AGRI-MACHINERIES • POULTRYHOUSE • GREENHOUSE • IRRIGATION DESIGN & EQUIPMENT • CONSTRUCTION

Office Address: Sitio Kasilagan, San Juan de Milla, Paniqui, Tarlac
E-mail Add: irritech_3c@yahoo.com
Cellphone No. : 0908–89 66681 To 84

AUTHORIZED DEALER
KUBOTA
YANMAR
MITSUBISHI
ROBIN
KAMA
SUMO
GENSETS
PUMPS
DRYER
DRIP & SPRINKLER EQUIPMENTS
POULTRY & PIGGERY EQUIPMENTS
SERVICES OFFERED:
- Design & maintenance of Drip & Sprinkler Irrigation System
- Landscape Irrigation
- Agricultural Irrigation Consultancy
- Swimming Pool Design
- Construction of Poultry and Piggery Buildings
- Design and Installation of Mechanical Dryers

ALSO AVAILABLE:
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- P.E Bags
- Insect Net
- Seeds
- Plastic Crates
- Connector
- Filter
*UV Stabilized P.E Film
*HDPE PIPES and FITTINGS.

GREETINGS FROM:
ENGR. RODELL B. ACERES
ENGR. JINEPEL J. ACERES
CAMILLE J. ACERES
CHARLES ADRIANNE J. ACERES
CLARISSE J. ACERES
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| About the Organizers | 42 |
As Chairperson of the International Tropical Fruits Network and as the Secretary General of The Ministry of Agriculture Malaysia, I would like to sincerely thank TFNet, The Bureau of Plant Industry Philippines, the Philippines Fruit Association, Inc., and the Department of Agriculture Philippines for organizing this international symposium on tropical fruits with subject theme Towards Sustainable Fruit Production and Global Food Security.

Trade in fruits and vegetables has expanded rapidly than trade in other agricultural commodities, claiming a significant share of the world trade. 95% of the fruits are produced in developing countries. Fruits have mostly been cultivated for domestic consumption but is increasingly becoming very popular internationally as other nations have become accustomed to their exotic taste and value.

Agriculture is deemed as an important engine of countries’ economy growth and most of the countries strongly depend on this sector. This part of the world has a dynamic geography producing a variety of food and agriculture. Some of the countries in this region rank as global top exporters of rice, fruits, vegetables and coffee. Strong trade links in these products with countries across the globe have been established. In this forum we have multinational representations with one agenda to improve tropical fruit production sustainably and in turn enhance food security.

We need to revitalize and intensify the fruit sector through modern technology, production of high quality and value-added products, wider application of ICT and use of better marketing approaches emphasizing product standards and farm accreditation in order to get safe produce.

Emphasis today is to increase farmers’ income and quality of life. Strategies are needed to be in line with nutritional aspect of the food system to ensure that people stay healthy and productive as well as strategies to increase fruit production by way of optimizing to the fullest of high potential use of land, improving agriculture infrastructure, upgrading value chain in fruit productions, expanding compliance in fruit productions, strengthening human capital especially in research and development and enhancing mechanization towards minimizing post-harvest losses.

I wish everyone a fruitful discussion throughout this event.

YBHG. DATUK SERI DR. ISMAIL BIN HJ. BAKAR
Secretary General,
Ministry of Agriculture and Agro-Based Industry, Malaysia
and
Chairperson,
International Tropical Fruits Network
As the Chief Executive Officer of the International Tropical Fruits Network (TFNet), it is a pleasure to welcome all notable guests, presenters, and participants to the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security here in beautiful Davao City.

Tropical Fruits are an important food group, contributing up to 50% of micronutrient intake in developing countries. In addition to conventional nutrients, they also have bioactive compounds with purported benefits such as improved intelligence, prevention of disease, and a longer life. It is estimated that about 98% of tropical fruits are grown in developing countries, mostly by smallholder farmers. Thus, tropical fruits play an important role for millions of rural households around the world for income generation. Meanwhile, demand for tropical fruits in developed countries has been increasing over the past decade as consumers seek healthier food options. Although current tropical fruit exports are only about 10% of total production, export numbers are projected to increase to meet the rising demand.

As the industry expands to meet increasing demand, it is also our responsibility to use sustainable production techniques to protect the environment, human communities, and public health. The tropical fruit industry is also affected by reduced productivity, postharvest losses, pest and diseases, low fruit quality, poor marketing, trade issues, and climate change.

In 2016, TFNet launched its Global Action Plan for Tropical Fruits (GAPROF) with the aim of supporting sustainable agriculture, strengthening value chains, enhancing markets, increasing profitability of farming enterprises, and promoting balanced nutrition for all. The plan illustrates how the tropical fruit sector can contribute towards the achievement of the United Nation’s Agenda for Sustainable Development.

In this Symposium, we are inviting stakeholders from all fields: farmers, entrepreneurs, traders, distributors, government agencies, policy makers, researchers, the academe, and consumers to work together towards sustainable fruit production and global food security. I encourage everyone to actively participate in the discussions.

I would like to thank the Department of Agriculture - Bureau of Plant Industry, Philippines and the Philippine Fruit Association for organizing this symposium with TFNet. I also would like to thank the Food and Agriculture Organization of the United Nations, Department of Agriculture – Region XI, Tagum Agricultural Development Co., University of Southeastern Philippines, and the Consulate General of Malaysia in Davao City for their unwavering support.

DR. MOHD DESA HASSIM
Chief Executive Officer,
International Tropical Fruits Network
On behalf of TFNet board members and on behalf of the Organizing Committee (including The Department of Agriculture – Bureau of Plant Industry, Philippines (BPI), and the PhilFruits Association, Inc. (PFA)), I am delighted to welcome you all to this important “International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security”.

We are here today because we believe that the tropical fruits sector has the great potential to significantly reduce poverty, hunger and malnutrition around the world. We are here today because we believe that TFNet is leading the way to reach the noble goal of touching the lives of real people, especially those who are living in despair, looking for job, basic food or better nutrition. And we are here today because we believe in the future of this great international network to further strengthen the collaboration among member countries to deliver innovations for the tropical fruits sector.

The tropical fruits industry is at a key moment as the rising production and demand is still threatened by various problems such as environment degradation, climate changes, and plant diseases. Trade in tropical fruits still faces tariff and especially and non-tariff barriers undermining the industry’s efforts to expand trade volume and revenue.

There is no better place than here or better time than now to discuss, exchange ideas, and make recommendations to address these challenges. Speaking based on the facts, I am confident that this international network has the best assets and the best minds to be—as its stated vision says—the leading global player in facilitating international cooperation in production, consumption, logistics, marketing and trade development in the global tropical fruits sector.

For that, I invite you all during this important meeting and in our active discussions to make sure that our work both during and after this meeting will contribute to solving the problems of the most vulnerable in our society. In closing my remarks, I particularly thank the Organizers both on and behind the scenes for their hard work and dedication for the preparation of this important International Symposium.

I wish all of us a successful and fruitful meeting.

MR. MANITRA RAKOTOARISOA
Economist,
Trade and Markets Division,
Food and Agriculture Organization to the United Nations
On behalf of the PhilFruits, Inc. Board of Trustees, my warmest felicitations and warm welcome to all the guests and participants of the "International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security". It is indeed with great pride that the Philippines is considered to host this commendable event.

Together with our collaborating agencies, the International Tropical Fruits Network (TFNet) and the Bureau of Plant and Industry (BPI), our collective aspirations and commitment for a scientific process to national and international sustainability on tropical fruits production and marketing will contribute tremendously in the tropical fruit industry. We are reenergize to address issues concerning tropical fruits in Asia and the world through various scientific studies towards the general welfare of the humanity.

May all the guests and participants of this prestigious event will gain fruitful undertakings and pave the way towards the fulfillment of our objectives.

Mabuhay!

DR. MARILYN E. ROMAQUIN
President
PhilFruits, Inc.
It is a great pleasure to welcome the international and local guests and participants to the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security.

The Philippines – being the host country considers this international symposium as one of the significant gatherings which may bring camaraderie, collaborations and technology dissemination among TFNet member countries for the world food advancement and security.

The Organizing Committee has done commendable efforts and selected the most beneficial topics favourable in today’s challenging issues in tropical fruit industry not only in Asia but the entire world. Issues on climate change mitigation, preserving genetic diversity, food security and nutrition, empowering smallholders through sustainable fruit production, market trends, among others, will provide solutions to these challenging issues. It also provides the participants a platform to exchange ideas, discover novel opportunities, reacquaint with colleagues, and broaden the perspective of innovations and practices.

Additional highlight in this international gathering are promoting the vast land of fruit production in Davao Region and its rich culture and tradition of the Filipinos especially in the Mindanao Island.

Wishing a fruitful symposium to all!

DR. VIVENCIO R. MAMARIL
OIC, Director
Bureau of Plant Industry
My warmest greetings to the Plenary Speakers, Research Presenters and participants of the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security on August 29-September 3, 2016 at Grand Regal Hotel, Davao City.

I commend the International Tropical Fruits Network (TFNet), the Bureau of Plant Industry (BPI) and the Philippine Fruit Association, Inc. (PFAI) as you hold this joint Board of Trustees Meetings and scholarly and informative events for the advancement of our tropical fruit industry.

Tropical fruits play an imperative role in our agricultural economy, particularly in fulfilling the goals of fruit production and management, fruit growers and exporters’ welfare, and food security. Thus, your sector must remain abreast of the latest trends in tropical fruit production to ensure sustainability and competitiveness in international market. May this symposium successfully promote more effective cultivation techniques, help achieve sustainability and global food security and address the challenges of today’s competitive global market.

As we encourage our local fruit growers, academic researchers, community and extension technologists, entrepreneurs and other stakeholders to apply the technologies and good practices that keep farms productive throughout our country, we also empower them to sustain the production, supply, promotion and marketing chain of our fruit industry. Let the knowledge and technology shared in this international gathering lead to global realization of equitable progress.

Congratulations to all! Mabuhay!

USEC. EVELYN G. LAVIÑA
Undersecretary for Agribusiness and High Value Crops,
Department of Agriculture
My warmest greetings to the participants and organizers of this International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security.

Congratulations to the organizers, Phil Fruits Association, Inc. (PFA), the Bureau of Plant Industry (BPI) and the International Tropical Fruits Network (TFNet), which simultaneously holds its Board of Trustees meeting of 14 TFNet member countries. And my warmest welcome to all the participants from Malaysia, China, Vietnam, Sri Lanka, Sudan, India, Saudi Arabia, Bangladesh, Indonesia, Nigeria, Syria, Fiji, Australia and the Philippines.

Your symposium comes at a time when the Philippines once more brims with so much hope and fervor as it embraces its new government’s call for far-reaching political and social changes. As we therefore explore out-of-the-box approaches in doing agriculture and fisheries in our country, we hope that this virus of enthusiasm will infect your meeting towards exploring new technologies and innovations in fruit production, processing and marketing. Although each of our countries aims for its own globally competitive fruit industry, I am encouraging all the participants in this symposium to be selfless in sharing their knowledge, insights and resources towards a globally collaborative, productive and sustainable fruit industry.

May this symposium therefore be bold and innovative enough to go beyond discussions on fruit research towards possible joint applications in product development, agri-business, health and nutrition, economic and trade policy, sustainable fruit production, promotion and marketing, and other areas that will speed up the growth and progress not only of the international fruit industry, but also of each of our nations and peoples.

Welcome to the Philippines, the Pearl of the Orient Seas!

Welcome to Davao City, the Philippines’ Fruit Basket!

SEC. EMMANUEL F. PIÑOL
Secretary,
Department of Agriculture
SYMPOSIUM OVERVIEW

Tropical fruits are important crops to developing countries, both from a nutritional and a commercial perspective. They are relatively cheap and are an accessible source of vitamins, minerals, dietary fiber, and other phenolic compounds that are vital to human health, reducing the incidence of micronutrient malnutrition that leads to stunting and wasting in children below 5 years of age.

While they are mostly cultivated for domestic consumption, trade volumes have been consistently increasing over the years. The expansion of the tropical fruit industry relies on institutional support for the continuous improvements in production, postharvest, and marketing.

Addressing the gaps in the supply chain through effective policies, technology interventions, capacity building, development of quality standards, and the formation of legal commercial entities can improve fruit quality and increase the income of small farmers.

Supporting the growth of the tropical fruit industry around the world will significantly contribute towards the United Nation’s sustainable development goal of zero hunger and no poverty by 2030.

However, steps have to be taken to implement sustainable food production systems that remain resilient amidst the shocks brought about by climate change. Improving the genetic diversity of crops and preserving our ecosystems will strengthen our capacity to adapt to extreme weather, drought, flooding, and pests and diseases.

Cognizant to these issues, the International Tropical Fruits Network (TFNet), the Department of Agriculture (DA) – Bureau of Plant Industry, Philippines (BPI), and the PhilFruits Association, Inc. (PFA) are jointly organizing the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security on 29 August – 03 September 2016 in the Grand Regal Hotel Davao, Davao City, Philippines with support from the Food and Agriculture Organization of the United Nations (FAO) and the private sector.

OBJECTIVES

1. Discuss how sustainable tropical fruit production can contribute towards global food security and mitigate the effects of climate change, especially for developing countries.
2. Present the most recent scientific findings tropical fruits.
3. Assess marketing opportunities for tropical fruits.
4. Deliberate on policies that can enhance research, production, and marketing.

