SYMPOSIUM NOTES

Symposium on

Developing research to enhance market demand and profitability of tropical fruits

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SYMPOSIUM OVERVIEW

According to FAO, world production and trade of fresh tropical fruitd are expected to expand over the next decade. Developing countries account for about 98 percent of total production, while developed countries account for 80 percent of world import trade.

The major tropical fruits, mango, pineapples, papaya and avocado account for approximately 75 percent of global fresh tropical fruit production, while other minor fruits such as lychees, durian, rambutan, guavas, soursop and passionfruit are produced and traded in smaller volumes. The trade for these fruits have also increased in recent years. More than 90 percent of tropical fruit produced fruits are produced in developing countries.

The expansion in production and trade of tropical fruits, marked by increasing market demand for quality produce is often affected by challenges such as reduced productivity, postharvest losses and pest and diseases incidences. Indirect factors influencing this scenario include global climate change, rapid population growth, middle class expansion and environmental degradation.

To address these challenges, research institutions worldwide have embarked on programs to improve tropical fruit productivity in such areas which pertains to breeding and selection for better adaptable cultivars, techniques to reduce postharvest losses, improving quality and food safety attributes, all to satisfy consumer preferences and market demand. The question of Sanitary and Phytosanitary regulations is another issue which being discussed among countries for fruits with export potential.

Cognizant of the various issues and challenges in expanding production to meet market demands, and reducing impacts of elements such as diseases, postharvest losses and quality, International Tropical Fruits Network (TFNet), with support from the Food and Agriculture Organization of the United Nations (FAO), is organising a symposium to look at the recent developments in tropical fruit research to enhance market demand and profitability.

The objectives of the symposium are to:

1. Inform participants of the vvarious current research initiatives on tropical fruit to improve productivity and marketability
2. Inform participants the selection of a new Cavendish banana cultivar that is resistant to Fusarium wilt disease.
3. Share experiences on the various initiatives taken to improve productivity and quality for export markets
4. Discuss on policies to enhance tropical fruit research and markets
5. The presenters in the symposium are all experts in the field of tropical fruit and members of International Tropical Fruits Network.

Welcome Message from

THE CHAIRPERSON OF INTERNATIONAL TROPICAL FRUITS NETWORK (TFNET)

As Chairperson of International Tropical Fruits Network (TFNet), it gives me great pleasure to welcome all participants to the 'Symposium on Developing Research to Enhance Market Demand and Profitability of Tropical Fruits' in Putrajaya, Malaysia.

TFNet is currently hosted by the Malaysian Government, which has been a key member since 2000. We have been supportive of the role of TFNet as a global organisation in developing tropical fruits in member countries, and this occasion is no exception.

According to FAO, horticultural crops, especially fresh tropical fruit production is expected to expand over the next decade. An increasing market demand also puts pressure on producers to come up more innovative ways through research to produce better quality and marketable fresh or processed fruit product. Besides the increasing demand, other issues that have hampered production include post- harvest losses, pests and diseases and low productivity. Pests and diseases is an important component that can change the course of a fruit type, besides appropriate handling and postharvest practices and conforming to sanitary and phytosanitary requirements of importing countries, to sustain export fruit types. In this regard, the theme of this symposium on developing research to enhance market demand and profitability of tropical fruits' is most apt in the current scenario. Research is the primary component and essential driver in agriculture. Therefore research and innovations underpin any efforts in developing any kind of horticultural crops, including fruit trees for the domestic or export market.

The ten presenters from 10 countries for this symposium will share their experiences regarding the research agendas on tropical fruit in their countries for us to learn and later deliberate whether we can formulate directions or the way forward to improve the tropical fruit situation. This includes the mitigation of diseases that have devastated fruit crops and livelihoods of smallholders.

I am happy that TFNet and FAO have organised this symposium and provided a platform for stakeholders in the tropical fruit industry to deliberate and discuss on pertinent issues influencing the global tropical fruit development. This TFNet and FAO collaboration signifies the importance of tropical fruits in the global fruit market today.

I would like to convey my heartfelt gratitude to all distinguished speakers, chairpersons and presenters, and for sharing your knowledge and experiences.

