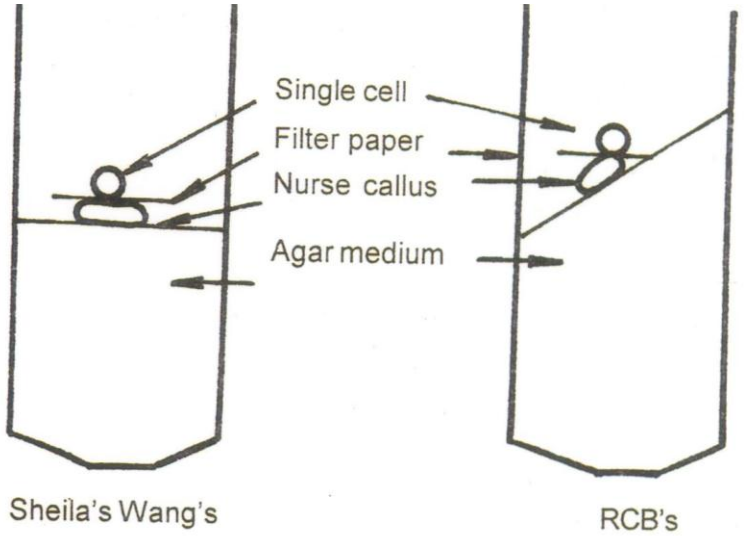


Diagram 1: Sheila Wang's and RCB's experiments

Challenges to find chemical flower inducer of mango

- 1969, back to UP College of Agriculture (UPCA)

- Assistant Professor 1
  Fruit Crops Section, Dept. of Agronomy,
  UP College of Agriculture (UPCA)

- Idea to induce flowering in mango using chemicals

Challenges to find chemical flower inducer of mango (Cont.)

- 1969, back to UP College of Agriculture (UPCA)

- June 1969, Proposal to induce flowering in mango using ethrel

- Chair, Dept. of Agronomy, UPCA rejected the proposal

Challenges to find chemical flower inducer of mango (Cont.)

❑ Proposal was rejected:

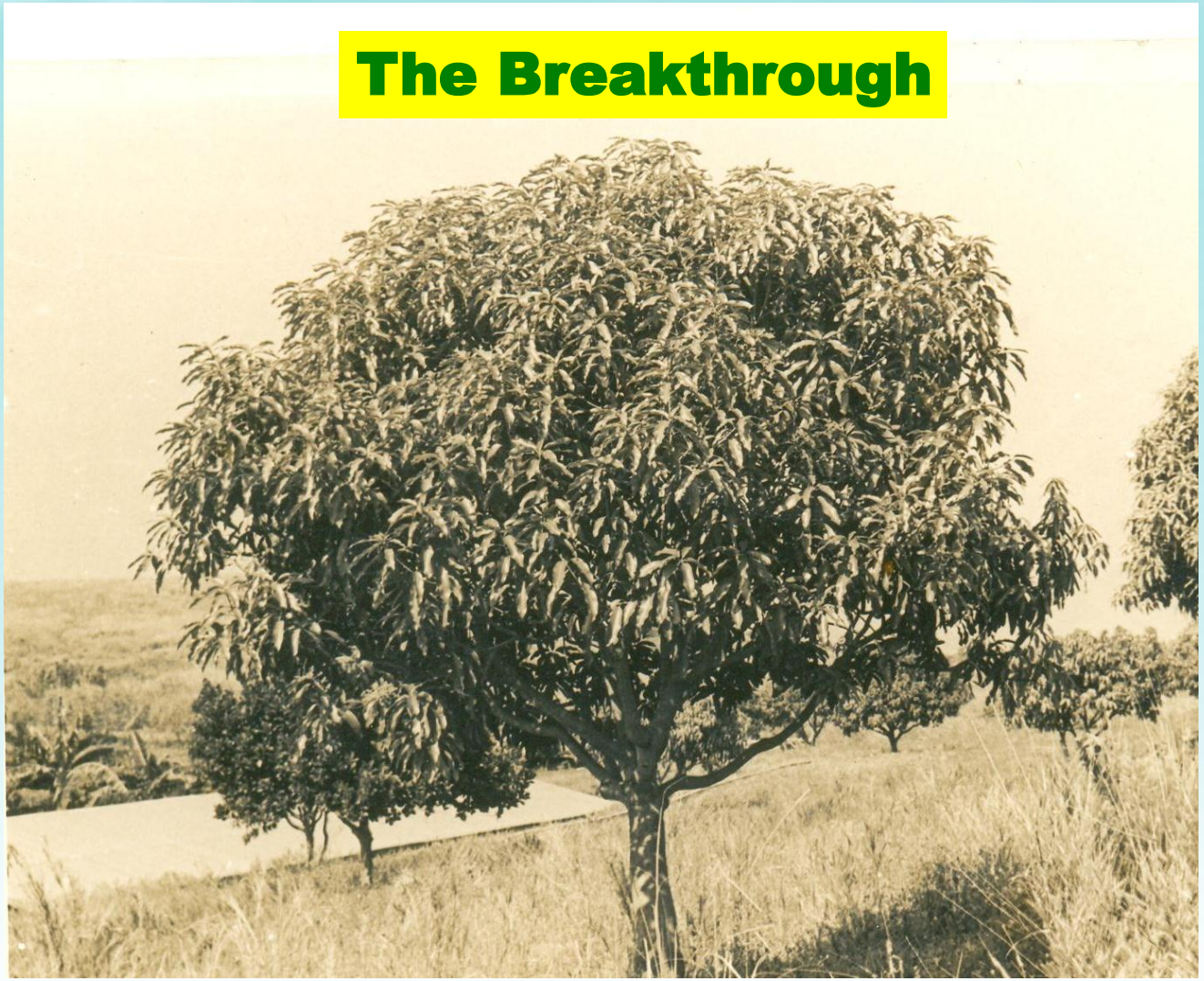
- redundant because a PhD exchange student from Cornell University doing thesis on mango flowering
- mango not assigned crop to conduct research