SYMPOSIUM TOPICS

- Health and Nutrition
- Crop Diversification, Germplasm Collection, and Varietal Improvement
- Molecular Biology and Biotechnology
- Climate Change Mitigation
- Crop Protection and Pest and Disease Management
- Postharvest Technologies, Product Development, and Utilization
- Sustainable Production and Management
- Agribusiness, Economics, Marketing, and International Trade
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<tr>
<td>Aug 29 (Mon)</td>
<td>Registration and Arrival</td>
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<td>Aug 30 (Tue)</td>
<td>Symposium – Day 1</td>
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| 08:00      | Registration  
Opening of Posters and Exhibits                                                                                                 |
| 09:00      | Opening Ceremony  
1. Philippine National Anthem  
2. Opening Remarks:  
   a) Dr. Mohd Desa Hassim, Chief Executive Officer, International Tropical Fruits Network (TFNet)  
   b) Dr. Marilyn Romaquin, President, Philippine Fruits Association, Inc. (PFA)  
   c) Dr. Vivencio Mamaril, OIC Director, Bureau of Plant Industry  
   d) Mr. Manitra Rakotoarisoa, Food and Agriculture Organization of the United Nations, Rome  
3. Welcome Address: Hon. Marissa S. Abella, Councilor and Chairperson of the City Council Committee on Agriculture and Food, Davao City, Philippines  
4. Special Address: Usec. Evelyn Laviña, Undersecretary for High Value Crops, Department of Agriculture, Philippines  
5. Group photo session |
| 10:00      | Keynote Paper:  
Are Tropical Fruits Providing Income Opportunities and Better Nutrition for the Poor?  
by Mr. Manitra Rakotoarisoa  
Food and Agriculture Organization of the United Nations, Rome, Italy |
| 10:30      | Snack Break                                                                                                                            |
| **Plenary Session 1** | Session Chairman: Dr. Mohd Desa Hassim, International Tropical Fruits Network (TFNet)                                                                 |
| 11:00      | Paper 1. Horticulture for Sustainable Development and Global Food Security  
by Dr. Hannah Jaenicke  
GlobalHort, Germany |
| 11:20      | Paper 2: Mitigating the Effects of Climate Change in Tropical Fruit Production Systems  
by Dr. Felino P. Lansigan  
Dean, College of Arts and Sciences, University of the Philippines Los Baños and Member, Climate Change Commission, Philippines |
| 11:40      | Paper 3: Empowering Smallholders through Fruits Production in Rural Asia and Africa  
by Eng. Wassfi Hassan El-Sreihiin  
Secretary General, African Asian Rural Development Organization (AARDO) |
<p>| 12:00      | Lunch Break                                                                                                                            |</p>
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<td>13:00</td>
<td><strong>Paper 4: Tropical Fruit Production in Latin America: Challenges and Opportunities Amidst a Changing Climate</strong>&lt;br&gt;by Mr. Frank Lam&lt;br&gt;Representative, Inter-American Institute for Cooperation on Agriculture, Dominican Republic</td>
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<td>13:20</td>
<td><strong>Paper 5: Sustainable Approaches for Improving the Fruit Sector in Sri Lanka</strong>&lt;br&gt;by H.M.S. Heenkenda&lt;br&gt;Additional Secretary for Agriculture Technology, Ministry of Agriculture, Sri Lanka</td>
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<td><strong>Paper 7: Fruit Production Systems in the Pacific</strong>&lt;br&gt;by Mr. Shalendra Prasad&lt;br&gt;Ministry of Agriculture, Fiji</td>
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<td>14:00</td>
<td><strong>Paper 8: Mitigation of Foc TR4: Updates and the need for regional collaboration</strong>&lt;br&gt;by Dr. Agustin B. Molina&lt;br&gt;Regional Coordinator, Asia-Pacifc Bioversity International</td>
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<td>Snack Break</td>
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<td>14:40</td>
<td><strong>Paper 9: Tropical Fruits of Bangladesh</strong>&lt;br&gt;by Mr. Manik Chandra Karmoker&lt;br&gt;Ministry of Agriculture, Bangladesh</td>
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<td>15:00</td>
<td><strong>Paper 10: Avocado Production in Myanmar</strong>&lt;br&gt;by Mr. Sai Phyo Lwin Oo&lt;br&gt;Managing Director, SPSH &amp; Associates Co., Ltd.</td>
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<td>15:20</td>
<td>Poster Session</td>
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<td>19:00</td>
<td>Fellowship dinner and cultural show by the University of Southeastern Philippines (USEP)</td>
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Aug 31 (Wed) Symposium – Day 2

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<td>08:30</td>
<td><strong>Plenary Session 4</strong>&lt;br&gt;Session Chairman: Prof. Lilian F. Pateña, Associate Professor, College of Agriculture, University of the Philippines Los Baños</td>
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<td>08:30</td>
<td><strong>Philippine Recognition as a Pest Free Area for Mango Pulp Weevil and Mango Seed Weevil</strong>&lt;br&gt;by Ms. Merle B. Palacpac&lt;br&gt;Chief, National Plant Quarantine Services Division, Bureau of Plant Industry, Department of Agriculture, Malate, Manila, Philippines</td>
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<td>08:50</td>
<td><strong>PhilGAP</strong>&lt;br&gt;by Mr. Santiago Palizada&lt;br&gt;Bureau of Plant Industry, Department of Agriculture, Malate, Manila, Philippines</td>
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<td>09:10</td>
<td><strong>The Discovery of the Mango Flower Induction Technology and the Research Process</strong>&lt;br&gt;by Dr. Ramon C. Barba&lt;br&gt;National Scientist, National Academy of Science and Technology, Bicutan, Taguig, Metro Manila Philippines</td>
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<td>09:30</td>
<td>Snack Break</td>
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<td>Time</td>
<td>Concurrent Technical Sessions</td>
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| 10:00 | Differences in the Response of Strawberry Cultivars to Chilling and Subsequent Growth Under High Temperature Conditions  
by Nadine A. Ledesma  
De La Salle University, Manila, Philippines                                                                                 | Selection of Banana Cultivars Against Tolerance to Strong Wind Damage in the Philippines  
by Lavernee S. Guico  
Institute of Plant Breeding, University of the Philippines Los Baños, Philippines                                      |
| 10:20 | Banana Bunchy Top Virus Incidence in Quirino Province  
by Fredisiminda M. Dolojan  
Quirino State University, Quirino, Philippines                                                                         | Characterization and Evaluation of Promising Citrus Varieties for Commercial Production  
by Nancy T. Aspuria  
Bureau of Plant Industry-Baguio, Baguio City, Philippines                                                             |
| 10:40 | Symptoms Variation and Sequence Analysis of Different Banana Bunchy Top Virus (BBTV) Isolates in the Philippines  
by Maricel C. Gonzales  
Institute of Plant Breeding, University of the Philippines Los Baños, Philippines                           | Breeding Strawberry for Organic Production  
by Danilo P. Padua  
Benguet State University, La Trinidad, Benguet, Philippines                                                             |
| 11:00 | Geographic Distribution and Vegetative Compatibility Grouping Analysis of Fusarium oxysporum f.sp. cubense isolated from Banana Growing Areas in Luzon and Visayas  
by Alyssa M. De Castro  
Institute of Plant Breeding, University of the Philippines Los Baños, Philippines                             | Native Fruit Species in the Philippines and their Phenotypic Traits and Potential Uses  
by Pablito M. Magdalita  
Institute of Plant Breeding, University of the Philippines Los Baños, Philippines                                       |
| 11:20 | Combating Foc TR4 in the Philippines Using Resistant Somaclones  
by Lorna E. Herradura  
Bureau of Plant Industry – Davao NCRDPSC                          | Development and Evaluation of Durian (Durio zibethinus) Seed Flour Based Edible Film for Food Application  
by Mylene A. Anwar  
Department of Food Science, Central Mindanao University, Bukidnon, Philippines                                      |
| 11:40 | Evaluation of Disinfestants and Boot Scrapers in Wet And Dry Conditions in Managing Fusarium Wilt in Bananas  
by Tamsi Jasmin D. Gervacio  
University of Southeastern Philippines, Davao City, Philippines                                                      | Aratiles: Birds’ Fruit No More  
by Maydee O. Gervacio  
Quirino State University, Quirino, Philippines                                                                      |
| 12:00 | Lunch                                                                                                           |                                                                                   |
| 13:00 | Managing Fusarium Wilt of ‘Cavendish’ Banana Using Microbial Control Agents and Resistant Somaclones  
by Belly T. Dionio  
University of Southeastern Philippines, Compostela Valley Province, Philippines                                     | Starfruit and Rattan: Now an Economic Star  
by Jerome Taguiam  
Quirino State University, Quirino, Philippines                                                                       |
| 13:20 | Etiology of Destructive Dragon Fruit Fungal Pathogens in the Philippines by Conventional and Molecular Techniques  
by Jamie Ann B. Tumolva  
Institute of Plant Breeding, University of the Philippines Los Baños, Philippines                                       | Jackfruit Seed Cookies  
by Isabel F. Salvador  
Quirino State University, Quirino, Philippines                                                                       |
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<th>Speaker</th>
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<tr>
<td>13:40</td>
<td>Host Plant Resistance in Mango Against Fruit Fly and Anthracnose</td>
<td>Ana Kristine S. Barcos</td>
<td>Institute of Plant Breeding, University of the Philippines Los Baños, Philippines</td>
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<td></td>
<td>by Ana Kristine S. Barcos</td>
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<td></td>
<td>The Effect of Packaging and Stacking on the Quality and Marketability of Mandarin (Citrus reticulata Blanco var Szinkom)</td>
<td>Perlita A. Nuevo</td>
<td>Postharvest Horticulture Training and Research Center, University of the Philippines Los Baños, Philippines</td>
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<tr>
<td>14:00</td>
<td>Biological Control of Snoutbeetle (Metapocyrtus (Trachycyrtus) spp.) on Strawberry (Fragaria x ananassa) and Citrus (Citrus spp.) in the Cordillera Region, Philippines</td>
<td>Maritess A. Alimurung</td>
<td>Baguio National Crop Research, Baguio, Philippines</td>
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<td>by Maritess A. Alimurung</td>
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<td></td>
<td>Cherry and Caramay Tamed to Suit the Palate: Jellies from the Wilds</td>
<td>Arlyn J. Yra</td>
<td>Quirino State University, Quirino, Philippines</td>
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<tr>
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<td>by Arlyn J. Yra</td>
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<td>14:20</td>
<td>Economic Impact of Aerial Spray in the Philippine Cavendish Banana Industry</td>
<td>Larry N. Diga</td>
<td>University of the Philippines Mindanao, Philippines</td>
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<td>by Larry N. Diga</td>
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<td>Determination of Inhibitory Activity of the Bioactive Peptides, Derived from Pineapple (Ananas comosus L.) Fruit and Juice, Towards Angiotensin-Converting Enzyme</td>
<td>Jeric C. Villanueva</td>
<td>Institute of Plant Breeding, University of the Philippines Los Baños, Philippines</td>
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<td>14:40</td>
<td>Snack Break</td>
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<td>15:00</td>
<td>Symposium Wrap Up Session</td>
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<tr>
<td>16:00</td>
<td>(For PFA Members) PFA General Assembly, Election of Board of Trustees, and Awarding</td>
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**Sep 1 (Thu) Symposium Field Trip**

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<thead>
<tr>
<th>Time</th>
<th>Activity</th>
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<tr>
<td>07:30</td>
<td>International Participants</td>
<td>Travel to TADECO, Panabo, Davao del Norte</td>
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<tr>
<td>08:30</td>
<td>Arrival and Tree Planting Ceremony</td>
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<tr>
<td>09:00</td>
<td>1. Cavendish Banana plantation and Harvesting Process</td>
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<td>2. Pummelo Plantation and Harvesting Process</td>
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<td>3. Packaging Process of Pummelo</td>
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<td>4. Packinghouse Process of Banana Cavendish</td>
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<td>5. Water Treatment Process</td>
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<td>11:30</td>
<td>Lunch</td>
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<tr>
<td>07:30</td>
<td>Local Participants</td>
<td>Travel to Durian Farm and Blast Freezing Facility</td>
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<tr>
<td>08:30</td>
<td>Arrival at Durian Farm and Blast Freezing Facility</td>
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<td>11:30</td>
<td>Lunch</td>
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<td>13:00</td>
<td>International and Local Participants</td>
<td>Bangkerohan Fruit Market</td>
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<td>Aldevinco Cultural Market</td>
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<td>15:00</td>
<td>Travel Back</td>
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**Sep 2 (Fri) (For TFNet Members) 10th TFNet Board of Trustees Meeting**

**Sep 3 (Sat) Travel Back**
Abstracts for Plenary Papers

ARE TROPICAL FRUITS PROVIDING INCOME OPPORTUNITIES AND BETTER NUTRITION FOR THE POOR?
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As the world production of tropical fruits continues to rise (from 94 million tons in 2010 to 111 million tons in 2014), how the tropical fruits sector contributes directly to increasing farmers and worker’s income and combatting malnutrition deserves attention. Increased competitiveness and marketability in both domestic and international markets will help seize opportunities stemming from the fast growing demand especially in key products such as mango, pineapple and avocado. Moreover, affordable high quality tropical fruits combined with an acute awareness of health benefits will help curb malnutrition especially in low income countries. The challenges are however numerous. On the supply side, small growers of tropical fruits still lack the means to increase competitiveness and any increased revenue at the sector level does not always trickle down to small farmers and workers. Recent case studies by FAO on pineapple in Ghana, cashew nut in Tanzania and mango in the Philippines point specifically to the lack of access to credit and of risk management tools, and especially asymmetric distribution of market and trade benefits along the value chain. On the demand side, the lack of awareness of the health benefits of consuming tropical fruits is aggravated by the seasonality and storage problems, becoming a stiff barrier to domestic consumption. That the main concern of the majority of exporters of tropical fruits is finding stable supplies of good quality raw materials puts however greater emphasis on the need to deal more urgently with the supply side problem. In sum, the potential for tropical fruits to provide income opportunity and better nutrition for the poor and reduce malnutrition is vast but conditional to an increased competitiveness at each link of the value chain, and especially to ensuring a distribution of market and trade benefits reaching small growers and workers.

Keywords: Food security; nutrition; poverty alleviation; market and trade.

HORTICULTURE FOR SUSTAINABLE DEVELOPMENT AND GLOBAL FOOD SECURITY
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As the world population is projected to reach 9 million by the year 2050 and pressures such as changing weather patterns, increasing water scarcity, loss of soil fertility and productive land are limiting the options to increase food production in an environmentally and socially sustainable way, there are increasing calls for novel approaches to sustainable development. The UN Sustainable Development Goals (SDGs) are one approach to focus global efforts. Thanks to direct and indirect benefits of production, processing, marketing and consumption of horticultural crops, horticulture can make a significant contribution to the achievement of several of the SDGs and hence to the achievement of global food security. These diverse benefits are captured in the concept of ‘Horticulture for sustainable development – H4sD’. Horticultural activities pave the way for the integration of subsistence farmers, the landless and other resource-poor people once excluded from markets into broader economic activities, and thus play a significant role in sustaining rural communities and improving the living conditions of the poor. In addition, processing, trading and other elements of the value chain for horticultural crops create comparatively more employment and open additional new market opportunities than can be realized with staple crops. In addition, fruits and vegetables play a pivotal role in any approach to fight the threats of hunger, micronutrient deficiency and over nourishment and hence contribute to better health which is an important component of food security. Because horticultural products are generally high-value crops, they directly create wealth via higher incomes due to higher market prices compared to staples. Moreover, horticulture has positive impacts on the empowerment of women and contributes to the protection and enrichment of agro-biodiversity and liveable cities.