I would like to thank the Food and Agriculture Organisation (FAO) of the United Nations for being part of the symposium and who have been supportive of all TFNet programs and activities.
For the international delegates from various parts of the world, welcome to Putrajaya and Kuala Lumpur, I sincerely hope you will enjoy your stay in Malaysia.

I would like to wish all Symposium participants, a fruitful learning and sharing experience.

I would like to extend my appreciation to TFNet, without which this symposium would not be possible.

Thank you.

His Excellency Dato' Mohd Arif Bin Ab. Rahman
Secretary-General, Ministry of Agriculture and Agro-Based Industry, Malaysia and TFNet Chairperson

Welcome Message from

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (FAO)

Distinguished Speakers, Participants, Ladies and Gentlemen, on behalf of the FAO Intergovernmental Group on Bananas and Tropical Fruits, I would like to convey best wishes for a successful Symposium on: Developing Research to Enhance Market Demand and Profitability of Tropical Fruits. I wish to extend warm greetings to all participants and to express my sincere appreciation to the International Tropical Fruits Network (TFNet) for extending their warm hospitality to all of us.

Tropical fruits are important to developing countries from both a nutritional and commercial perspective. They are cultivated widely in the tropics at commercial and subsistence levels and until the 1980s were mostly utilized for domestic consumption, except for banana trade which was well established by the late 1950s. These fruits are a relatively cheap and ready source of vitamins and minerals which are important nutritional components of the human diet.

Banana is one of the top five most commonly eaten fruit in the world. Including Cavendish, which is the largest internationally traded variety, banana is the fourth most important food crop in agriculture after rice, wheat and maize. In most producing countries, banana production is exclusively for domestic consumption, similar to other tropical fruit production. Only about 17 percent of banana output (almost exclusively of the Cavendish variety) is traded internationally, involving a small number of countries and primarily controlled (more than 80 percent) by 5 major multinational banana trading companies. However, supermarket chains in major import markets have wrestled power from these multinationals in recent years and now account for more than 60 percent of international trade. World production of bananas was 101 million tonnes in 2012, of which 17.2 million tonnes, valued at USD 8.4 billion was exported.

In recent years trade volumes of tropical fruits, other than bananas, have expanded dramatically, as developing countries perceived these fruits as representing viable options for diversification from traditional export crops like coffee, which have experienced downward trends in prices. However, international trade prospects are subject to uncertainties, some of which derive from the very success of export efforts of the pioneers in the field. Exports to major markets must comply with certifiable international production, food safety and quality standards.

World production of tropical fruits, excluding bananas, was estimated at over 71 million tonnes in 2012. Mango was the dominant variety (39 percent of world production), followed by pineapples (23 percent), papaya (12 percent), avocado (4 percent) and minor fruits (fruit which are exported at less than USD 50 million annually each) made up 22 percent. Global trade of fresh tropical fruits was estimated at 8.1 million tonnes, with an export value of USD 7.7 billion. An additional USD 4 billion was traded as processed tropical fruits such as juices, slices and pulp.

The banana market is a mature one; international trade began in the 1950s. However, the market of other tropical fruits has only evolved since the late 1970s. A significant development in the trade of tropical fruits has been the increasing share of fresh fruit traded compared to processed fruits, taking advantage of advances in post harvest technology particularly in packaging and cool storage, as well as highly efficient logistics. These developments have enabled tropical fruits to compete at the upper end of the market, maximising earnings through the sales of fresh fruit in a segment where unit prices are at a premium. With increasing maturity, price premiums based on novelty have virtually disappeared, to be replaced by quality based premiums. However, recent hikes in oil prices and their subsequent effect on freight rates have eroded profit margins somewhat. Traders are reluctant to pass on the costs to retailers because of the intense competition in the fruit trade where demand elasticities could easily result in tropical fruits being substituted by other fruits if prices are subject to sudden increases.

In the medium term, demand will continue to grow strongly, albeit at a slower rate than the last decade. Supply per se is not a major constraint to international trade, as only a small percent of production is actually exported. However, the importance of quality in an increasingly crowded international fruit market has led to major initiatives by several multinationals to

establish orchards with the necessary post harvest infrastructure to produce and pack fruit for specific export markets. Major challenges for future market growth appear to be associated with a co-ordinated approach to managing the field-to-market-supply chain, for both fresh and processed products. Issues related to food safety, pest and disease control as well as quality issues related to size and appearance of produce should find a proper balance between cost and demand.