Challenges to find chemical flower inducer of mango

Research on mango flowering was conducted at a friend's orchard on personal capacity (Saturdays and Sundays):

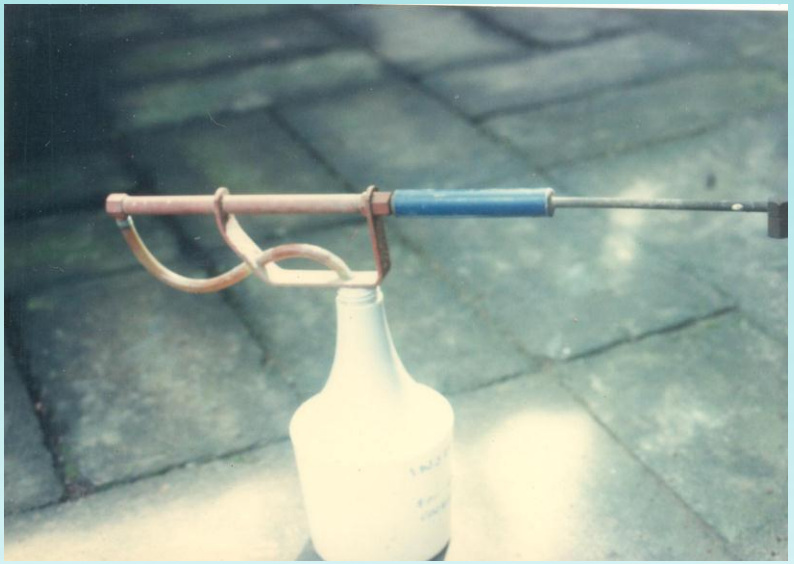
- **in private using a PhP 27.00 hand sprayer**
- **10kg KNO_3 worth PhP5.00**

Discovery of Flower Induction in Mango Using KNO_3 @ Quimara Farm



Discovery of Flower Induction in Mango Using KNO_3

- **Personal budget of PhP500.00**
- **Exploratory test of several chemicals on selected shoots**



- **1% KNO_3 induced flowers in 2 weeks**

Discovery of Flower Induction in Mango Using KNO_3 (Cont.)

- **Within 2 weeks, 100 trees, 10 yrs old & never flowered, were sprayed.**
- **Produced abundant fruits in 4 mos.**
- **Complete technology including field application & farmers' adoption in 4.5 mos.**

Perils of a Commercially Important Discovery

- 1971, realization of the perils of the discovery and innovation
- Former Research Assistant (RA), Fruits Crops Section, Dept of Agronomy, UPCA, requested to visit Quimara Farm
- RC Barba divulged to the RA the chemical, where to buy, conc and method of application

Perils of a Commercially Important Discovery (Cont.)

- The Research Assistant (RA), promised not to reveal the discovery without RC Barba's permission.
- The RA even requested RC Barba to be his M.Sc. adviser, & the discovery as his thesis.

- RC Barba expected the RA to respect his discovery, and
- that the technology was already completed, rejected RA's proposal to be his M.Sc. thesis.

Perils of a Commercially Important Discovery (Cont.)

- The Research Assistant (RA), disobeyed his own promise, used the technology without RC Barba's permission & divulged the discovery to the Department Chair.
- They tested the technology, claimed the discovery and results published in several publications.
- Another person applied patent for the mango flower induction technology using same chemical (KNO_3).

- **Patents from the Philippines, USA, Australia, New Zealand, and United Kingdom**

- **Never enforced**

- **So, free use of technology by growers**

INTELLECTUAL PROPERTY
PHILIPPINES

October 4, 2007

Mr. Ramon Barba
Inventor

Dear Mr. Barba,

Intellectual property (IP) assets like trademarks, patents and trade secrets, have become more valuable than physical assets in today's competitive knowledge based economy.

To showcase success stories on successful IP asset management, the World Intellectual Property Organization (WIPO) is producing a documentary film about inventors and entrepreneurs who have used IP effectively. These short features will be uploaded on the WIPO website to serve as an educational tool to promote creativity and innovation. It is hoped that these documentaries will also inspire inventors and entrepreneurs to know more about intellectual property rights and manage their IP assets. You may visit WIPO's Webcast homepage to see some examples of previous works at http://www.wipo.int/multimedia/en/webcast/

After a rigid selection process, the Philippines was chosen as one of the two countries from the Asia and the Pacific Region for this project. Among many candidates from around the world, you were chosen as one of the individuals to be featured in this documentary.

We hope that you will agree to participate in this project, which not only gives recognition to your achievements but also brings honor and pride to our country.

The WIPO documentary team will be visiting our country on the second half of November, during which they would like to interview our proposed candidates. If you agree to be interviewed and featured, please let us know and we will communicate your decision to WIPO.

I would like to invite you to an informal meeting on Friday, 19 October, so we can discuss the project in detail. We shall call your office to arrange this meeting at a mutually convenient time.

Thank you and best regards.