Keywords: UN Sustainable Development Goals; food security; empowerment of women.
EMPOWERING SMALLHOLDERS THROUGH FRUITS PRODUCTION IN RURAL ASIA AND AFRICA

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Agriculture sector is the backbone of most of the African and Asian countries, which contributes significantly to its economic growth and development and provides home to majority of global agricultural population. It plays a crucial role in the economies of rural population and provides food, income and employment to rural areas. Rural households are largely dependent on agriculture sector, followed by the non-farm activities for their livelihood. Farmers are predominantly marginal and small landholders and the growth of agriculture sector is severely constrained by the low level of modern inputs adoption and limited access to improved technologies. Rapid increase in food demand, unsustainable use of scarce resources and increased uncertainty are putting new pressures on agriculture and small farmers. Today, one of the main global challenges is how to ensure food and nutrition security for a growing population whilst adjusting to an overall net increase of disasters, including those caused by climate change, and increased economic volatility, and ensuring long-term sustainable development. During the past six decades, world population increased from 2.5 billion to 6 billion in 2000 and 7.0 billion mark in October 2011. The world population is now projected to grow to 8.2 billion (2030) and 9.3 billion (2050). Nearly all of this increase will occur in the developing countries. The per capita availability of arable land for food production has been declining and is expected to decline further from 0.23 hectares in 2000 to 0.15 hectares per person by 2050. Income levels will be multiples of what they are now. Thus, the increase in both population and income will require additional food production and also a shift in the types of food to be produced. Therefore, the challenge is to produce enough food to meet the needs of increasing population while preserving and enhancing the natural resource base upon which the well-being of present and future generations depend.

Food security with its dimensions (availability, accessibility, affordability, quality, nutrition) is an important concern for sustainable development. It is threatened by factors such as rapid population growth, land use change, urbanization, migration, and climate change due to anthropogenic activities. Climate change is characterized by increasing atmospheric temperature, erratic rainfall distribution, more intense extreme events such as droughts and typhoons, and sea level rise affecting the area planted to fruit trees particularly in low lying areas. Climate change is now a reality based on observational evidences in many locations in different countries. For example, minimum temperature has increased over a 30-year period, and rainfall patterns have changed disturbing the growth and development of fruit trees. Regional climate analyses support the projections that future seasonal climate in some locations including the Philippines will become even warmer during the dry season, and wetter during the wet season. These changes in climatic variables are expected to significantly affect growth and development of crops resulting to reduced productivity. Fruit trees will have faster growth rate leading to shorter growth duration, and thus reduced yields. Effective crop areas will be reduced due to drought, sea level rise, and other environmental stresses. Erratic rainfall patterns will lead to changes in onset of flowering and maturity affecting yields. Extreme climate variability also triggers incidence of pests and diseases that attack crops. However, there are mitigation and adaptation strategies and measures that can be implemented to reduce the adverse effects of climate change. Good practices and innovative approaches including science-based measures such as crop forecasting, adaptive cropping calendar, and agri-insurance now being piloted in the Philippines are described. Moreover, some issues and challenges for effective management of climate-related risks are also highlighted which provide opportunities for revisiting the research and development agenda in support of tropical fruit production systems.

Keywords: Food security; climate change; mitigation and adaptation.
from self consumption to sell in markets and generate significant income. As high value agricultural products are comparatively perishable in nature, it requires greater coordination in the way the food is produced, transported, processed, marketed and consumed. The small farmers are facing number of challenges relating to backward and forward linkages such as production constraints; lack of comprehensive land policy; low investments; lack of post-harvest processing and storage facilities as well as of appropriate marketing systems; and social and environmental constraints. The expansion of the tropical fruits production relies on institutional support for the continuous improvements in production, postharvest, and marketing. Addressing the gaps in the supply chain through effective policies, technology interventions, capacity building, development of quality standards, and the formation of legal commercial entities can improve fruits quality and increase the income of small farmers leading to their empowerment. Taking it into consideration, paper will discuss the challenges of small farmers and highlight the strategies to overcome these challenges to empower them. It will also highlight the role of AARDO for empowering the smallholders, through its technical activities, especially financing of development pilot projects in African and Asian countries.

Keywords: Africa and Asia; smallholder farmers; agriculture transformation; capacity building; technology interventions.

TROPICAL FRUIT PRODUCTION IN LATIN AMERICA: CHALLENGES AND OPPORTUNITIES AMIDST A CHANGING CLIMATE

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Climate change could present serious effects on the tropical fruit production worldwide, and particularly in some countries in Latin America and the Caribbean (LAC). It threatens to increase the incidence of drought in some regions and flooding in others, while increasing climate volatility and thus exacerbating variance in yields in all regions. Within LAC, climate change is expected to have different effects in different geographic areas. For example, higher temperatures have already caused critical water shortages in the Andean region (Bolivia, Ecuador, Colombia, Peru, and Chile). By changing the weather patterns in the tropical Pacific, climate change is expected to increase weather variability, with dry areas becoming even drier and rainfall levels increasing where rainfall is already high. On the other hand, steady declines in precipitation have been observed in areas of southern Chile, Peru, northeast Brazil, and most of Central America. The incidence and severity of extreme weather events are also projected to increase. Central America and the Caribbean are particularly vulnerable to increased weather extremes because of their already-high exposure level to hurricanes. Within this context, climate changes anticipated in recent years may exert additional pressure on environmental conditions under which tropical fruit production has developed, and if not properly addressed may result in significant economic and social impacts.

Keywords: Latin America and the Caribbean; climate change; mitigation and adaptation.

SUSTAINABLE APPROACHES FOR IMPROVING THE FRUIT SECTOR IN SRI LANKA

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As a tropical island in the Indian Ocean, Sri Lanka is rich in natural resources and agriculture plays a vital economic role. The fruit industry in Sri Lanka is quickly catching up to accommodate a diverse range of over 200 edible fruit species scattered in 46 ecological zones. The main fruits grown in Sri Lanka are banana, mango, pineapple, papaya, orange, lime, and passion fruit. Current issues are irregular yields and quality, poor tree management, ineffective extension, and low consumption. To address these problems, the Ministry of Agriculture is implementing the National Food Production Programme (2016-2018) that includes fruit security. Solutions include expanding cultivation through the establishment of fruit villages, increasing availability of planting material, adapting improved agro-techniques, manipulation of fruit season, productivity enhancement of mature trees, postharvest handling and product development, strengthening of R&D, promotion of consumption, quality and food safety improvement, extension, formation of associations, creating special projects, and introducing supporting policies at a national level.

Keywords: Sri Lanka, National Food Production Programme
SUSTAINABLE PRODUCTION OF INDIGENOUS FRUITS TOWARDS ADDRESSING FOOD AND NUTRITIONAL SECURITY IN NIGERIA

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Nigeria is blessed with various agro-ecologies from mangrove forest in the South coastal areas where rainfall varies between 2000-3000mm per annum, up to Sudan Savannah in the extreme North with rainfall as low as <500mm per annum. These agro-ecologies favour the production of various staples, arable, vegetable crops and fruit trees (super fruits). The country’s forests are also rich in different types of fruit trees, which are useful as food, medicine, spices and other culinary purposes. Most of these species have been exploited over the years by the populace for various purposes without much effort in the study of their reproduction, physiology, production techniques, storage and utilization. Agriculture continues to remain a major driver of economic growth and employs over 75% of the labour force in Nigeria. However, the global recession, the rising unemployment and the ravaging food crisis pose tremendous challenges for Nigeria; hence the need for an in-depth study of the food value, nutritional qualities as well as to develop technologies of these endangered super fruits. This paper presents the food, nutritional quality and the production techniques of a few of the indigenous fruit trees are Irvingia wombolu (Irvingiaceae), Irvingia gabonensis (Irvingiaceae), Crysophyllum albidum (Anacardaceae), Treculia africana (Moraceae), Dacryodes edulis (Annonaceae), Parkia biglobosa (Fabaceae), Spondias mombin (Anacardaceae), Solanum aethiopicum (Solanacea), Garcinia Kola (Clusiaceae). The food value, nutrient composition, medicinal and culinary uses as well as the propagation techniques are presented and discussed.

Keywords: Nigeria; indigenous fruits; food security.

FRUIT PRODUCTION SYSTEMS IN THE PACIFIC

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There has recently been an increased awareness of the importance of horticulture sector in the Pacific. The role of the sector in terms of supporting rural economy development, poverty alleviation, and creating more robust and diverse domestic food security and developing exports of produce and fruit products has been recognized. Pacific Island Country (PIC) Governments have launched a series of horticulture development strategies and action plans aimed at stimulating the growth of the sector. Within this policy framework, intensification and diversification of fruit production has emerged as one of the key Government priorities in Fiji, Samoa and Tonga. Re-enforcing this agenda is the fact that fruit crops represent less than 10% of the overall horticultural output of most Pacific countries, and are therefore seen as having significant growth potential. The rapid expansion of the Fiji red papaya industry in recent years has provided clear evidence that the Pacific can establish international competitive niche fruit export industries. Expanded fruit production is not dependent on export success. There are also significant high-value domestic markets associated with the large Pacific tourism sector that create supplementary homegrown opportunities. In seeking to enhance fruit production support, PIC Government’s industry development priorities are diverse, and often country-specific. Major fruit commodities identified for development in the Pacific include Papaya, Pineapple, Mango, Citrus and Breadfruit.

Keywords: Pacific Islands; Fiji red papaya; policy framework; export.
MITIGATION OF FOC TR4: UPDATES AND THE NEED FOR REGIONAL COLLABORATION
Agustin B. Molina, Jr.
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Recent epidemics of virulent strain of Fusarium Wilt on Cavendish bananas in China and the Philippines in the turn of 2000 remind us of the severe destruction caused by Fusarium oxysporum f. sp. cubense (Foc) to Gros Michel bananas in Central America in the early 1900. It has since affected more than 40,000 hectares in southern China and 6,000 ha. in the Philippines. Caused by Foc strain VCG1213/16, known as tropical race 4 (TR4), it had also caused severe damages on Cavendish plantations in Taiwan, Indonesia and Malaysia, and northern Australia in the 1990s. Recently it has been found in the main banana growing area in North Queensland. There are unpublished reports that this virulent strain has spread to Vietnam and other Southeast Asian countries and South Asia as well. Foc TR4 threatens the survival of the Cavendish monoculture production system. Small-scale farming systems employing cultivar and crop diversity are less affected. Research in Asia carried out by Bioversity International and regional R&D partners yielded promising results, including the development of Foc TR4-resistant Cavendish somaclones and inoculum-reducing cultural and biological practices to mitigate disease epidemics. Prevention of spread to new areas is highly relevant. This disease problem requires industry and regional collaboration and sharing in R&D and mitigation.

Keywords: Asia-Pacific; Fusarium Wilt; bananas; mitigation.

TROPICAL FRUITS OF BANGLADESH
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Bangladesh enjoys generally a sub-tropical monsoon climate. There are three distinct seasons in Bangladesh. Winter from November to February a cool temperature (10-25°C) and little or no precipitation prevails. Summer continues from March to May with a little rainfall with temperatures as high as 40°C. The monsoon prevails from June to October having heavy rainfall, high humidity and temperature from 27-36°C. The average precipitation per year varies among the regions from 1194-3454mm. The climate and soil of Bangladesh are favorable for growing a large number of fruits. About 70 different kinds of fruits are grown here. Major fruits, such as mango, banana, jackfruit, pineapple, papaya, litchi, jujube and Guava are produced on 79 percent of the harvested area. Banana constitutes over 40% of the total fruit production in Bangladesh. This cultivation is favored by the range of latitudes and altitudes of the country. According to recent figures, total fruit production accounts for more than 10 million metric tons. Among summer fruits are mango, jackfruit, litchi, banana, pineapple, watermelon, guava, lemon, star fruit etc. are available between May and August. Quality and varieties of Mangoes produce in northern part of the country. So, it is no surprise that summer in Bangladesh is called season of fruits especially for mango, jackfruit, litchi and jam (blackberry) the popular crowd favorites. In taste, flavor and texture, scores of most these fruits in Bangladesh are higher than similar fruits in other countries. One needs not to be an expert to feel this difference. Visitors to Bangladesh may just taste any of the fruits and judge for themselves. Winter fruits are Oranges, Hog-plums (Amra), Pomelo (Jambura), etc. Orange grows in hilly areas. Lime, Banana, papaya is available throughout the year; everywhere in Bangladesh. There are very few industries for processing of fruits in Bangladesh. The annual requirement of fruits in the country is over 1,16,80,000 metric tons. But current production is only around 1,06,08,295 metric tons, leaving the country deficient in fruits production. According to statistics compiled 2014-15, production of varieties of fruits in Bangladesh is around: Banana 15%, Mango 19%, Jackfruit 16%, Papaya 1%, Melon 2%, Litchi 1%, Guava 1%, Ber-around 2%, Pomelo 1%, Lime & Lemon-around 2%. Bangladesh also imports fruits from different countries in the world as per demand of the local consumers. Major imported fruits are apple, orange, grapes, pomegranate, kinnow, pears, mango, water melon, cherry fruits, melon, ber/jujube etc. In 2015-16 Bangladesh import around 5,30,576 metric tons of fresh fruit. Bangladesh is endowed with favorable soil and climate for cultivation of many horticultural crops yet total production far less than enough. One of the reasons for low production is less commercial cultivation of fruits. In the rural areas of the country, the farmers in addition to other food and fruits are grown. Today, Bangladesh requires an intensive collaboration among the researchers, extension organizations, private fruit gardens and nurseries to achieve higher levels of yield.

Keywords: Bangladesh; fruit industry, imports and exports.
AVOCADO PRODUCTION IN MYANMAR

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Avocado was introduced into Myanmar over 60 years ago and it was first at Shan State which is a hilly region with pleasant weather, relatively lower temperatures and favorable annual rainfall distributed over a period of five months, from mid-May to mid-October. Avocado continues to be cultivated by the farmers as a backyard crop and no commercial plantation since five years ago. The avocado trees grown are all seedlings. Under normal conditions each plant bears 150 to 200 fruits and each fruit weights about 0.33 kilograms. It is propagated by seed, and all raised plants are seedlings. Normally, one-year-old seedlings are planted out in the field. There are no budded/grafted plants as vegetative propagation of avocado is not practiced. Avocado fruits mature in about 180 days from the date of fruit setting. In general, the fruits are hand-picked as soon as they are mature. There are good prospects for avocado production development in the country for two main reasons. One is that the nutritional value of the fruit is very high; it is very rich in vitamins as well as minerals. It will help the local people to improve their nutritional standards. The second reason is that with the development of the hotel and tourist industry there will be an increasing demand for this fruit by the tourists who will be visiting the country, and they already know its value. At present, there is very little appreciation to this fruit by the local people, probably because they are not aware of its nutritional value. Another obstacle in its development is the unavailability of superior commercial varieties. Now with the initiation of Myanmar Fruit and Vegetable Producer Association (MFVP), some of the farmers are cultivating avocado as a commercial production. They are trying to get a good variety and also looking for export market.