Policy issues of concern are those on phytosanitary measures. Although market access and sanitary issues are of importance, compliance is not problematic as phytosanitary ones. Several exporting countries have actively challenged phytosanitary measures in major importing countries on scientific and equivalency grounds. In addition, the costs and benefits of implementing alternative treatment to methyl bromide fumigation, which was phased out a few years ago under the Montreal Protocol, are clearly linked to supply outputs and hence, could be a limiting factor to smaller producing/exporting countries.

Before concluding, I would like to touch on a couple of important issues.

Firstly, the issue of the banana disease, Fusarium Wilt Tropical Race 4 or simply referred to asTR4. A major concern was the spread of this fungal disease to regions outside Asia, which could impact severely on the viability of the global banana economy, financially, economically, environmentally and socially. It has been reported widely in the media that the disease threatens to wipe out the banana industry in Asia. Fortunately, the Guangdong Fruit Tree Research Institute, the research body responsible for studying this fungal disease and developing preventative and mitigating measures in China, was also the roject executing agency (PEA) of a recent Common Fund for Commodities (CFC) funded project on organic bananas. By the time project implementation began, research on the fungus including chemical and organic control measures; transgenic development; and plant breeding for resistant varieties was already well advanced. Contrary to current reports, fusarium wilt control appears to be well in hand, as annual production has progressively increased in China over the last five years. This topic will be discussed more extensively at this symposium.

Secondly, the role of the Intergovernmental Group (IGG) on Bananas and Tropical Fruits is of extreme importance, as it monitors developments in the international banana and tropical fruits markets and advises Governments on related policy matters. Significant developments have occurred, which impacted the banana and tropical fruit markets. As exports of banana and tropical fruits have been an important income source for millions of smallholder farmers in developing countries, it is of great policy relevance to understand how these latest developments have affected and will affect the world banana and tropical fruit markets.

Finally, I take this opportunity to thank TFNet for organizing the symposium and I wish you a very constructive and fruitful discussion.

Kaison Chang
Secretary, Intergovernmental Group on Bananas and Tropical Fruits, Food and Agriculture Organization of the United Nations (FAO)

Welcome Message from

THE ORGANIZING CHAIRMAN

On behalf of the International Tropical Fruits Network (TFNet) I would like to extend a warm welcome all guests, participants and presenters, to the international symposium on 'Developing research to enhance market demand and profitability of tropical fruits', this time in Malaysia. Capacity building and information sharing have been important roles of TFNet's in providing information on the recent advances in tropical fruit development to stakeholders.

This time the theme of the symposium puts a focus on research developments that are conducted to enhance value, competitiveness and marketability of tropical fruits. This has also been one of the frequent issues raised by producers and exporters of tropical fruits, that research and development be given more emphasis. Research developments for tropical fruits, as in other horticultural crops, cover the total components of the value chain, from initial production inputs right until the consumer level. Research directions and priorities by institutions should also be based on current issues and scenarios affecting the components along the value chain.

For the symposium we have invited 11 presenters from 11 countries. The keynote presentation from China, on Fusarium wilt disease in banana, is expected to generate interest among participants, as this has been a problem for bananas producers in Asia. Other presentations are also expected to indicate the research focus in selected countries, all with goals to improve and enhance the market potential of tropical fruits. I am hopeful that the knowledge imparted and resultant deliberations from the presentations would be useful for all participants, as well as be used as inputs for projects. I also believe the recommendations from this symposium can be used as indicators and as guides to proper policy formulations.

I would also like to express my heartfelt thanks to all participants, presenters, chairpersons and all those who have supported and contributed to the success and smooth running of this symposium.

I would like to thank the FAO for their involvement in this symposium and for continuously supporting the activities of TFNet.