Sincerely,

Atty. Adrian Cristobal, Jr.
Director General

Republic of the Philippines
INTELLECTUAL PROPERTY OFFICE
351 Sen. Gil Puyat Ave., Makati City 1200 Philippines • www.ipophil.gov.ph
Telephone: +632-7525450 to 65 • Facsimile: +632-8904862 • email: mail@ipophil.gov.ph

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INTELLECTUAL PROPERTY
PHILIPPINES

October 4, 2007

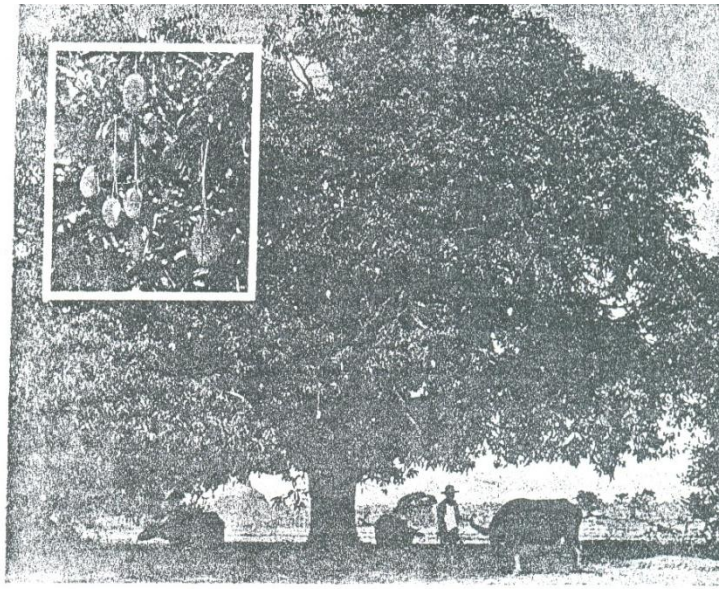
- **Flower induction considered worldwide- most important discovery in mango**

- **Flower induction quickly became worldwide practice**

The young RCB examines mango plants used in his experiments.

- **Generated interest on research on flowering**

- **Mexico used it since 1975, 41% share of world trade**



The Magnificent Mango

By William Warren

This worldwide taste-pleaser has become leading candidate for king of tropical fruits

"Mango, mango, he so delicious. Soothes the body and calms the mind."

In the West Indies they sing this calypso in praise of the fruit which, until recently, was for most only an exotic name in travel books. Now the mango is enjoyed all over the world and is likely to become the king of tropical fruits.

One of the pioneers is the Philippines, where researchers are developing ways to increase production. Scientists at the Los Banos College of Agriculture have found that potassium nitrate sprayed on mangoes in a one percent concentration induces the trees to flower early and profusely. And a chemical plant hormone sprayed on young fruit the size of corn kernels increases their final weight.

1978 Reader's Digest

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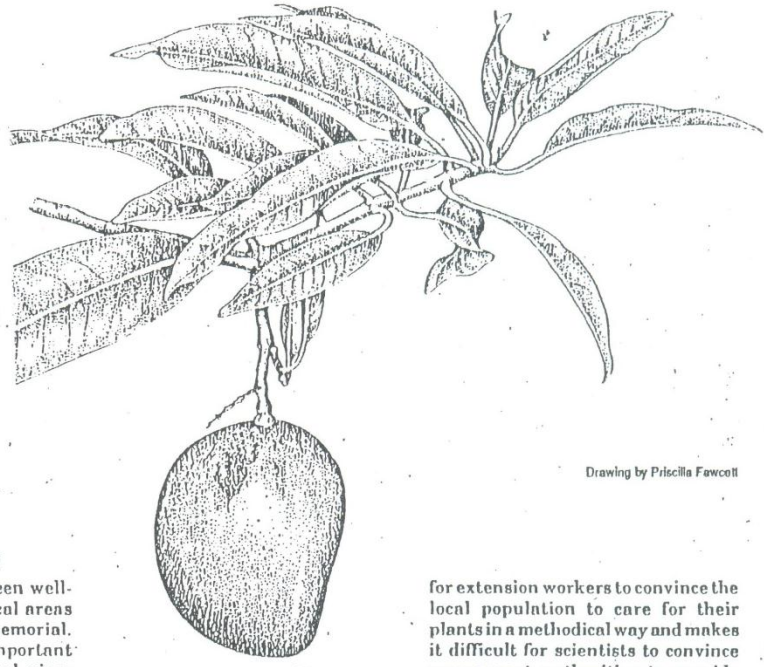
New Developments In Tropical Fruit Production

A fascinating example of one of the results of current research involves methods developed in the Philippines that are now being used to control mango flowering in Tropical America.



Drawing by Priscilla Fawcett

By Carl W. Campbell

Tropical fruits have been well-known and important in local areas of the tropics since time immemorial. However, except for a few important ones like banana, citrus and pineapple, most tropical fruits are newcomers to the world market and, compared with the fruits of the temperate zones, there is little organized research and little information available on their culture. This shortcoming is keenly felt by growers everywhere.

The literature on tropical fruits is scattered through many scientific and popular journals, books, bulletins and pamphlets. But even with the current availability of computerized searches, it is still difficult to find much of this literature because the sources are not included in many libraries or databases.

One explanation for the problem is the fact that many tropical fruits are considered "traditional" crops and are grown in gardens, parks, pastures, roadsides and the forest, but not in organized orchards. They are conceived as community property and no one thinks of caring for them as commercial crops. This traditional notion makes it difficult for extension workers to convince the local population to care for their plants in a methodical way and makes it difficult for scientists to convince government authorities to provide funding for the necessary research on which to base recommendations for production practices.

Right now, however, a significant change is taking place. Tropical fruits are sleeping giants who are waking up and making an impression in the world. Producers in the tropics have learned that consumers in the developed countries are willing—even eager—to try new fruits, and that they are affluent enough to buy them at relatively high prices.