Keywords: Myanmar; avocado; Myanmar Fruit and Vegetable Producer Association.

PHILIPPINE RECOGNITION AS A PEST FREE AREA (PFA) FOR MANGO PULP WEEVIL (MPW) AND MANGO SEED WEEVIL (MSW)

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Mango is the third most important fruit crop of the country based on export volume and value next to banana and pineapple. There are threats associated to it production and fruit quality. One of these is the occurrence of two important pest, the Mango Pulp Weevil (MPW), Sternochetus frigidus and alleged occurrence of Mango Seed Weevil (MSW), Sternochetus mangifirae in the Philippines. MPW however, is present only in Southern Palawan. MPW feeds on the flesh of the mango fruit and destroys both value and marketability of the product making it one of the major pests of concern of importing countries. To confirm the presence of MPW in Palawan and absence of MSW in the Philippines, the Bureau of Plant Industry (BPI) conducted a Nationwide Detection Survey for Mango Pulp and Seed Weevil in 2006 to 2009. This survey was funded by USDA under the Food for Progress Program. Results of the surveys conducted in Luzon, Visayas and Mindanao showed not a single specimen (egg, larva, pupa and adult) of MPW (except Palawan) and MSW was found, proving the absence of these pests in the country. The Philippines submitted the survey results to US and Australia to request for recognition of the Philippines as a pest free area (PFA) for MPW (except Palawan) and MSW. On October 1, 2014, USDA issued the Final Rule Declaring the Philippines as Area free from MPW (except Palawan) and MSW. On December 18, 2015, Australia issued the same recognition. To maintain this recognition the BPI – National Plant Quarantine Services Division (BPI-NPQSD) strengthened quarantine measures to contain MPW in Palawan. Low monitoring survey in areas where MPW is not present is also being conducted. The recognition of the Philippines as a PFA for MPW (except Palawan) and MSW will mean that we can source mangoes for export from all over the Philippines (except Palawan) for those trading partners that would require mangoes to be obtained from PFA.

Keywords: Philippines; Mango pulp weevil; Bureau of Plant Industry
OVERVIEW OF THE PHILIPPINE GOOD AGRICULTURAL PRACTICES (PHILGAP) CERTIFICATION PROGRAM

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The good agricultural practices (GAP) refers to the practices that address environmental, economic and social sustainability for on-farm processes, and which result in safe and quality food and non-food agricultural products. In the Philippines, the GAP certification program is voluntary. It is administered by the government through the Department of Agriculture-Bureau of Agriculture Fisheries Standards (DA-BAFS) since 2005. Pursuant to the Food Safety Act of 2013, the PhilGAP certification program is currently on transition period to the DA-Bureau of Plant Industry (DA-BPI) with the full implementation starting 2017. The standards, guidelines, protocols and code of practices are developed and aligned to the international norms and best practices. The elements of the PhilGAP program are anchored to the ASEAN GAP. It contains four modules, namely on: (1) food safety; (2) produce quality; (3) environmental management; and (4) workers health, safety and welfare. Among the relevant developed Philippine National Standards (PNS) are code of practices for fruits and vegetable farming, corn, mango, onion, banana, rice, papaya, coffee and cassava. As of July 2016, a total of 82 GAP certified farms for various crop commodities covering 22,595 hectares. The DA is committed to intensify the program encompassing the regulation, production support, research and development, marketing, extension service education and training as well as capacity building. Partnerships, collaborations and engagements with the various stakeholders are strengthened and intensified.

Keywords: Philippines; Good Agricultural Practices (GAP).

THE DISCOVERY OF THE MANGO FLOWER INDUCTION TECHNOLOGY AND THE RESEARCH PROCESS

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The research on mango flowering was conducted at a friend’s orchard (Quimara Farm) in late December 1969 on 10-year old mango trees that have not previously flowered. It was done on personal capacity (during Saturdays and Sundays) with a budget of five hundred pesos (PhP 500.00). Exploratory test of several chemicals (two concentrations each), including 10kg KNO3 worth five pesos (PhP 5.00), was done on selected shoots, replicated four times in different trees, using a twenty-seven peso (PhP 27.00)-hand sprayer. One week after treatment, shoots sprayed with 1% KNO3 started to bulge and in another week, the shoots developed into flower panicles. Within two weeks after the exploratory test, whole trees, numbering 100 in a hectare, were sprayed with a drenching spray using a power sprayer to cover the whole canopy. This treatment represents plantation or field application. Trees flowered in two weeks except two trees that flowered two weeks later. Unsprayed trees did not flower that year. The flower induction technology, including field application and farmers’ adoption, was completed in 4.5 mos. It revolutionized the country’s mango industry by inducing the mango trees to flower regardless of season. The results were presented during the annual scientific conference of the Crop Science Society of the Philippines (CSSP) in 1974 in Nueva Caceres, Naga City, and won the Best Paper Award. The technology spread in the Philippines in two years and was featured in the Reader’s Digest four years after publication. The technology was chosen as one of two success stories featured as a documentary of the World Intellectual Property (WIPO) (http://www.wipo.int/wipo_magazine/en/2008/03/article_0001.html)(Ramón Barba, inventor, Philippines-YouTube www.youtube.com/watch May 25, 2011). It was quickly used in Latin American countries particularly Mexico and probably its biggest user is Brazil. The research paved the way to the discoverer’s numerous awards including the NAST Academician in 2004, National Scientist in 2014 and the leading Philippine scientist (among five) in the top 100 Asian scientists (ranked third) included in the 2016 “Asian Scientists 100” list released recently by The Asian Scientist magazine (maiden issue) based in Singapore.

Keywords: Mango; KNO3; flower induction; research process.
DIFFERENCES IN THE RESPONSE OF STRAWBERRY CULTIVARS TO CHILLING AND SUBSEQUENT GROWTH UNDER HIGH TEMPERATURE CONDITIONS

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²AgriVet Sciences Institute, De La Salle Araneta University, San Jose del Monte, Bulacan, Philippines
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The strawberry is a temperate crop that is nonetheless grown in the Philippines at higher elevations where the relatively low temperature conditions are more suitable for its growth and development. There have been attempts to grow the crop under warmer, lowland conditions, but fruit quality and yield remain very low. The strawberry requires a chilling treatment to break a dormancy period and enhance vegetative and reproductive growth. In the strawberry-producing areas of the Philippines this is not done; however, it may help improve plant vigor and fruit production under lowland conditions. This study was conducted to determine if chilling can enhance the growth and development of four local strawberry cultivars under high temperature conditions in the field. Rooted runners from each cultivar were chilled at 4°C for six days prior to planting in open-field plots. Results showed that the cultivars responded differently to chilling. Chilling enhanced vegetative growth in three cultivars, improved flowering in one cultivar, and increased fruit size in another. On the other hand, it proved detrimental to the reproductive growth of another cultivar. It remains unclear whether the reduction in percentage fruit set and fruit development was a result of chilling or the negative effect of higher growth temperatures in the field. The results of this study can help in the breeding of improved strawberry cultivars that are more tolerant to high temperature stress in this era of climate change.

Keywords: strawberry, Fragaria x ananassa, chilling, high temperature stress

BANANA BUNCHY TOP VIRUS INCIDENCE IN QUIRINO PROVINCE

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Vast areas of banana farms in Quirino province are still found in the municipality of Maddela, followed by Nagtipunan, Cabarroguis, Diffun and still the smallest banana area is the municipality of Aglipay. Saba variety is dominantly planted on these farms, while Latundan and Lakatan are rarely found in the different banana farms due to their susceptibility to BBTV disease. BBTV disease is still prevalent but its degree of infection compared with the previous survey conducted has been reduced from severe infection rating to moderate. Based on the survey conducted, banana farms in Nagtipunan and Maddela which were planted mostly with Saba variety were moderately infected with BBTV. BBTV disease is still prevalent but its degree of infection was lower compared to the previous survey conducted in 2000. The 95% severe infection result for the last thirteen years in Cabarroguis is rated now as moderate.

Keywords: banana bunchy top virus disease, incidence, prevalent, severe infection, Quirino Province
Banana bunchy top disease (BBTD) caused by the Banana bunchy top virus (BBTV) poses serious threat in banana production worldwide. Plant samples showing symptoms of marginal chlorosis, necrosis, stunting, erect and bunching of the leaves at the top of the pseudostem as well as asymptomatic samples were collected during field surveys. A total of 40 isolates were collected in 9 provinces all over the country. Symptoms of BBTV from different banana cultivars were also noted. In general, collected plant samples were associated with typical severe bunchy top disease symptoms except for cv. Saba which did not exhibit necrosis and death of infected plants. Approximately 1-1.1kb of the DNA-R and DNA-M genomes were successfully amplified and sequenced from the symptomatic samples. Nucleotide sequence analysis for both DNA-R and DNA-M genomes ranged between 98.7-100% homology among isolates. Phylogenetic analysis based on the obtained DNA-R sequences to other sequences in the GenBank database revealed 99-100% similarity with the Asian group and 88-90% with the South Pacific group. Based on the results, there is no variability present in both the DNA-R and DNA-M nucleotides sequences among BBTV isolates in the Philippines and are closely related to the Asian group. Knowledge on the possible presence of virus strains is important in the development and deployment of banana resistant lines.

Keywords: banana, Banana bunchy top virus, symptoms, sequence, variation

Fusarium wilt is an economically important disease of banana causing severe losses in the banana industry. The disease is caused by a fungus, Fusarium oxysporum f. sp. cubense. In the Philippines, the disease was already observed on different banana plantations in Mindanao. An ongoing study is being conducted primarily to determine the geographical distribution of Fusarium wilt across the different banana growing areas in Luzon and Visayas and to identify the races of the collected Foc isolates using vegetative compatibility grouping (VCG) analysis. Disease survey and sampling was done in different provinces in Luzon and Visayas. These include banana growing areas in provinces of Laguna, Quezon, Albay, Camarines Sur, Camarines Norte, and Oriental Mindoro for Luzon and Cebu, and Negros Occidental for Visayas. Symptomatic samples from each sampling location were randomly collected and processed in the laboratory. A total of 259 field isolates were obtained from the collected diseased banana strands. Pathogenicity trials were done as well as race identification. Race of the collected Foc isolates was identified using VCG analysis. Among the 26 Cebu isolates, 4 VCG 0123 was identified while in Bicol region, 8 VCG 0123 was identified. FocTR4 was not identified from any of the isolates.

Keywords: Banana, Fusarium oxysporum f. sp. cubense, vegetative compatibility grouping, distribution
COMBATING FOC TR4 IN THE PHILIPPINES USING RESISTANT SOMACLONES

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Fusarium wilt or Panama disease is a soil-borne fungal disease of banana which causes death of plants. It is caused by *Fusarium oxysporum* f. sp. *cubense* (Foc). Epidemic reports of fusarium incidence in 2011 in Cavendish plantations in Davao del Norte, Mindanao, Philippines led to the concerted efforts of private and government agencies to look for management strategies to combat the disease. The use of fusarium resistant variety introduced from Taiwan through Bioversity International is the most promising strategy to control the disease together with other interventions. Evaluation of the somaclonal variants was done in selected commercial plantations in Davao Region in Mindanao. Results of field evaluation in farmer’s field identified two somaclones for recommendation to farmers as alternative variety for Grand Nain to be planted in fusarium-infested areas. The two varieties are GCTCV 219 identified as highly resistant and GCTCV 218 as moderately resistant.

Keywords: *Fusarium oxysporum* f. sp. *cubense* (Foc), epidemic, somaclonal variant, highly resistant, moderately resistant

EVALUATION OF DISINFESTANTS AND BOOT SCRAPERS IN WET AND DRY CONDITIONS IN MANAGING FUSARIUM WILT IN BANANAS

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*Fusarium oxysporum* f. sp *cubense* (Foc) is a soil-borne plant pathogen that is a serious threat to commercial banana production in the Philippines. Two important methods in controlling the spread of Foc and other soil-borne pathogens are the use of disinfestants and reduction of infested soil movement (Bennett et al, 2011). In the Philippines, there is no published study assessing disinfestant efficacy when used together with boot scrapers in the field setting. The study aimed to determine the efficacy of five kinds of boot scraper designs and the efficacy of Major D (Benzalkonium chloride), Formo (2,2-Dibromo-3-nitrilopropionamide), and Chorox (Sodium hypochlorite) in wet and dry conditions. The boot scraper designs were made using recyclable and easily available materials such as bottle caps, nylon brush, coco coir, rubber, and mesh wire. Results of the experiment indicated that the most efficient boot scraper design was mesh wire followed by brush, bottle caps, rubber and coco coir for dry condition and mesh wire followed by bottle caps, rubber, brush, and coco coir for the wet condition. Three formulations of disinfectants (1) recommended rate of the manufacturer, (2) half of the manufacturer’s recommended rate, and (3) twice the manufacturer’s rate were tested for the presence of Foc in the soil sample collected from boot soles. In dry condition the average colony forming unit/gram soil was lowest in Major D at 4% concentration with 5,517 cfu/gram soil, 18% in Formo with 951 cfu/g soil, and 9.4% in chlorox with 3,360 cfu/g soil. In wet condition, the average colony forming unit was lowest in Major D at 4% with 1,402 cfu/g soil, 18% in Formo with 1,402 cfu/g soil, and 9.4% in chlorox with 3,072 cfu/g soil. In both conditions, the highest *Foc* cfu/g soil was recorded in water.