Yacob Ahmad

Chief Executive Officer, International Tropical Fruits Network

KEYNOTE PAPER

STRATEGY FOR COMBATING FUSARIUM WILT IN BANANAS THROUGH CONVENTIONAL BREEDING, GMOS AND CULTIVATION TECHNIQUES

Yi Ganjun
Vice President, Guangdong Academy of Agricultural Sciences, P.R. China

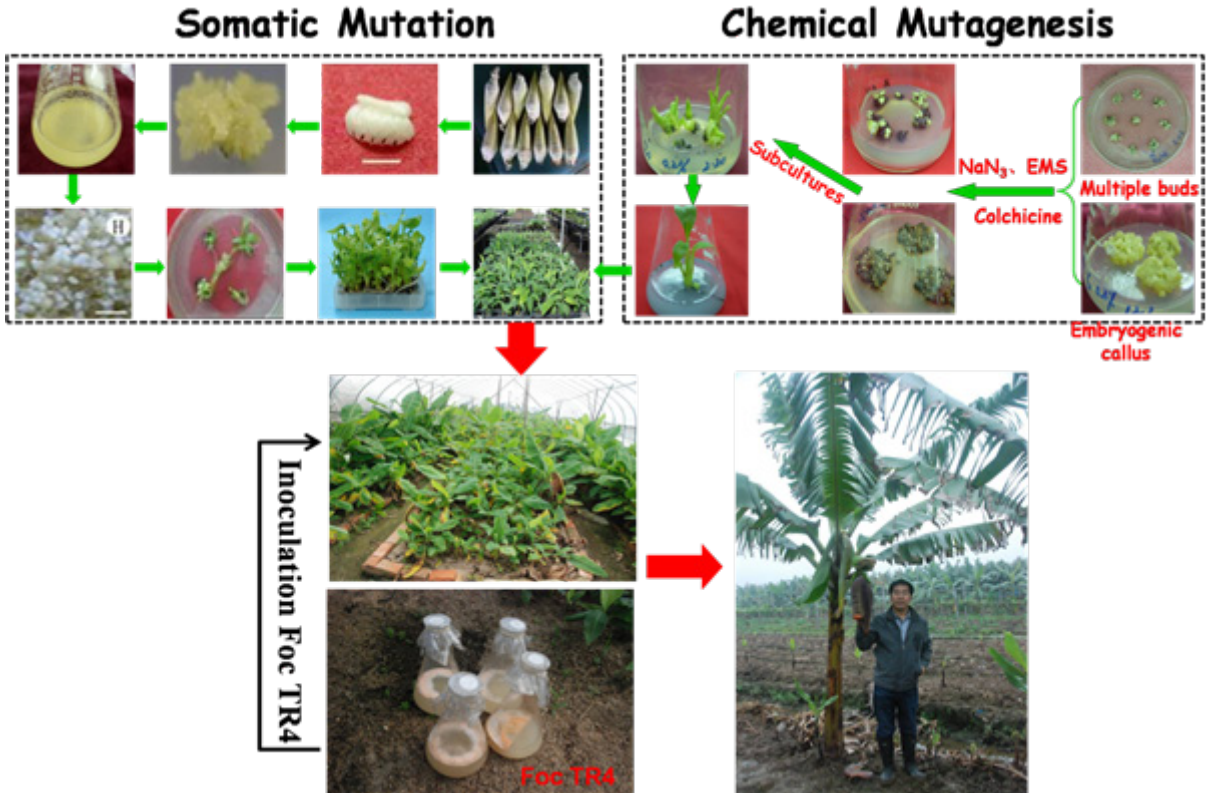
Currently banana is grown on an area of 300,000 ha in China, with Guangdong province topping the list with about 120,000 ha. China's banana industry is built on the Cavendish variety which, occupies more than 90% of planted area. The Giant Cavendish clone 'Baxi' is the most popular variety, occupying more than 70% of Cavendish in China.

One major obstacle which is a threat to the sustainability of the industry is the prevalence of the banana wilt disease also known as Fusarium wilt. Almost all cultivated Cavendish clones are sensitive to Foc TR4, including 'Baxi'. Almost all production areas have reported the outbreaks of such disease.

Fusarium wilt (or Panama disease), caused by the soil-borne fungus *Fusarium oxysporum* f. sp. cubense (Foc), is considered as one of the economically devastating plant diseases in the world, affecting many banana growing countries especially in Asia.

Efforts have been stepped up by the Guangdong Academy of Agricultural Sciences, specifically at the Fruit Tree Research Institute at Guangzhou to contain, mitigate and prevent spread of the disease.