The mango is the leader of the

A fascinating example of one of the results of current research involves methods developed in the Philippines that are now being used to control mango flowering in Tropical America.

- **FLUSH, a growth enhancer for tree species (1980)**

- **To speed up growth and advance fruiting of trees**

- **First used for a 3,000 ha mango and cashew plantations in the Magat and Pantabangan watersheds (1980's)**

The Department of Horticulture, CA, UPLB honored Dr. Ramon C. Barba in 1999 with a technology award and a citation that highlighted the impact of his mango flower induction technology during the 25th Anniversary of the Department and the 25th year of the technology.

"The advent of flower induction in mango with potassium nitrate is the single most important factor that stimulated growth of the industry. Its multiplier effect is wide and far-reaching benefiting the economic well-being of growers, investors, pesticide manufacturers, baggers, contractors, kaing-makers, bamboo raisers, viajeros, truck and jeepney operators, drivers, middlemen, wholesalers, retailers, exporters, processors, consumers, employers, and employees of mango establishment among many others. A neglected crop grown for fun, shade, and shelter before and after the introduction of the technology, yield of mango was 2 and 6 metric tons per hectare, respectively. Whereas few or none existed in the past, by 1995 alone there were at least 174 professional mango contractors, 33 "dried" mango manufacturers, 105 processed mango products, and about 20 mango growers associations. These and mango's contribution to the national economy, estimated at 7 billion pesos in gross value and 43 million dollars in foreign exchange earnings, are largely due to the technology unraveled at UPLB".

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YIELD OF MANGO IN TONS PER HECTARE IN RELATION TO FLOWER INDUCTION

PHILIPPINES			
Before adoption	1970	-	3.3
Early adoption	1975	-	5.1
Full adoption	1980	-	9.6
WESTERN VISAYAS			
Before adoption	1970	-	1.5
Early adoption	1975	-	3.5
	1977	-	12.9
Full adoption	1980	-	22.6
	1985	-	22.6

Ref. Mango Statistics, PCARRD, 1996

VOLUME OF PRODUCTION IN THOUSAND METRIC TONS			
	1995	1996	1997
Banana	1,540	1,521	1,581
Pineapple	840	845	652
Mango	495	520	574
VALUE OF PRODUCTION IN MILLION PESOS			
Mango	7,342	9,188	10,338
Banana	5,035	5,978	7,052
Pineapple	2,973	4,193	6,521
FARMGATE PRICE PESO PER KG			
Mango	7.48	14.83	17.65
Banana	1.91	3.54	4.96
Pineapple	1.80	3.27	3.93

BAS, 1997

ESTIMATED COSTS AND RETURNS FROM 50 FULL-GROWN GRAFTED TREES. BONDAD, 1985

Item	With Flower Inducer	Traditional Method
Yield ("Kaing")	1,200.00	170.00
Gross Income (P)	124,800.00	11,050.00
Total Production Cost (P)	30,401.80	3,317.60
Net Income (P)	94,398.20	7,735.00

PHILIPPINE MANGO – AFTER FLOWER INDUCTION

1. **Harvested area increased from 36,000 ha in 1980 to 159,000 ha in 2005, mostly from backyard trees**

2. Plantation Development:

- **1980 – 4,000 ha in Negros, 2,000 ha in Digos, ECJ**
- **1992 – 4,000 ha in Mindanao, GEM-USAID**
- **2005 – 100,000 more in Davao and Cotabato, GEM-USAID**

PHILIPPINE MANGO – AFTER FLOWER INDUCTION (CONT.)

3. Mango contract growing evolved after 1975

4. Contract growing of individual

5. Plantations, 10-100 ha or more

6. Corporate plantation development – Conjuangco, Menzi, Consunji, Benguet Consolidated, Marsman, others

PHILIPPINE MANGO – AFTER FLOWER INDUCTION (CONT.)

7. Mango No. 1 in gross value and GVA in agriculture

- No. 2 in export after banana - $60M
- 4% of fruits exported, mostly from backyard trees
- 22% banana exported – mostly from Corporate Farms

PHILIPPINE MANGO – AFTER FLOWER INDUCTION (CONT.)

8. Phils, No 2 in world export, 1M tons, 7.8% world share, var 'Carabao'

9. Mexico # 2, 1.6 million tons, 41% of world share, variety Manila

10. USA, Australia and China gave grants to facilitate export of 'Carabao' mango to each country

11. Thousands of nurseries were established.

PHILIPPINE MANGO – AFTER FLOWER INDUCTION (CONT.)

12. Higher business in processing of various mango products as juice, dried, fruits, other

13. Big market for production products as flower inducers (16 brands), pesticides, insecticide, fertilizer, machineries, etc.

14. Research generated in public and private institutions, universities

MANGO PRODUCTION IN MEXICO:

1. Main variety is "Manila"
2. 1975 – Raul Mosqueda Vasquez, Mango Leader in Mexico then Ph.D. student in Hawaii, requested a copy
3. The Mexican Ambassador to Philippines with Dr. EQJ visited IPB
4. 1980 – Vasquez was in PCARRD. Mexico since 1975 planted "Manila" mango on a large scale, 60,000 ha

MANGO PRODUCTION IN MEXICO:

5. 1986 – Ruben D. Joo Ayar, a Mexican delegate, in Guatemala reported:

   - Mexico plantings in 1975 were then fruiting

6. 2008 – Ruben D. Joo Ayar and team with Panfi Tabora visited plantations in the Phils about 'Carabao' mango

MANGO PRODUCTION IN LATIN AMERICA:

1. Barba, Tabora and Mondoñedo delivered monthly seminars each year
   - from 1985 to 1990
   - in Mexico, Guatemala, Honduras, Costa Rica, Ecuador, Peru and Brazil
   - sponsored by USAID