Keywords: Boot scrapers, disinfectants, *Fusarium oxysporum* f. sp *cubense*
MANAGING FUSARIUM WILT OF ‘CAVENDISH’ BANANA USING MICROBIAL CONTROL AGENTS AND RESISTANT SOMACLONES

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Fusarium wilt caused by the soil-borne fungus Fusarium oxysporum f. sp. cubense Tropical Race 4 (Foc TR4) is a threat to global banana production. Current management strategies include preventive and eradicative measures. Antagonistic microbes had been reported to control Fusarium wilt and other crop diseases. Host plant resistance likewise offers best alternative in plant disease control. Effective microbial control agents and resistant somaclones can be part of an integrated approach in managing Fusarium wilt of ‘Cavendish’ banana. This paper presents the results of greenhouse and field experiments conducted from 2014-2015. Vesicular -Arbuscular Mycorrhizae (VAM), Trichoderma harzianum, and Effective Microorganisms Activated Solution (EMAS) were further evaluated in the greenhouse on Grand Nain and in fields with high incidence of Fusarium wilt using Grand Nain and resistant somaclones Giant Cavendish Tissue-Cultured Variants (GCTCV) 218 and 219. Test plants were pre-treated in the nursery prior to transplanting and field planting. In greenhouse experiment, VAM significantly reduced Fusarium wilt incidence in susceptible Grand Nain to 16.67% with disease reduction (DR) of 61.5% followed by T. harzianum (33.33%) compared to untreated Grand Nain (43.3% incidence). Significant reduction in disease severity index (DSI) based on corm discoloration was recorded in T. harzianum-treated plants (DSI= 2.31) followed by VAM-treated plants (DSI=2.44). Untreated Grand Nain had DSI of 3.03. Disease incidence varied across locations. Application of VAM + T. harzianum in susceptible Grand Nain reduced disease incidence to 26.1% (DR=73.43%) compared to the untreated plants (65.79% incidence). Data across locations showed that the moderately resistant GCTCV 218 reduced Fusarium wilt incidence to 39.62% (DR=39.78%). Addition of T. harzianum further reduced incidence to 11.45% (DR=82.57%) compared to untreated Grand Nain (65.79%). In resistant GCTCV 219, incidence was reduced to 6.25% (DR=90.5%) and application of T. harzianum resulted to 100% control of Fusarium wilt.

Keywords: ‘Cavendish’ banana, Fusarium wilt, Vesicular-Arbuscular Mycorrhizae, Trichoderma harzianum, Effective Microorganisms Activated Solution

ETIOLOGY OF DESTRUCTIVE DRAGON FRUIT FUNGAL PATHOGENS IN THE PHILIPPINES BY CONVENTIONAL AND MOLECULAR TECHNIQUES

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Dragon fruit (Hylocereus sp.), also known as Pitaya, has become increasingly popular across the Philippines due to its claimed health benefits and commercial value. A recent study in the University of the Philippines Manila showed that white dragon fruit has anti-proliferative agent for cancer cells while the red ones has a potential use in the cosmetic industry due to its high tyrosinase inhibition activity and % radical scavenging activity. TF Tepora of Cavite State University (CavSU) identified some of the early small scale growers in Cavite in 2010-2011 stopped their production due to pests particularly scale insects and other disease problems (personal communication). However, very few research activities on dragon fruit diseases were conducted in the Philippines. In 2010, respective student theses from University of the Philippines Los Baños and CavSU by Sandoval and Sangalang identified bacterial diseases collected from a 5-ha Silan’sAgri Farm in Indang, Cavite. To have an update on the existing destructive diseases of dragon fruit, infected specimens were collected in June, 2016 from Silan’s Agri farm. After isolation into pure culture, phenotypic, pathogenicity tests and molecular assays, the following fungal pathogens were identified: Colletotrichum gloeosporioides, Neoscytalidium dimidiatum and Fusarium sp. were the cause of anthracnose in stems and fruits, stem canker and fruit and stem rot, respectively. These are the common fungal pathogens in Luzon based on recent field observations. No bacterial isolate was found. Correct diagnosis and identification of the causal organism is the prerequisite for proper management of the disease. This is the first report on the damaging fungal pathogens of dragon fruit in the recent observable climate change in the country.

Keywords: dragon fruit, pitaya, Hylocereus sp., etiology, fungal pathogens
HOST PLANT RESISTANCE IN MANGO AGAINST FRUIT FLY AND ANTHRACNOSE

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The Philippine mango industry has been consistently expanding judging by the trends in area harvested. Initially, yield was also increasing from 6 T/Ha in 1990 to 8 T/Ha in 1997 before plummeting to current levels of only 4 T/Ha. The drop in production may be traced to typhoons, wind damage, anthracnose, bacterial wilt, fruit flies and leafhoppers. Fruit flies (Diptera: Tephritidae) are the most economically important pest species in the world. Mango anthracnose caused by Colletotrichum gloeosporioides, is also the most serious disease of mangoes throughout the world. Identification of resistant lines, accession or varieties may serve as basis for the management against fruit fly and anthracnose as an important aspect for the improvement of Carabao mango through breeding for resistance to insect pests and diseases. Currently there had been 56 mango collections, 12 (9 of these were ‘Carabao’ mango and 3 other varieties) were subjected under such evaluation to establish resistance against fruit fly while 11 (11 of these were ‘Carabao’ mango) were tested for resistance against mango anthracnose. There were also physical characteristics of the different varieties of mango fruits considered such as the thickness of peel if there were any correlation between the numbers of infestation caused by the fruit fly. The results from the fruit fly preference tests was that there were no significant difference in the number of visits from Tommy Atkins, Red Admin, Haden and NV Guimaras, as well as between T200, T5 and NV Guimaras. However there was a significant difference between T203, T156, T184, T98, T61, T157 and T1, having T98 as the variety being least visited by the fruit flies. Eleven varieties were evaluated using Percent Diseases Intensity (PDI) wherein the variety T98 was observed to have the lowest score at 4 while T1 scored the highest at 34.

Keywords: Mangifera indica, Oriental fruit fly, Anthracnose, host plant resistance, varietal improvement

BIOLOGICAL CONTROL OF SNOUT BEETLE (METAPOCYRTUS (TRACHYCYRTUS) SPP.) ON STRAWBERRY (FRAGARIA X ANANASSA) AND CITRUS (CITRUS SPP.) IN THE CORDILLERA REGION, PHILIPPINES

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Snout beetle (Metapocyrtus (Trachycyrtus) spp.) is a destructive pest affecting strawberry and citrus production in the highland areas of the Cordillera. The white grubs feed on the root system while the adult beetle feeds on the shoots and young leaves of both fruit crops thus affecting fruit and plant material production. To manage the pest, the effect of Beauveria bassiana and four (4) isolates of Metarrhizium anisopliae as biological control agent were evaluated against the white grubs attacking strawberry and citrus. Field and nursery trials were conducted from August 2013 to March 2016 at the Baguio National Crop Research, Development and Production Support Center located at Guisad, Baguio City. Based on population and damage, B. bassiana and M. anisopliae isolates MA-RB and MA-RBB were found effective against the white grubs of snoutbeetle. Soil application of the fungus one week before transplanting and one to two follow-up applications one month after transplanting significantly reduced population and damage of white grubs on the roots of strawberry and citrus. For better strawberry and citrus production, the use of B. bassiana and M. anisopliae as biological control agents against white grubs could be integrated with other pest management methods.

Keywords: Snout beetle, Metarrhizium, Beauveria, strawberry, citrus
An average of 20 typhoons hit the Philippines every year. Most of the typhoons were concentrated in Luzon areas but recently, the islands of Visayas and Mindanao were not spared. The experimental area at UPLB, showcases different cultivars of banana but was greatly damaged by two typhoons: Bebeng and Glenda. The test cultivars included 8 varieties from the International Musa Testing Program (IMTP) of Bioversity International, and 9 Philippine popular local cultivars. A dwarf variety from Thailand, Klueai Namwa, was also included. Cultivar selection was based on their importance as dessert as well as cooking types. Data on agronomic traits like plant height, stem girth, number of leaves and maturity were collected. Recurrent typhoon at the experimental location provided an opportunity to evaluate the resistance of these cultivars against wind damage. A typhoon with sustained speed of 50 km/hr, and a maximum gusty wind of 67 km/hr as recorded by a meteorological station, hit the experimental station. The typhoon felled some test varieties due to pseudostem breakage. Data were collected on the percentage of plants from each variety that was toppled down. Results showed that some varieties were severely affected while others withstood wind damage. In general, it was observed that plants with bigger stem girth and shorter plant stature were more resistant to wind damage. Another typhoon that hit the experimental are at UPLB was typhoon Glenda, which had maximum sustained winds of more than 100 km/hr. Most of the cultivated varieties were toppled down, except for the introduced cultivar Klueai Namwa, dwarf selection. Recent studies on the selections of promising ‘Saba’ cultivars that are shorter and early maturing are currently being evaluated in multi-location trials. The saba strain LSG 001, already started shooting in as early as 8 months after transplanting.

Keywords: banana varieties, typhoon, wind damage, Pseudostem height, girth

CHARACTERIZATION AND EVALUATION OF PROMISING CITRUS VARIETIES FOR COMMERCIAL PRODUCTION

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Eleven citrus varieties were characterized and evaluated under Baguio City conditions, 1330 masl, to identify promising varieties for commercial production. These include the clementine group (*Citrus clementine* Hort. Ex. Tan), mandarin group (*Citrus reticulata* Blanco) and lemon group (*Citrus limon* (L.) Burm. On tree growth habit, majority of the varieties are spreading. Fruiting season of most varieties starts from October to December. Among the clementine group, significant differences were observed on fruit, rind and flesh weight with Oroval having the heaviest fruit (177.82 g), rind (36.21g) and flesh (139.87g) weight. The different varieties are comparable on all other characters such as rind thickness, number of seed, weight of seeds, weight of flesh, 0Brix and edible portion. Among the mandarin group, the different varieties are comparable except on seed characters and rind thickness. Highly significant differences were observed on number of seed with Honey having the most number of seeds with 12 pieces per fruit, with a mean weight of 1.06 grams. On rind thickness, Fairchild has the thickest rind of 2.60 mm while Gayunan has the thinnest (0.52 mm). Among the lemon group, the varieties are comparable, except on fruit and rind weight. Verna registered a significantly higher fruit weight of 241.5 g, while Meyer has the least of 86.25 g which is comparable with Taylor. On yield, Oroval registered the highest among the clementine group. On mandarins, Fremont and Honey have the highest yield. Among the lemons, yields are comparable. As to the reaction to pests and diseases, the different varieties show variable level of susceptibility from very low to high against common pests such as aphids, snow scale, red mites, scab and powdery mildew. Several trees succumb to Huanglongbing, foot rot/gummosis and pink disease.

Keywords: citrus, characterization, evaluation, commercial production
BREEDING STRAWBERRY FOR ORGANIC PRODUCTION

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Local strawberry (Fragaria x ananassa) production presently occupies only about 150 hectares but it is a major tourist attraction in the highlands of northern Philippines, particularly in the Baguio City-Benguet province area. The first local strawberry breeding program in the country was instituted because of this. The program initially aimed to develop new, locally adapted cultivars with high yield potential, acceptable fruit qualities, and resistance to mites and diseases such as Botrytis rots. Breeding for organic production was later added. All locally available cultivars were collected and used for hybridization. Other recently introduced varieties from five countries were added to the gene pool. Crossings using at least 30 cultivars and two wild relatives were done continuously and more than 200 intercrosses were made. Hybridizations are still continuing. The first part of the program produced 6 potential varieties. These six potential varieties together with Sweet Charlie as the check variety, were tested for growth, yield and quality on-station and on-farm under conventional (last 6 years) and organic farming systems (last 3 years). Recent crosses were also being tested under both systems but they were not included in this report as they had only undergone observation for only one season yet. Under conventional system, Fern x Strawberry Festival and (Fern x Toyonoka) x Toyonoka performed much better than the check variety, achieving 1-3 tons more yield per hectare. For the organic system, the two, together with BSU Pierre were the best performing while Agsapa variety had the longest shelf-life. The results were consistent for every year. The findings of this study show that it is possible to produce varieties that could be used for both conventional and organic production systems.

Keywords: hybridization, organic production, strawberry

NATIVE FRUIT SPECIES IN THE PHILIPPINES AND THEIR PHENOTYPIC TRAITS AND POTENTIAL USES

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Twelve native fruit species belonging to seven families were evaluated and characterized for fruit qualities. Their potential economic uses were also assessed. Random sampling of 20-30 ripe from the fruiting trees was done. These species and the family they belong included the following: “Niyog-niyogan” or Philippine fig (Ficus pseudopalma Blanco - Moraceae), “Limonsito” or seedless limeberry (Triphasia trifolia (Burm. F.) P. Wils - Rutaceae), “Libas” (Spondias pinnata – Anacardiaceae), “Tagbak” (Kolowratia elegans – Zingiberaceae), “Is-is” (Ficus ulmifolia – Moraceae), “Kamuning” (Murraya paniculata – Rutaceae), “Bignay-pugo” (Antidesma pentandrum – Rutaceae), Kaffir lime (Citrus hystrix – Rutaceae), “Bayag-usa” (Voacanga globosa – Apocynaceae), and “Alingaro” (Elaeagnus triflora Roxb. – Elaeagnaceae). The selected fruit characteristics including: fruit weight, fruit length, fruit width, total soluble solids (TSS), taste, seed weight, length and width and percent edible portion, and fruit color at ripe stage were assessed. These native fruit species have food and medicinal uses.

Keywords: “Alingaro”, “Bayag-usa”, “Bignay-pugo”, “Is-is”, “Kamuning”, Kaffir lime, “Libas”, “Limonsito” or Seedless Limeberry, “Pandakaki”, “Tagbak”, “Tambis” or waterapple, “Niyog-niyogan” or Philippine fig
ECONOMIC IMPACT OF AERIAL SPRAY IN THE PHILIPPINE CAVENDISH BANANA INDUSTRY
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Aerial spraying in the Philippine Cavendish banana industry is a major issue that has not been resolved at the moment despite a number of studies conducted by opposing groups. While it was banned in Davao City, other major producing areas continue to use the method of controlling sigatoka disease pending a clear policy from the national government. Banning it, mainly supported by non-government organizations and some farmer groups, was based on the arguments that it is detrimental to health and the environment and that the economic effects are minimal relative to the other two. The business and some farmer groups, on the other hand, support the use of aerial spray. This paper focuses on the economic effects of banning aerial spray using key informants, survey data of 60 farmers conducted in Davao City, secondary data of 200 farmers surveyed in Davao del Norte and key informants. Results show that aerial spray is generally more profitable compared to ground spray by 71%. While costs are higher compared to ground spraying, prices and productivity are higher. Better prices indicate higher quality. Applying economic surplus analysis using survey data, shifting from aerial spray to ground spray will decrease producer surplus by PhP43.9M for Davao del Norte and PhP3.7M for Davao City. Producer surplus will decrease by PhP125M for the entire industry in the country. Government needs to settle the issue accounting for the trade-offs between health, environment and the economy and to conduct a definitive study where the approach is agreed upon by various stakeholders before conducting the study.