The ongoing overall banana research programme embarked by Guangdong Academy of Agricultural Sciences (GDAAS) focuses on large-scale evaluation of Musa germplasm resource for all aspects of valuable traits, discovery and understanding the genetic base of host-pathogen interactions, integration of breeding technologies (cross, mutagenesis, transgenics etc.) for enhancing



Somaclonal selection for varieties resistant to Foc TR4

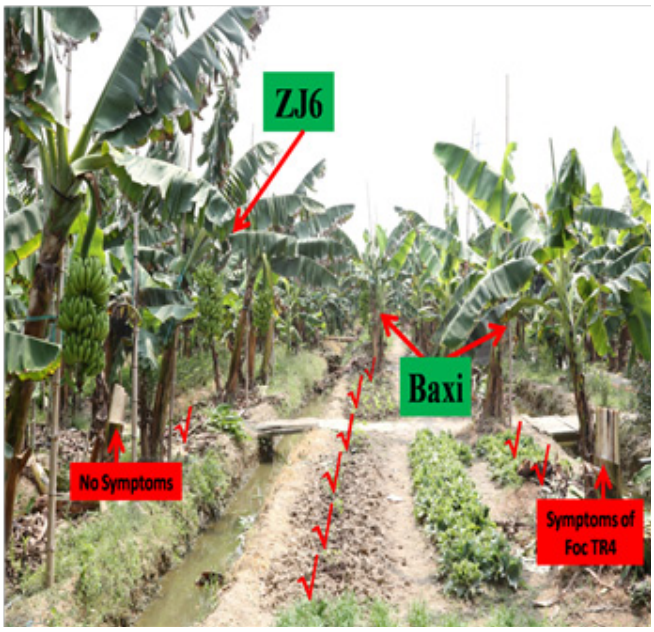
Greenhouse evaluation of ZJ4, ZJ6 and 'baxi'

resistance to Fusarium wilt and cold tolerance, appropriate cultural practices as complementary measures, improving nutritional properties and quality to benefit human health and enhancing banana utilization.

In developing resistant varieties to Foc TR4, selection was conducted from somaclonal variants from various micro-propagated populations which went through somatic mutation and chemical mutagenesis.

As a result, two new Cavendish varieties ('ZJ4' and 'ZJ6') selected from somaclonal variants with high resistant to Foc TR4, were officially released and have planted more than 20,000 hectares in China .

ZJ 6 is 98% tolerate to Foc TR4 and Baxi is 45% tolerate to Foc TR4 in two infected fields during 2 years test. Compared with Baxi, ZJ6 has similar yields and quality except for a greener fruit colour.



Field Evaluation of Cavendish Somaclonal (A: ZJ4, B: ZJ6, CK: Baxi) for Resistance to Foc TR4.

***Note: '√ ' indicates the banana plant death caused by Foc TR4**

Table 1: Comparison of plant characteristics and Infection rate of ZJ4, ZJ6 and 'baxi to Foc TR4

	Zhongjiao No.6 (ZJ6)	Zhongjiao No.4 (ZJ4)	Baxi
Production cycle	360~380 d	340~350 d	340~360 d
Plant height	2~3 m	2~3 m	2~3 m
Bunch weight	24.7 kg	26.2 kg	~25 kg
Yield per hectare	44.4 T	47.2 T	~45 T
Number of hands per bunch	6~8	6~8	6~8
Number of fingers per bunch	148	139	~145
Fruit (finger) weight	176	177	~175
Fruit length	23.6	25.5 cm	~25
Fruit diameter	12.5	12.74	~12.5
Pulp colour at maturity	Ivory	Ivory	Ivory
Mature fruit peel colour	Bright yellow	Bright yellow	Bright yellow
Predominant taste	Sweet	Sweet	Sweet
Infection rate (Foc TR4)	5~15%	0~5%	>50%

Cultural techniques such as growing Cavendish banana intercropped with leek have shown positive results in reducing the incidence of Fusarium wilt. Nowadays, some farmers in China have adopted this technique to reduce disease incidences.

ZJ4 (LEFT) and ZJ6 (RIGHT) are selection of somaclonal variation from 'Baxi' that are highly resistant to Foc TR4, have good bunch, hand, finger shape, and superior fruit quality and taste.

RESEARCH NEEDS TO ALIGN WITH COMMERCIAL PRACTICE: ALTERNATIVE CONCEPT FOR MARKET ACCESS PROTOCOL

Bob Williams
Director of Plant Industries, Darwin, Australia

The main challenges in developing tropical fruit for the export market are to ensure availability throughout most of the year for seasonal fruits, and to produce quality products that are in compliance to market access protocols of the importing countries. As the consumer demand for horticultural products increases and there is an expectation that some seasonal commodities are available all year round in local supermarkets.