2. 21 years later
   - 145,000 ha new hectarage for export
   - 70% share of world trade with value of 1 billion USD

MANGO PRODUCTION IN LATIN AMERICA (Cont)

3. Mexico – 104,000 ha in 1988 increased to183,000 ha in 2007
   - Volume of 50,000 tons in 1988 increased to 1,600,000 tons in 2003

4. Costa Rica (8,000 ha), Guatemala (8,000 ha), Nicaragua and Honduras (3,000 ha)
   - Harvest advanced to February – April to avoid peak harvest of Mexico in May

MANGO PRODUCTION IN LATIN AMERICA (Cont)

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MANGO PRODUCTION IN LATIN AMERICA (Cont)

5. Peru developed 14,000 ha and Ecuador some 6,600 ha for export.

6. 1990 – Brazil – Petronila Valley, part of dry tropics

- planted to 20,000 ha
- non-existent before 1987
- now rivals Mexico.

MANGO PRODUCTION IN LATIN AMERICA (Cont)

7. Hydrothermal plants monitored by USDA APHIS officers must operate fully on schedule times

- schedule of monitoring from one country to another, NOW programmable with KNO_3

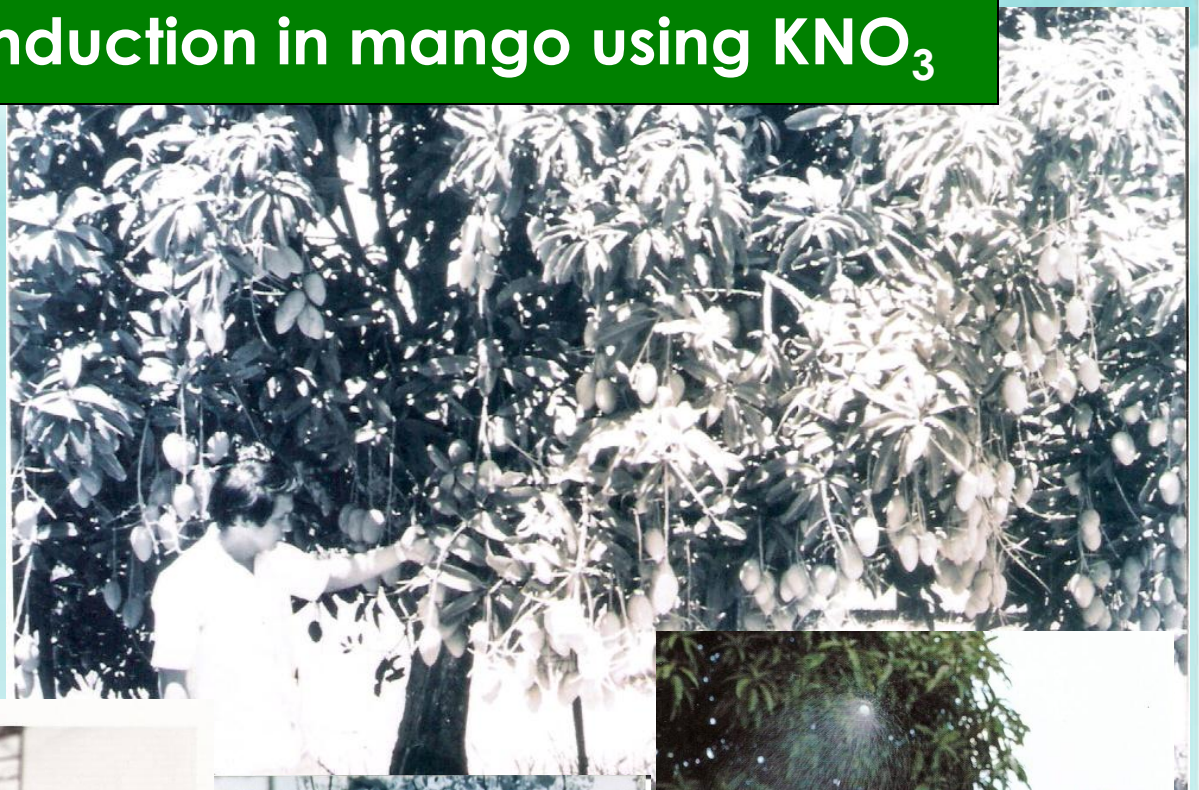
In these 7 countries – a mix of small, medium and large plantations get an income of US$3,000-US$8,000 per ha

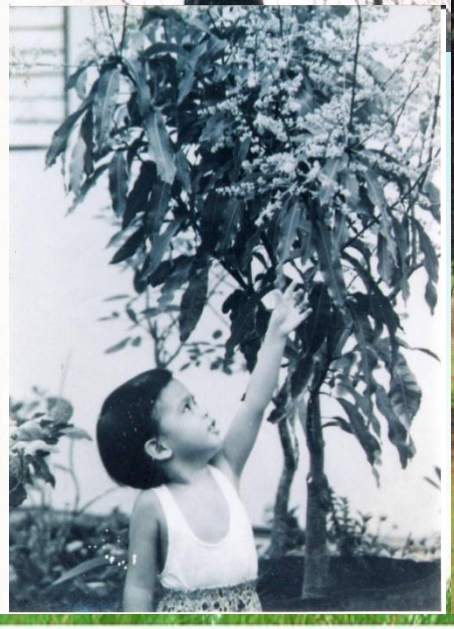
- Not possible with natural flowering, seasonal