Keywords: Cavendish banana, aerial spray, Philippines, Sigatoka disease, economic effects

DEVELOPMENT AND EVALUATION OF DURIAN (DURIO ZIBETHINUS) SEED FLOUR BASED EDIBLE FILM FOR FOOD APPLICATION
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This study aimed to develop edible film utilizing durian seeds for food application. Film’s physical and sensory properties that include thickness, pliability, transparency, color, aroma, texture, pliability and general acceptability were evaluated. Plackett-Burman design was used in the variable screening process to identify variables that significantly affect the sensory acceptability of the film. Type of Durian Seed Flour (DSF) (with and without inner seed coat) and level, cornstarch, carrageenan, distilled water, and steaming time were the independent variables considered. Films have thickness ranging from 0.12 to 0.15 mm, which exhibited different pliability and transparency qualities. Results show that thicker films made of brown DSF and subjected to longer steaming time resulted to poor folding ability and film transparency while films made from white DSF, exhibited superior physical properties. Significant variables that negatively affect (p<0.05) the edible film’s color were the type of DSF and level of carrageenan while the pliability and general acceptability were negatively affected by the level of DSF. Results of sensory evaluation revealed that formulation having high levels of white DSF, cornstarch and distilled water with short steaming time resulted to highly transparent film with acceptability value of 7.03 based on the 9-point hedonic scale rating. In terms of aroma, texture and pliability acceptability, treatments with low level of DSF obtained the highest acceptability rating of 6.57, 5.40, and 6.53, respectively. For taste and general acceptability, films having low amount of DSF, carrageenan and distilled water in combination with high amount of cornstarch and steaming time, obtained an acceptability rating of 6.50 and 6.90. Results of the study showed that films produced using white DSF exhibited better physical properties and high sensory acceptability than films using brown DSF. The study showed that durian seed flour is a potential material for edible film production useful for food application.

Keywords: edible film, durian, Plackett-Burman experimental design, flour
ARATILES: BIRDS’ FRUIT NO MORE
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*Muntingia calabura* L. (commonly known as sarisa or aratiles), contains multiple tiny seeds and is succulently sweet with a sticky and pulpy flesh when fully ripe. Aratiles is considered as birds’ fruit since birds commonly feed on the fruits. This study was conducted to develop aratiles as jelly and assess the consumer acceptability of the product through sensory evaluation using the following criteria: consistency, color, aroma, texture and flavor including its overall acceptability. The evaluation was done by group of students from BS in Nutrition and Dietetics and caregiving NCII programs using the 9 and 5 point hedonic scales. Standardization of the jelly recipe from aratiles was initially conducted. The standardized recipes were used to produce the product and subjected to sensory evaluation. The result showed that the product is accepted by the respondents regardless of their age and gender with a mean score of 8.0 which is described as “liked very much”, Furthermore, the overall sensory evaluation of the product is described as “very good” for both age groups and gender including its overall acceptability with mean score of 7.5 which is described as “liked very much”. Hence, the developed standard recipe for aratiles jelly is acceptable to the respondents. A second set of evaluation will be conducted, that will involve more evaluators with varied age and gender for purposes of validity and consistency of evaluation. In addition, future researches on aratiles-based products should include shelf-life study.

**Keywords:** aratiles, jelly, consumer acceptability, standardized recipe

STARFRUIT AND RATTAN: NOW AN ECONOMIC STAR
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Starfruit known as (*Averrhoa carambola* L.), is an attractive, exotic, tropical, and shrub-like ornamental tree of the Oxalidaceae family. The ripe fruits can be eaten fresh or used to produce juice, jelly, or wine. The fruit is also widely used in traditional medicine for the treatment of a wide range of ailments. It is also a potential source of pectin and a very good source of oxalic acid. This study assessed the consumer acceptability of starfruit and rattan fruit jelly. Three treatments were used as follows: T0-commercial guava jelly, T1-rattan jelly, and T2-starfruit jelly. Organoleptic evaluation of the product was done by a group of evaluators using the 5-point organoleptic scale while the overall acceptability evaluation was done using the 9-point Hedonic scale. The analysis of variance showed that there were no significant differences among the three treatments. However, based on the results, the commercial guava jelly is best preferred in terms of consistency, flavor, aroma and overall eating quality by the group of evaluators. Therefore, starfruit and rattan jelly could be a potential substitute for guava jelly because it has comparable quality and acceptability with that of a commercial jelly.

**Keywords:** starfruit, rattan fruit, consumer acceptability, hedonic scale

Jackfruit Seed Cookies
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This study was conducted to assess the quality and acceptability of jackfruit seeds cookies. This research aimed to determine the significant differences in the mean evaluation of treatments in terms of appearance, color, texture, aroma and taste; determine the acceptability of different treatments; and determine the existence of significant differences on the evaluation of the evaluators along the different parameters on the product when they are grouped by sex and civil status. Four treatments were used in the research as follows: T0-100% commercial All-purpose flour (AFP), T1-100% jackfruit seeds, T2-75% jackfruit seeds, and T3-50% jackfruit seeds. Data gathered from the evaluation were analyzed using analysis of variance (ANOVA) and t-test. The results showed that: 2) T2 is “best” in terms of appearance, texture, aroma and taste while all the treatments were “very good” in terms of color and aroma; 2) T1 and T2 are best preferred/accepted by the evaluators; 3) evaluation of taste in T1 was affected by the sex of evaluators. In conclusion, jackfruit seed flour could be a potential substitute in preparing cookies. Future researches on jackfruit seed cookies should include shelf-life and cost and return of investment (ROI) which are very important input for commercialization purposes.

**Keywords:** jackfruit cookies, acceptability, color, texture, taste
THE EFFECT OF PACKAGING AND STACKING ON THE QUALITY AND MARKETABILITY OF MANDARIN (CITRUS RETICULATA BLANCO VAR SZINKOM)

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Mandarins, locally known as “dalandan”, “sintunis” or “dalanghita”, are usually transported in bulk using 3-ton capacity jeepneys or trucks from the farm to the local markets. Depending on the availability of packaging materials, other containers that are commonly used include recycled carton boxes of various sizes, plastic sacks and red net bags. However, these practices result in mechanical damage and fast deterioration of quality leading to decreased marketability of fruits. The study was conducted to determine and compare the quality of Szinkom mandarins packed using different containers; and to determine the physical and mechanical properties of the fruit in relation to packaging. Mandarins were evaluated during the early and late harvest seasons. It was found that plastic crates and cartons provided better fruit protection resulting in reduced damage and ripening. Based on the physical and mechanical properties of Szinkom, larger mandarins require more force to deform than the smaller fruits. The recommended stacking height should not exceed 38 cm hence, the standard 50 L plastic crate can be used for storage and handling. Horizontal dividers can be used for every 1-foot depth of piled mandarins during bulk loading.

Keywords: Citrus reticulata, mandarin, packaging, quality, stacking

CHERRY AND CARAMAY TAMMED TO SUIT THE PALATE: JELLIES FROM THE WILDS

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Fruits from the wild such as wild cherry (Prunus avium) and caramay (Phyllantus acidus) were considered raw materials for jelly. Cherries are a small, rich fleshy fruit with a stone in the middle. Their colour is usually dark red but can also be pale pink and even yellow. The two cultivated forms of cherries are the sour cherry (Prunus cerasus) and the wild cherry (P. avium). Most cultivators grow the wild cherry variety, which is the variety most often utilized commercially while Caramay or Bangkiling (P. acidus) or Otaheite or Tahitian Gooseberry is used on sour soups and other dishes in some parts of the Visayas. The jelly produced from wild cherry and caramay met the standard requirement for jelly as to its pectin content, consistency, aroma, flavor and color. Result of the sensory evaluation revealed that wild cherry and caramay jelly were highly accepted by panel of evaluators. Analysis of variance showed that there is no significant difference among the treatment means which indicate that jelly from wild cherry and caramay is comparable to the usual guava jelly as control for this study. The summary of evaluation on the wild cherry jelly and caramay jelly with standardized proportions of sugar revealed that the evaluators “liked extremely” both jelly.

Keywords: Gooseberry, sensory evaluation, caramay, wild cherry
DETERMINATION OF INHIBITORY ACTIVITY OF THE BIOACTIVE PEPTIDES, DERIVED FROM PINEAPPLE (ANANAS COMOSUS L.) FRUIT AND JUICE, TOWARDS ANGIOTENSIN-CONVERTING ENZYME

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Bromelain is a group of proteolytic enzymes that are found in the pineapple plant (Ananas comosus). Its relevance in medicinal applications is magnified through its anti-inflammatory and anti-hypertensive properties. MD2 pineapple fruits with different ripeness level (green skin, 50% and 100% yellowing of skin) were used to isolate, purify and characterize bromelain on its angiotensin-converting enzyme (ACE) inhibitory activity. The crude protein extract was saturated to 40% using ammonium sulfate. The residue from the saturated extract was purified using gel-filtration chromatography and fractions with high readings were pooled and resolved to 15% SDS-polyacrylamide gel. Bromelain bands correspond to approximate molecular weight ranging from 20-25 kDa. The purified bromelain was hydrolyzed using mixture of four digestive enzymes, such as pepsin, trypsin, α-chymotrypsin and thermolysin, and then determined the flesh part’s ACE inhibitory activity. Also, total soluble proteins and ACE inhibitory activity of the commercially available canned pineapple products from two different manufacturing companies, labeled as brand A and brand B, were determined and compared. The inhibitory activity of the canned products was found out to be highest in brand A’s fortified pineapple juice 1 and pure pineapple juice with 57.72%±1.63% and 53.55%±0.18%, respectively. Captopril and Diovan, two of the known commercial ACE inhibitors, were used as positive references and gave responses of 70.27%±3.43% and 45.63%±0.15%, respectively.

Keywords: Angiotensin-converting enzyme, bromelain, pineapple, anti-hypertension
EFFICACY OF DISINFESTANTS IN MANAGING FUSARIUM WILT IN BANANAS

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The use of disinfestants in controlling the spread of plant pathogens has been shown to be effective against several species of microorganisms. However, literature on proper disinfestant usage against Fusarium oxysporum f. sp. cubense Tropical Race 4 (Foc TR4) is scarce and usually limited to the authors’ opinion on proper application. The aim of this research was to assess the efficacy of Formalin, Beloran, Biocit, Chlorox, and Formo in vitro and greenhouse conditions. The Foc TR4 isolates used in this study were obtained from the PCR Laboratory of USEP-Apokon campus. In the laboratory, disinfestants were prepared based on actual farm usage and manufacturer’s recommended rate as well as half and double of its recommendation. Aliquots of disinfestants were mixed with spore solution containing 1,000 spores/ml of water and the colony forming units (cfu) were counted after three days of incubation. In the greenhouse, 500g sterile soil was inoculated with 2x10⁶ Foc TR4 spores. The inoculated soil was divided into five 100g samples and placed in an angle bar then sprayed with 10ml of disinfestants and left overnight. Soil sub-samples of one gram were taken from each 100g samples and cultured in Komada’s medium then the colony forming units were counted after three days of incubation. Results from in vitro experiment of disinfestants showed the largest reduction of spore growth in all treatments of Beloran and Biocit with zero spore growth and with the least reduction observed in 4.5% Formo with 1.03 cfu/ml. Greenhouse experiment results showed the largest reduction of spore growth in 18% Formo and 50% Formalin both having 0.06 cfu/g of soil and the least reduction was in 2.35% Chlorox with 23.46 cfu/g of soil. Possibly, the results between spore growth recovery in vitro and greenhouse experiment are affected by the presence of organic matter in the second experiment.

Keywords: disinfestant, Fusarium oxysporum f. sp. cubense, in vitro, greenhouse, colony forming units

EFFECT OF VARIOUS COLORS OF POLYETHYLENE MULCH ON THE GROWTH AND YIELD OF STRAWBERRY

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The study was conducted to determine the effect of the different color of polyethylene plastic mulch on the growth and yield of strawberry, to identify the best color of polyethylene plastic mulch appropriate for strawberry production and to determine if the different colors of polyethylene plastic are suitable mulching materials. The days to first flower appearance and days from transplanting to first harvest showed that plants mulched with white polyethylene plastic enhanced earlier flower formation and harvesting. The days from transplanting to last harvest showed that strawberry plants mulched with polyethylene plastics had highly significant effects as compared to the plants that were not mulched with polyethylene plastics. Strawberry plants mulched with black polyethylene plastic had significantly higher marketable yield per plot over the plants that were mulched with the other colored polyethylene plastics. In the total yield per plot and computed yield per hectare strawberry plants mulched with black, yellow and orange polyethylene plastics had the highest total yield of berries produced. The results on the percentage of abnormal fruit showed that black polyethylene plastic mulch had the lowest percentage as compared with the other plastic mulch used. On the growth and yield of strawberry, the use of the different polyethylene plastic mulch did not have significant effect on the percentage of fruit set, non-marketable yield, monthly sugar content and incidence of insect pest. The cost and return analysis showed that black polyethylene plastic used as mulching material induced a higher return on investment followed by silver polyethylene plastic.

Keywords: Photoperiod, achenes, polyethylene, mulching, Fragaria x ananassa
GROWTH AND DEVELOPMENT OF TISSUE CULTURED-DERIVED ‘CARDAVA’ BANANA PLANTLETS AS AFFECTED BY MYKOVAM AND MYCOROOT

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‘Cardava’ is the most important cooking banana in the Philippines and mass production of clean planting materials is usually done using tissue culture techniques. A lot of efforts have been done to enhance ex vitro growth of tissue cultured plantlets. This study was conducted to determine the effects of different levels of two commercially available soil-based mycorrhizal preparations on growth and development of tissue cultured ‘Cardava’ banana plantlets. The plantlets were potted in sterilized soil mix (garden soil [G]: vermi compost [VC]: carbonized rice hull [CRH] at 1:1:1 by volume) and supplemented with Mykovam and Mycoroot at 2 and 5 grams per pot. No supplementation was done for the control. The plantlets were maintained under protective structure for eight weeks with regular water application to keep the medium moist. Results revealed that both Mykovam and Mycoroot supplementation improved growth and development of plantlets. However, based on shoot parameters, Mykovam at 5 grams was better than the control only up to six weeks from planting while at 2 grams, it was not effective. On the other hand, Mycoroot at 2 and 5 grams consistently induced better growth of shoots than the rest of the treatments. After 8 weeks from planting, results revealed that Mycoroot induced more primary root production than Mykovam although the latter at 5 grams produced the longest roots. Overall, the most effective among the treatments was 5 grams Mycoroot.