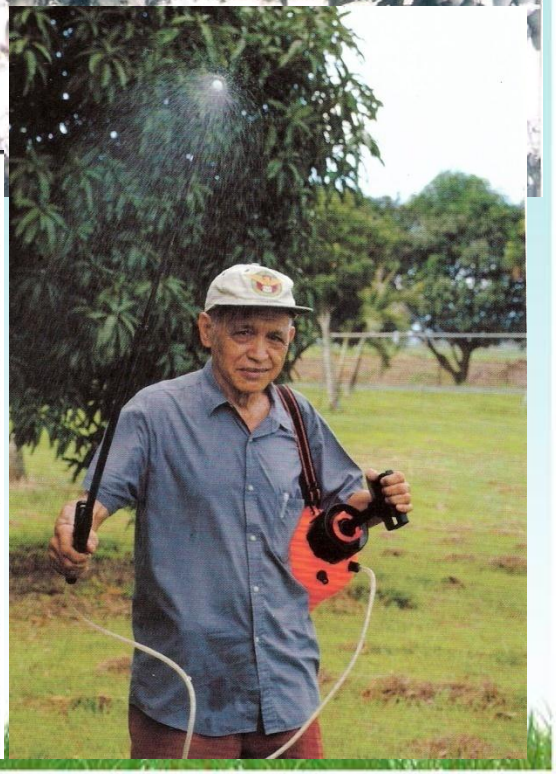
Other countries that have favorably used KNO3:

1. Puerto Rico
2. Kenya
3. Australia
4. Hawaii
5. Africa
6. Venezuela
7. Vietnam
8. Latin American countries
9. Southeast Asia

Discovery of flower induction in mango using KNO_3







CURRENT RESEARCHES

Somatic Embryogenesis in 'Carabao' Mango

- ✓ propagation
- ✓ conservation
- ✓ genetic transformation

Somatic Embryogenesis in 'Carabao' Mango

- **PFA Best Poster, 2000**
- **CSSP Best Paper, 2001**
- **PFA Best Paper, 2009**
- **LBSCFI-PAARFI Outstanding R&D Award, 2009**

***In Vitro* Cellular & Developmental Biology – Plant (by Springer)**

- **2002**
- **2011**

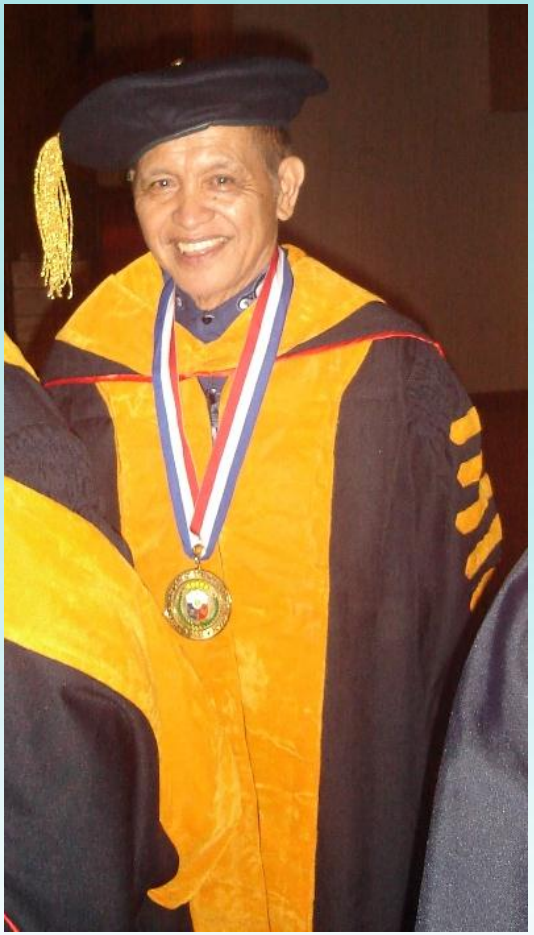
CURRENT RESEARCHES

Mango Rejuvenation & Flowering (Del Monte Phils, Inc)