Keywords: ‘Cardava’, banana, mykovam, mycoroot, mycorrhiza, tissue culture

CROP PROTECTION AND PEST AND DISEASE MANAGEMENT

MOLECULAR DETECTION AND IDENTIFICATION OF CANDIDATUS LIBERIBACTER ASIATICUS, THE CAUSE OF A RE-EMERGING HUANGLONGBIN (HLB) DISEASE OF CITRUS IN THE PHILIPPINES

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Citrus Huanglongbing (HLB), or citrus greening or leaf mottling is a devastating disease of citrus in the Philippines. It is caused by the fastidious phloem limited bacterium Candidatus Liberibacter asiaticus, transmitted through the psyllid vector or diseased budwood. Threatening the citrus industry for decades, a rehabilitation program for citrus HLB was enforced by the middle of the ‘70s that included eradication of infected trees and establishment of foundation materials as source of propagating materials obtained through cooperating citrus centers abroad. The program worked for some time but the HLB disease has not been completely eliminated owing to its manner of transmission by the psyllid vector, and propagation through asymptomatic planting materials. The HLB bacterium (Candidatus Liberibacter) was detected by PCR from different citrus species obtained from Laguna, Cavite and Guimaras in 2015 to early 2016. DNA extracts from Citrus sinensis (perante and dalandan) and C.grandis (pummelo) gave a 1.1 kb amplification fragments with HLB specific primers in PCR. Sequence analysis of the 16Sr DNA of Ca L. asiaticus ‘Perante isolate’ showed 99.2-99.9% similarity with other Ca. L asiaticus isolates and 94.4% homology to the Ca.L.americanus and Ca.L.africanus isolates deposited in the GenBank. This result confirms that our isolate is Candidatus Liberibacter asiaticus. The other citrus species including ‘dayap’, ‘kolongkolong’, ‘suhu’, ‘kolism’, ‘calamansi’,’ladu’, ‘ponkan’ and ‘satsuma’ orange which showed negative amplification to the HLB primers were positive to the Citrus tristeza virus (CTV) antibody in enzyme linked immunosorbent assay (ELISA). Some samples of ‘Perante’ and ‘dalandan’ were also found positive to both HLB and CTV. Results obtained in this study indicated the usefulness of PCR in HLB disease diagnosis and can be recommended as a tool for early detection of the disease towards an effective disease management, for surveys, regulatory purposes and establishment of HLB-free nurseries.

Keywords: Huanglongbin (HLB), PCR, Candidatus Liberibacter asiaticus, Citrus tristeza virus
MANAGEMENT STRATEGIES OF BANANA FUSARIUM WILT AND GEOTAGGING OF AFFECTED AREAS IN DAVAO REGION


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This project was conducted to assess the affected areas of fusarium wilt disease in Region XI, to mapped-out these areas through geotagging and assist the affected farmers by giving package of interventions such as GCTCV 219/218 or banana resistant variety, eradication-cash for work with Trichoderma harzianum and crop shifting of cacao/coffee seedlings, corn/vegetables seeds and reward system. This project study was conducted through actual survey and field validation in six (6) provinces/cities of Region XI. Based on the result of the validation, a total of 15, 507.53 hectares of Region XI were affected by the disease. Davao del Norte has the highest hectarage of fusarium infected farms with 13, 743.00 hectares, followed by Compostela Valley, Davao del Sur, Davao City and Davao Oriental with 1082.78, 436.00, 209.75 and 36.00 hectares, respectively. A total of 7,147 farmers were recipients of the project. Among the seven interventions given by the DA-HVCDP XI, most of the farmer-recipients opted to avail the GCTCV 219/218 or banana resistant variety with a total number of 4,586 growers, eradication-cash for work program with 1827 growers and crop shifting to cacao/coffee seedlings, corn/vegetables seeds with 734 growers.

Keywords: Fusarium, banana resistant variety, eradication-cash for work, Trichoderma harzianum, crop shifting

DESIGN, DEVELOPMENT AND EVALUATION OF A MECHANICAL CACAO POD BAGGER


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Cacao farmers bagged the cacao pods to control the pest infestation of the pod borer (most serious pest especially in Mindanao, Philippines). Common practice is manually bagging using plastic bag. Pods should be bagged when they are about 8-10 cm long and the bags should be left throughout the pod maturation period (International Cocoa Organization, 1996). When bagging is properly applied it reduces infestation from 30% to 50 % (Cocoa Industry Development Sub-committee, 1996). In manual bagging, farmers often need to climb the cacao tree with or without ladders. These results to damage on the leaves and branches; fallen pods and may also cause injury to worker if they will fall. This current method has been observed to be effective but laborious, time consuming and prone to accident. There has not noted innovation or mechanism to make the operation easier, safer and faster. This poster presents a mechanical cacao pod bagger that would solve the problem. The developed bagger will provides solution to increase the productivity of the farmer, reduce drudgery and accident. Eighteen trees with 20 pieces pod/tree ready for bagging were randomly selected and assigned to (T1) mechanical cacao pod bagger and (T2) manual bagging method. A total of three workers/laborers were assigned to perform on both treatments. T-test was used to analyze the significant difference between two treatments. Result of the evaluation showed that the mechanical cacao pod bagger had an effective capacity of 311 pods/hr. It is almost five-times faster than the manual bagging method (58.6 pods/hr). Further, statistical analysis showed that the mechanical cacao pod bagger capacity was significantly different from manual bagging at 0.0046 probability. In addition, no damage was found on the cacao tree using the mechanical cacao pod bagger during the operation, thus had better performance than manual method.

Keywords: Cacao, Mechanical cacao pod bagger, Effective Capacity
PHENOTYPING OF DIFFERENT MUSA GENOMIC GROUPS FOR RESISTANCE TO FUSARIUM OXYSPORUM F. SP. CUBENSE TROPICAL RACE 4 (FOC TR4)

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Among the major diseases of banana, the most significant vascular wilt and the first serious disease to affect bananas, is Panama disease or Fusarium wilt caused by Fusarium oxysporum f. sp. cubense (Foc). Fusarium wilt disease, also called Panama wilt, has been reported in all banana producing regions of the world, except those bordering the Mediterranean, Melanesia, Somalia, and some islands in the South Pacific. The introduction of Cavendish bananas in the early 1960s prevented the industry from absolute end, however, a damaging strain of Foc ‘Tropical’ Race (TR) 4 caused an outbreak of Fusarium wilt on Cavendish bananas in Asia. In the Philippines, the damage due to Foc TR4 in Cavendish plantations has been humongous such that banana growers specifically the smallholders had abandoned their farms. The need to explore and identify sources of resistance to the disease from the national and global germplasm collections is deemed pressing. The response of banana cultivars from the International Transit Center, Belgium and from the Institute of Plant Breeding, UPLB including Cavendish somaclonal variants to Fusarium oxysporum f. sp. cubense ‘Tropical’ Race 4 was assessed under field condition with high but standardized pathogen concentration. Promising entries were identified based on incubation period, severity of symptoms, vascular discoloration and disease incidence.

Keywords: Fusarium wilt, Foc Tropical Race 4, Musa accessions

CROP DIVERSIFICATION, GERMPLASM COLLECTION AND VARIETAL IMPROVEMENT

DEVELOPMENT OF STRAWBERRY CULTIVARS FOR ORGANIC PRODUCTION

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In the Philippines there are a lot of varieties that have been imported. However, there is no variety that is grown only for organic production. Thus, a breeding program on strawberries for organic production was started two years ago aimed at developing cultivars that could be exclusively grown under organic conditions that can perform and compete with conventionally grown strawberry plants in terms of quality and quantity and consumer acceptability. The project identified four (4) varieties commonly used in the conventional strawberry production in Benguet. These are sweet Charlie, Winter Dawn, Whitney and Festival. These strawberry varieties carry the characteristics that are desired by the growers. The following are the different crosses (male x female) used; Sweet Charlie x Winter Dawn, Winter Dawn x Sweet Charlie, Whitney x Sweet Charlie, Sweet Charlie x Whitney, Winter Dawn x Whitney, Sweet Charlie x Festival. The progenies of the different crosses have now germinated and planted under protected condition. The progenies have started to produce runners. There are mites and aphid infestations observed in some of the progenies.

Keywords: organic production, organic strawberry, development of cultivars
CITRUS GERMLASM CONSERVATION AND UTILIZATION IN BAGUIO CITY, PHILIPPINES

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Citrus (Citrus spp.) is one of the important fruit commodities in the Philippines and source of income for many small farmers. It was once a major fruit industry until its decline in the late ‘70s due to the proliferation of systemic diseases. As a result, several of the local varieties have already been lost. Efforts were done to retrieve these local varieties and further expand the variety collection in order to renew, rehabilitate and further develop the citrus industry. To date, the citrus variety collection at the Bureau of Plant Industry in Baguio City consists of 85 accessions belonging to 21 citrus species and relatives. Majority of the collections belong to the group of sweet orange (C. sinensis L. Osb.), mandarins (C. reticulata Blanco) and pummelo (C. maxima (Burm.) Merr.). The trees are grown in large containers under an insect-proof screenhouse to prevent contamination of systemic diseases by insect vectors particularly aphids and psyllids. Disease indexing is done prior to inclusion in the protected Foundation Block and at least once a year thereafter. Collections which are infected with any of the systemic diseases are placed in another screenhouse and will be subjected to shoot tip grafting. The various collections were characterized and further evaluated in the field. To date, 12 of the citrus varieties have already been registered under the National Seed Industry Council. These varieties are now being propagated and planted commercially.

Keywords: citrus, germplasm collection, conservation

FRUIT VARIABILITY ASSESSMENT OF ECONOMICALLY-IMPORTANT TROPICAL FRUIT CROPS IN RESPONSE TO CLIMATE CHANGE IN THE PHILIPPINES

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Morphological variation and diversity of economically-important tropical fruit crops across several areas in the Philippines were assessed and analyzed using Shannon-Weaver Diversity Index (SWDI). Fruits from 208 mango, 14 pineapple, and 9 jackfruit accessions were characterized following the International Plant Genetic Resources Institute (IPGRI) descriptors for each fruit crop. Most pineapple varieties had long-conical crown green with yellow mottling color, ascendant stiff spines along the leaf margins, firm pear-shaped fruit with flat eye profile, and smooth firm pulp with rich aroma. Predominant characteristics of mango such as elliptic fruit shape, good to average fruit attractiveness, yellow skin, yellow orange pulp, intermediate texture, juicy, mild aroma, and very good eating quality were observed. Most jackfruit accessions exhibited oblong fruit shape, greenish yellow skin color, yellow or light yellow pulp color, firm texture, mild aroma, juicy and sweet pulp, reniform seed shape, and creamish seed coat color. Relatively lower variability on qualitative traits was observed among the pineapple (H'=0.41) and jackfruit (H'=0.39) accessions as compared to mango accessions having 0.63 mean diversity index. Significant diversity on quantitative traits was observed in all fruit crops ranging 0.66 – 0.71 diversity indices. On the average, low variability was observed in jackfruit (H'=0.55) followed by pineapple (H'=0.56). Analysis of morphological characteristics has been an important approach to differentiate plant genotypes/ cultivars as well as selection of parents for conventional hybridization for the desirable traits. The use of wild varieties for both crops in breeding can widen the genetic base of cultivated varieties making it more adaptable to climate change. The level of diversity (H'=0.67) observed among mango accession indicated that these accessions could be very useful in enriching the mango germplasm and utilizing these valuable accessions for varietal improvement.

Keywords: diversity, jackfruit, mango, pineapple, morphological, variability
PHENOTYPIC EVALUATION AND OVULE CULTURE OF THREE NATIVE CITRUS SPECIES

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Three native citrus species collected from Marinduque, Philippines were evaluated phenotypically for fruit and leaf characteristics. These are “Kolisom” (Citrus hystrix D.C.), “Gapas-gapas” (C. hystrix var boholensis), and “Bisbis” (C.aurantifolia). “Kolisom” is a wrinkled round fruit with green skin (RHCC N137A), 66.78g with titratable acidity of 1.59/10mL juice and an edible portion of 38.22%. “Bisbis”, on the other hand, is a round fruit with an olive yellow (RHCC 158C) skin, 36.59g with an edible portion of 50.169% and TA of 0.85/10mL juice. In addition, “Kolong-kolong” is a round fruit that has a light green skin (RHCC N137C), 66.182g with a TA of 1.06/10mL juice and an edible portion of 24.06%. Ovule cultures were successfully attained in the 3 species with 100% germination after 8 days.

Keywords: citrus, “gapas-gapas, “bisbis” “kolisom”, “kolong-kolong”, ovule culture

GERMLASM CHARACTERIZATION, EVALUATION AND CONSERVATION OF SEMI-TEMPERATE FRUIT CROPS IN BAGUIO CITY, PHILIPPINES

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The highland areas of the Cordillera Region are endowed with climatic conditions favorable for the cultivation of semi-temperate fruit crops. There is a limited number of fruit species being grown in the highlands, thus the need to evaluate and select suitable fruit crops for commercial production. However, the success of the fruit industry is largely dependent on the quality of the initial materials, primarily the root stock and scion in asexually propagated species. There are 36 fruit species representing 24 genera and 15 families collected from various accredited sources. These were planted in Baguio City, with an elevation of 1330 meters above sea level. Characterization and evaluation of these various fruit crops is being done. Of the various fruit species planted, the following fruit species show promise for further propagation, development and commercialization, namely: macadamia (Macadamia integrifolia Maiden and Betch), pear (Pyrus communis L.), lychee (Litchi chinensis Sonn), longan (Dimocarpus longan Lour.), peach (Prunus persica (L.) Batsch), Surinam cherry (Eugenia uniflora L.), avocado (Persea americana Mill.), indigenous blueberry (Vaccinium spp.).

Keywords: fruit crops, germplasm collection, conservation
TWO ALTERNATIVE MEDIA FOR SOMATIC EMBRYO INDUCTION IN AVOCADO, PERSIA AMERICANA MILL

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Tissue culture is an important tool in almost all biotechnology works to generate plants with improved characteristics. To succeed in tissue culture, the most critical factors are the culture medium and explant. This study aimed to evaluate the efficiency of somatic embryogenesis media developed by the Plant Cell and Tissue Culture Laboratory (PCTCL), IPB, CSC, CA, UPLB. These include the somatic embryogenesis (SE) medium for calamansi (BCO, Barba and Pateña [BP] medium with coconut water) and the mango medium for somatic embryogenesis (MMSE). Using the standard immature zygotic embryos as explants, 25% embryogenic culture was observed in BCO while 16.67% was noted in MMSE. This response is significant compared to the previous study of Avenido and Dimaculangan (2008) where only 7.1% and 14.6% were observed using Raviv et al. (1998) and Pliego-Alfaro and Murashige (1987) media, respectively. Moreover, BCO and MMSE induced direct somatic embryo formation in some cultures with minimal embryogenic calli formation. With the positive response obtained from this study, the protocol for somatic embryogenesis and plantlet regeneration of avocado was simplified. This will reduce the cost and time of producing avocado planting materials.