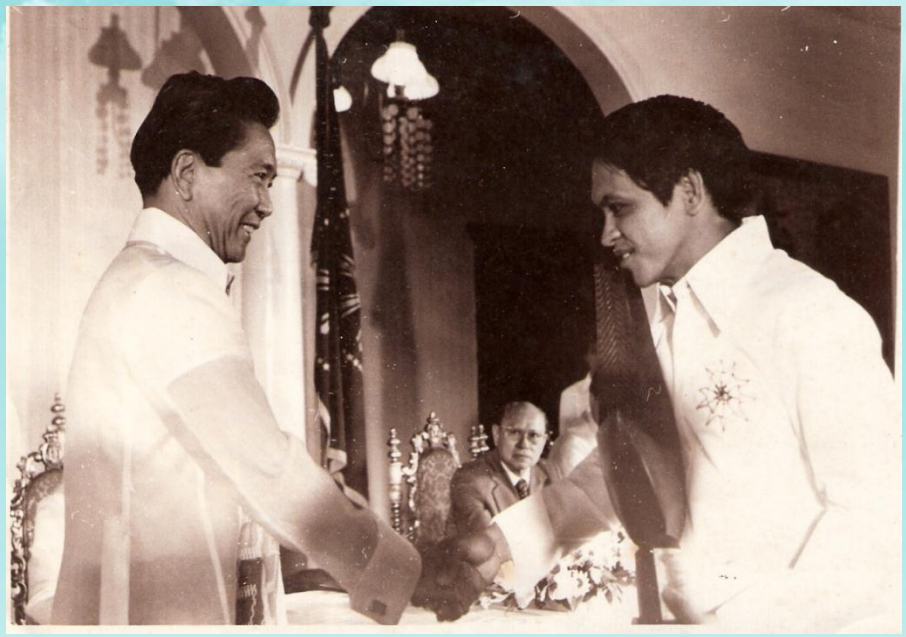
AWARDS

National Academy of Science & Technology (NAST), DOST

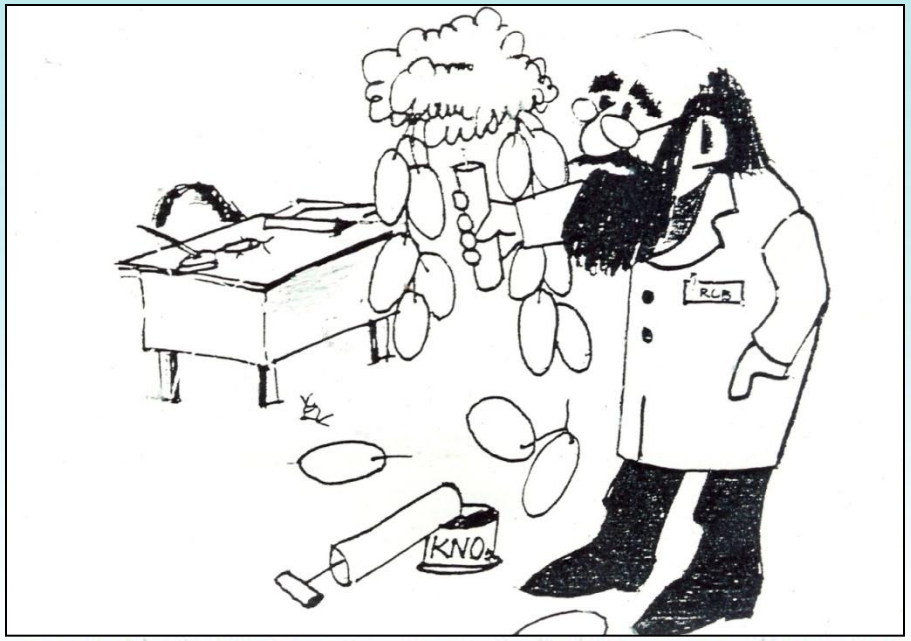
Academician, 2004



National Scientist, 2014



TOYM (1974)



5 Filipinos break into top 100 Asian scientists list

03:00 PM May 1st, 2016

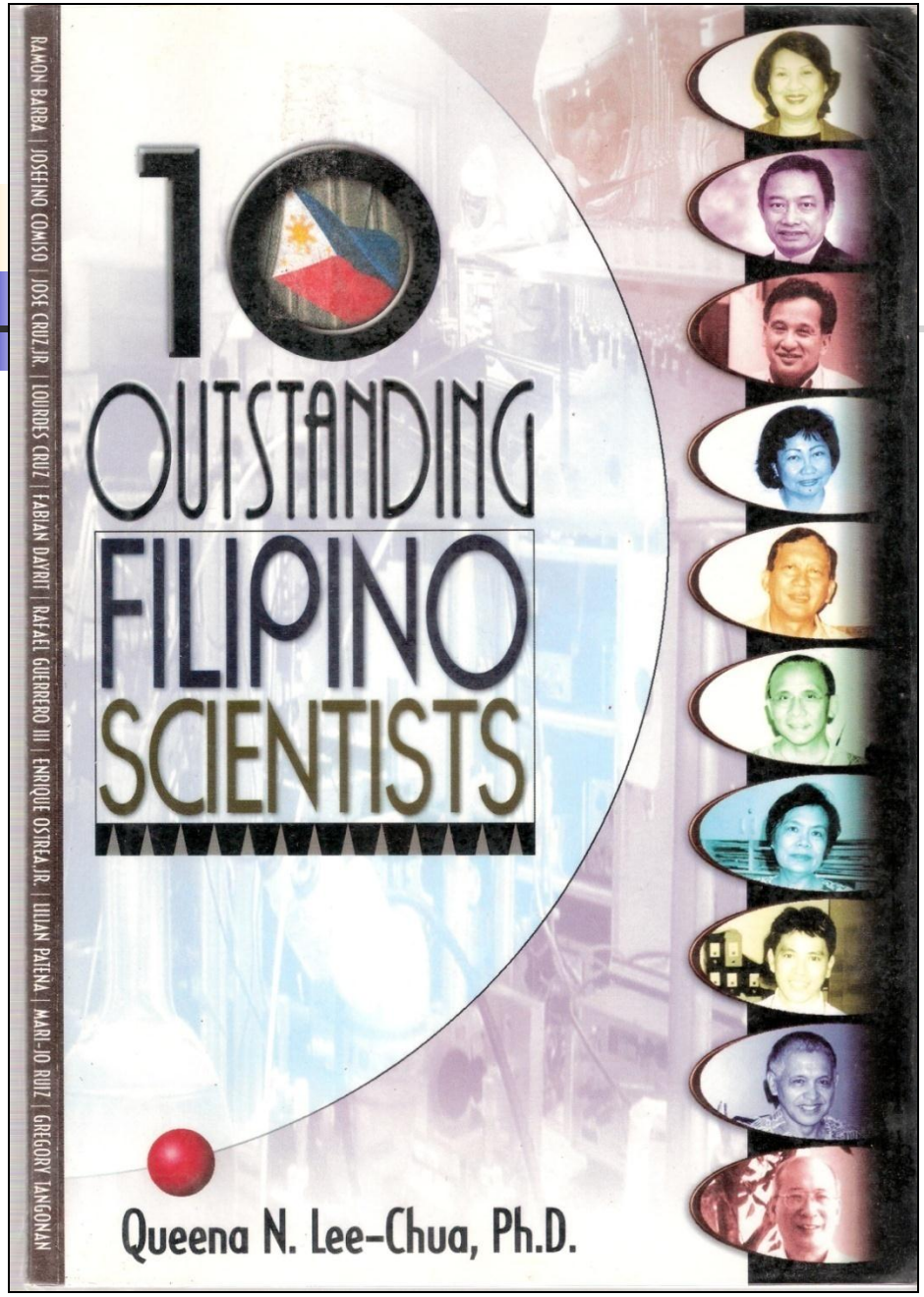
Five Filipinos were included in the *maiden "Asian Scientists 100" list* released recently by *The Asian Scientist magazine.*

Leading the Filipino scientists on the list is *National Scientist Ramon Cabanos Barba*, ranked third on the list.