Keywords: Avocado, Persea americana, somatic embryogenesis, MMSE, BCO

DIRECT AND INDIRECT SOMATIC EMBRYOGENESIS AND PLANT REGENERATION IN CALAMANSI (X CITROFORTUNELLA MICROCARPA BUNGEE)

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That seedless calamansi could be derived directly by regeneration of plants from the triploid endosperm tissue was first theorized by RC Barba and LF Pateña in 1976. Initial work showed that the endosperm developed about two weeks after pollination, first nuclear and at later stages cellular, with greater development within 1-2 months (Pateña and Barba,1980). Excision of endosperm alone was difficult, hence calli were established and plantlets were regenerated from the nucellus-endosperm (NE) tissue (Avenido, Zamora, Pateña and Barba, 1991). NE tissue was cultured in both BP (Barba and Pateña) medium and MMSE (Mango Medium for Somatic Embryo Induction, Proliferation and Germination) medium, both containing coconut water (100mL-1L) and respective sucrose levels of 20g-1L and 60g-1L. Two weeks after inoculation, 8.33% of NE tissues in MMSE medium showed simultaneous embryogenic callus (indirect) and somatic embryo (SE, direct) formation on both ends of the explant while only slight to moderate swelling and no embryo formation in BP medium. Four weeks after inoculation, the number of explants in MMSE with both callus and somatic embryos increased to 25% while cultures in BP medium started to form embryogenic callus and globular embryos. Subsequently, plantlets will be regenerated and planted in the field for evaluation following the protocol developed by the Plant Cell and Tissue Culture Laboratory (PCTCL), IPB, CA, UPLB. In an earlier study, five SE regenerants were transplanted in April 2012 at the IPB Compound. The regenerants reverted back to juvenile stage. First flowering and fruiting were observed in July 2015, three years after field planting, similar to seed-derived (SD) regenerants. The following year, the SE regenerants again flowered (July 2016). Succeeding study will involve comparison of seediness among the fruits harvested from SE, NE and SD regenerants.

Keywords: Calamansi, nucellus-endosperm (NE) tissue, somatic embryogenesis, BP, MMSE
MORPHOLOGICAL RESPONSES OF DROUGHT AFFECTED PAPAYAS AND SELECTION OF PUTATIVE TOLERANT TREES

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Agricultural crops have narrow range of adaptation to climatic elements for optimum and maximized productivity. Characterization of papaya responses to natural conditions (in situ) is important to establish the genotype by environment interactions based on anticipated fluctuations of climatic elements and edaphic factors, taking into account the temporal variability of the production areas. The goal of this paper is to evaluate the morphological responses such as growth and fruit qualities of drought affected papayas and eventually select putative tolerant trees. Papayas were planted in December 2014 in Tranca, Bay, Laguna and growth parameters and fruits qualities were assessed. After eight months of drought during DS 2016 papaya trees were affected especially during the months of March, April and May 2016. Growth parameters and fruit qualities were taken to compare the effect of drought with non-drought conditions. Preliminary results showed that drought affected the fruit development and qualities of papaya. Significant decrease in fruit weight, fruit length, fruit width, peel weight, peel thickness and seed weight were observed when papayas suffered drought stress in the field. However, total soluble solids (TSS, 12.98±0.21) of fruits during drought condition was significantly higher compared to TSS of fruits (10.94±0.09) harvested during non-drought condition. Selected plants that thrived well under drought condition were identified as putative drought-tolerant trees. Morphological responses of putative drought-tolerant and non-drought tolerant papayas were evaluated based on plant height, stem diameter, crown diameter, and number of functional green leaves. Preliminary results showed that drought-tolerant papayas are significantly taller (2.59±0.04 m), had thicker stem diameter (9.22±0.22 cm), wider crown (3.65±0.09 cm), and had more green leaves (24.40±0.53) compared to non-drought tolerant papayas.

Keywords: papaya, putative drought tolerance, fruit qualities, morphology, TSS

IMPROVEMENT OPPORTUNITIES IN THE POSTHARVEST HANDLING OF ORGANIC ‘BUNGULAN’ (MUSA GENOME AAA) BANANAS FOR EXPORT

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The organic ‘Bungulan’ banana is otherwise considered as a non-economically important fruit in the local market, compared to the exported Cavendish and other popular varieties such as Saba, ‘Lakatan’ and ‘Latundan’. In recent years, however, it has found an export niche and has become an important source of income for smallholder growers in several areas in Luzon, Visayas and Mindanao in the Philippines. Yet, postharvest losses are incurred from the farm to the packinghouse resulting in less marketable supply of export fruits and foregone farm income. The study was conducted to document the postharvest handling operations for ‘Bungulan’ bananas for export; determine the causes and extent of rejection and losses; and identify improvement opportunities to reduce losses and increase marketable supply of export fruits. Rejection at the packinghouse level varied by production area and postharvest operations, and ranged from 16% to 26%. The causes included defects such as undersize, immaturity, blemish and disease, and mechanical injuries in the form of cuts and bruises. Possible improvements to increase marketable supply can be implemented in hauling, quality control, temporary storage, sanitation, and continuing education of farmer cooperators and packinghouse personnel through training and provision of information, education and communication materials.

Keywords: banana, ‘Bungulan’, postharvest handling, packinghouse, quality
Musa spp. (banana and plantain) is one of the most widely consumed foods of the world. Aside from its use for food, it has an abundant fiber with good mechanical properties and considered as an environmentally friendly fiber source. The collection from the BPI-Davao in Bago Oshiro, Davao City can be utilized for local banana fiber sources which can alleviate fiber shortage and reduce wastage. Three (3) parts of banana plants such as pseudostem, leaf and bunch stalks were used as potential sources of banana fiber. Banana fiber extracted from the leaf stalks obtained the higher fiber recovery compared with that of pseudostem and bunch stalks. The more functional leaves there are at harvest, the higher the fiber that can be extracted. On the other hand, higher fiber yield can be obtained with taller banana cultivars with robust pseudostem. Color of banana fiber was comparable to abaca (check cultivar). Dominant colors ranged from creamy-white to cream. The ‘Pisang Klutuk Wulung’, a seeded black-stemmed cultivar with black leaf stalks was identified to have a naturally-colored fiber (cream fiber with black streaks). Wild (seeded) and cultivated (edible) bananas were identified as rich in banana fiber. Among sixty-nine (69) cultivars being screened, twenty (20) cultivars from the different types of banana, namely: Seeded types, Plantain types, Latundan types, Cavendish types, Saba types, Cardaba types and other desert and cooking type cultivars that are available in the BPI-Davao banana field genebank can be used both for fiber and fruits. The selection was based on fiber recovery, color and the edible part that was proven to be acceptable to consumers.

**Keywords**: banana, plantain, Musa spp., banana fiber

**SCREENING OF BANANA AND PLANTAIN (MUSA SPP.) COLLECTIONS FOR FIBER EXTRACTION**

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The latex or sap in mango causes skin blemish during harvesting and postharvest handling. Known as latex or sap stain or burn, it reduces mango quality. Latex production of ‘Carabao’ mango fruit harvested at different times of the day and delayed cutting (hourly from harvest up to 6h) of the pedicel at either the pedicel base or at the abscission zone was assessed. Latex volume per fruit ranged from 0.09 to 0.38 mL. The lowest latex volume was recorded in fruit harvested in the afternoon between 1:00 PM and 5:00 PM while the highest volume was noted at 7:00 AM and 10:00 AM. Relative humidity of the air was highest at 7:00 AM. Better quality at table ripe stage was noted in mango fruit harvested at 1:00-2:00 PM and 4:00-5:00 PM. Latex injury did not vary due to limited fruit handling during the evaluation compared with the common practice. Although latex volume was similarly reduced as the time to destemming was delayed, the overall latex production was not affected by the delayed cutting of the pedicel and location of cut. After harvest, cutting at the base tended to give a slightly higher latex volume relative to cutting at the abscission zone of the pedicel.

**Keywords**: mango latex, ‘Carabao’, sap injury, visual quality

**LATEX VOLUME AND QUALITY OF ‘CARABAO’ MANGO AS INFLUENCED BY HARVEST TIME & DELAY IN DESTEMMING**

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Rambutan is a highly perishable fruit crop. The effect of various 1-methylcyclopropene (1-MCP) concentrations (0, 10, 100 and 1000 nL·L-1) on postharvest quality of rambutan (Nephelium lappaceum L. cv. Rongrien) fruits was assessed. Rambutan fruits at orange-yellow maturity stage were harvested from a local rambutan farm in Tacunan, Davao City. Fruits were exposed to 1-MCP in an air-tight chamber for 6 h. Thereafter, fruits were stored at ambient conditions (Trial 1: 27.79 ± 1.28 ºC, 83.31 ± 3.04% RH; Trial 2: 27.3ºC ± 0.71, 84.12 ± 1.75% RH) for 8 days. During storage, browning, degree of decay, visual quality, weight loss, shelf-life, total soluble solids, titratable acidity and ascorbic acid were measured. The application of 10 nL-L-1 significantly maintained the visual quality longer and delayed the browning and decay development in the fruit. At 4 days after treatment, the ascorbic acid contents of treated fruit, measured using iodimetric method, were significantly higher than the control in both trials. However, weight loss, total soluble solids, and titratable acidity of treated and control fruit did not vary. The treatment with 10 nL-L-1 1-MCP for 6 h followed by holding at ambient conditions was able to extend the shelf-life of orange-yellow ‘Rongrien’ rambutan for up to 5.0 days in ambient as compared to 3.3±0.6 days for control fruit.

**Keywords**: rambutan, 1-MCP, visual quality, ambient conditions

**SHELF LIFE OF RAMBUTAN (NEPHELIUM LAPPACEUM L. CV. RONGRIEN) FRUIT AS INFLUENCED BY 1-METHYLCYCLOPROPENE POSTHARVEST APPLICATION**

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TFNet is committed to the sustainable development of the global tropical fruit industry in relation to production, consumption and trade.

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- **Catalyst**
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- **Coordinator**
  Organizes capacity building programs to enhance tropical fruit development

- **Experts hub**
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About the Bureau of Plant Industry

Bureau of Plant Industry (BPI) is a government agency which implements programs of the Department of Agriculture to help the Filipino farmers on plant genetic resource conservation and management; improving crop farming system through R&D; Production of quality seeds and planting materials; plant pest surveillance and forecasting; assisting farmers on pest management system and control strategies; enforcement of plant quarantine laws, rules and regulations; farm mechanization; provision of analytical services on physico-chemical, microbiological and pesticide residue analysis; provision of services on seed testing, seed certification and planting materials certification.

BPI, as one of the staff bureaus of the Department of Agriculture, is mandated to serve and support the Philippine plant industry sector. It is therefore committed to meet and satisfy the needs of its stakeholders in the areas of crop research, protection and production, analytical services, seed quality assurance, plant quarantine, agricultural engineering services and food safety, as well as comply and implement existing regulations and support/advocate the formulation of new regulations.

The BPI likewise regularly reviews its quality policies and objectives to keep them attuned with the present and future requirements of its clients. The agency also ensures that its quality policy is upheld, maintained, implemented and enhanced in terms of production planning of improved planting materials; preparation of program for the selection, certification and production of improved planting materials, including guidelines for its implementation; protection of agricultural crops from pests and diseases; recommend plant quarantine policies and prescribe rules and regulations for the prevention control and eradication of pests, diseases, and injuries to plant and plant products; development and improvement of farm equipment and other related structures to the plant industry; recommend plans programs, policies, rules and regulations to the Secretary and provide technical assistance in the implementation of the same; and ensure safe supply of fresh agricultural crops and promote its export (RA 7394-Consumer Act)

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The Philippine Fruit Association, (PFA) Inc., formerly the Philippine Association for the Advancement of the Fruit Industry (PAAFI), is a non-stock, non-profit organization which aims to promote the interest and the advancement of the Philippine fruit industry. Its goal is to unify the fruit growers, processors, traders, and researchers of the country into an organization that will have impact in the industry.

It was founded in 1983 during the Third National Fruit Symposium held at the Mountain State Agricultural College (MSAC), now Benguet State University (BSU) in La Trinidad, Benguet. Regional Chapters have been established in CAR, Region 1, Region VI and Region XI. Its 1,240 regular members, 127 life members and 8 sustaining members come from the academe, LGUs, government agencies and the private sectors.

The association has established linkages with State Universities and Colleges all over the country as well as with the Department of Agriculture (DA) and its Bureaus, and attached agencies. It has conducted several National and Regional Symposia to disseminate to the different players of the fruit industry, the latest technology and information on germplasm collection, varietal characterization and identification, registration, breeding, propagation, production, postharvest handling, processing, product development and marketing.

The concern of the Association is to reach out and rally the fruit growers, processors, traders, and researchers of the country into a unified organization making PFA a solid entity, as a strong voice for the Philippine Fruit Industry. PFA ultimately aims to promote the interest and advancement of the fruit industry in the Philippines. Members of the association meet every year in a fruit symposium where the Board of Trustees is elected.
PFA Awardees

DR. RAMON C. BARBA
Recognition Award as National Scientist

For his outstanding contribution to science and technology particularly in the discovery of chemical flower induction in mango and micropropagation of fruit trees (banana, mango, Citrus, Avocado) and other crops (Potato, Garlic, Shallot, Cassava, among others) and Development of New Tissue Culture BP (Barba and Pateña) medium.

POSTHUMOUS AWARD
PFA Leon G. Gonzalez Award of Distinction

Dr. Roberto E. Coronel

In recognition of his outstanding contribution to the science and praxis of pomology; scholarly works on Philippine indigenous fruits, especially his books - PROMISING FRUITS OF THE PHILIPPINES & IMPORTANT AND UNDERUTILIZED EDIBLE FRUITS OF THE PHILIPPINES; and tireless effort and inspirational leadership as a pillar of the PhilFruit Association, Inc. that has had a significant and enduring impact to the advancement of the Philippine fruit industry.

CONGRATULATIONS

to the International Tropical Fruits Network (TFNet), the Department of Agriculture (DA) - Bureau of Plant Industry, Philippines (BPI), and the PhilFruits Association, Inc. (PFA) for jointly organizing the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security.

From Mr. DENNIS L. SY

GREETINGS to

The PhilFruits Association, Inc. (PFA) for their success in holding the International Symposium on Tropical Fruits: Towards Sustainable Fruit Production and Global Food Security.

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