3rd **7th** **9th** **10th** **12th**

National Academy of Science & Technology (NAST) - Featured in SALINLAHI, Philippine Heritage Center

- Flower induction of mango by KNO_3 , , 1997
- Micropropagation of banana, with LF Pateña & OP Damasco, 1997


RAMON BARBA | JOSEFINO COMISO | JOSE CRUZ JR. | LOURDES CRUZ | FABIAN DAYRIT | RAFAEL GUERRERO III | ENRIQUE OSTREA JR. | LILIAN PATENA | MARI-JO RUIZ | GREGORY TANGONAN
10
OUTSTANDING
FILIPINO
SCIENTISTS
Queena N. Lee-Chua, Ph.D.


Mango Hero
RAMON CABANOS BARBA

- **Featured in a Booklet “Philippine Mangoes the Whole Year Round by Dr. Benito S. Vergara. Philippine Science Heritage Center, NAST, 1996**
- **Rizal Pro Patria Presidential Award for Tissue Culture (1980)**
- **IBM/DOST S&T Award (1989)**
- **SEARCA/Dioscoro L. Umali Achievement Award in Agricultural Development (2011)**
- **World Intellectual Property Office (WPO) (Switzerland) recognition of technology (2007)**

NEW TISSUE CULTURE MEDIUM

BP, developed by Barba & Pateña

1. **Based on nutrient analysis of tissues**
2. **Superior to the famous MS medium of Murahige & Skoog for such plants as:**

- **mango (PFA Best Poster, 2000; CSSP Best Paper 2001;**
- **calamansi & pummelo (CSSP Best Paper Finalist 1978),**
- **potato (CSSP Best Paper Finalist, 1992),**
- **orchids (PAPTCB 2nd Best Paper, PARRFI Best Research Project 2003)**
- **R medium, FCSSP Best Poster Finalist, 2000**

MICROPROPAGATION and CONSERVATION of INDIGENOUS ORCHIDS in the PHILIPPINES*

LILIAN F. PATEÑA*, SIMEONA V. SIAR*, MARY ANN O. CAJANO**,
ALICE B. FORMARAN*, CLAUDETTE N. DACUMOS*, AND RAMON C. BARBA*,

Institute of Plant Breeding, Crop Science Cluster
College of Agriculture and **Museum of Natural History,
University of the Philippines Los Baños, College, Laguna 4031 Philippines

*Paper presented during the **Darwin OSSSU Orchid Seed Conservation Workshop, 15-19 October 2007, Chengdu, China,**

Micropropagation of orchids using

BP (Barba and Patena), formerly R, Medium

BARBA AND PATENA (BP) MEDIUM IS SOLD COMMERCIALLY. FOR DETAILS:

http://hengduanbiotech.com/showprodinfo.asp?listid=52&cataid=26

http://www.hengduanbiotech.com/showprodinfo.asp?listid=100&cataid=31

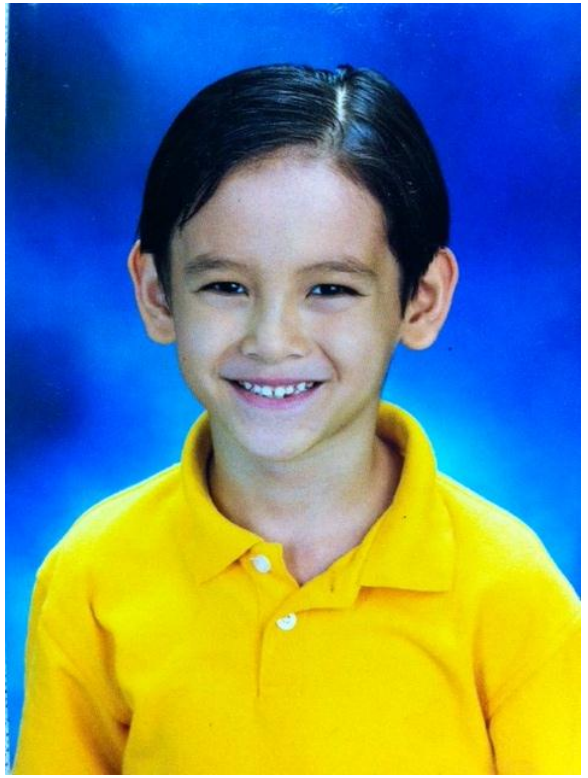
Plant Cell and Tissue Culture Laboratory (PCTCL) Team

2016 College of Agriculture and UPLB Outstanding Research Team

- One unique attribute of the team is its ability to perceive solutions to complex problems and to produce results with minimum expenditure and gadgetry.

“FAMILY”

The Scientist is married to Corazon Veron Cruz and is now a proud Lolo to 9 year-old grandson, Carlitos, son of Ricky and Danie Largo Barba



9 year-old grandson, Carlitos,
The future NATIONAL SCIENTIST

It takes a dream to create a new technology and a new technology creates new dreams!