Growers and supply chains have to change their practices to meet these expectations. To achieve this, the producer either has to manipulate the plant genetics or use chemical that can alter the plant phenology so that the fruits are available throughout the year.

Products now do not just have to be sold in the local market, they have to be packaged, refrigerated, transported far away, ripened and then presented to customers in a quality they prefer. Fruits and fruit products are sourced from different production regions around the world and made available to countries that want them.

The challenge with export is providing the consumer with an attractive product, the logistics of moving the product considerable distances, meeting the market access trade protocols of the importing country, and making profit for the producers.

Besides this, there have to be research efforts to facilitate the production of better quality and pest free products. One particular tropical fruit which has

Process	Time Interval
Harvest, hold and cool fruit	Day 1
Package fruit	Day 2
Cool fruit to 140 C	Day 3
Transport fruit to Disinfestation Facility	Day 8
Disinfestation process	Day 10
Sea freight to China at 140°C	Day 31
Ripening on arrival	Day 35
Distribution to supermarket	Day 36

The typical Australian mango supply chain from harvesting to export.

been given priority is the mango. Australia has an impressive mango export chain which ensures that only quality fruits are marketed.

The fruits are harvested at the mature, firm green stage, and are sorted and graded. Flesh colour is based on the industry standard and there should be NO defects. Only those graded as Class 1 are labelled export grade.

Mangoes need to undergo specific treatment procedures before being exported. The Vapour Heat Treatment (VHT) at inner fruit pulp temperatures of 46°C for 15 minutes, for fruit flies is mandatory for all mangoes being exported to China, Korea and Japan, while irradiation at doses of 150gy for fruit flies and 300 gy for mango fruit borers are required for exports to New Zealand.

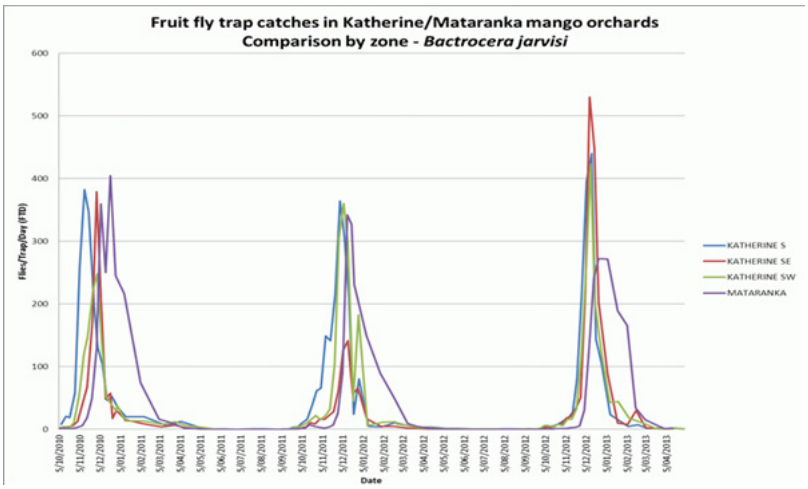
Much research has been conducted in Australia to comply with export requirements especially to mitigate fruit fly infestation.

The basic question that arose was all commercially harvested mangoes are harvested mature and hard green. The researchable questions that follow were, are mature hard green mangoes a host to fruit fly, at what stage of fruit maturity are they host and what is the correlation between fruit fly pressure and fruit maturity.

The research that followed involved an assessment on two pest species, four mango varieties, four production areas, fruit fly trapping program to determine the population dynamics, fruit collection at harvest and absence of field treatments to manage fly populations.

Besides fruit fly surveys, fruits were cut to assess presence/absence of fruit fly larvae. More than 100,000 fruits were assessed over four years.

It was a common observation that



Example on survey of fruit fly populations

Cutting fruit to check for fruit fly larvae

when mangoes are harvested at the mature hard green stage, without any skin damage (cuts, cracks, scratches), the two Fruit Fly species within Northern Territory, appear not to favour the fruit at this stage or the eggs are not able to develop.

Fruits were then categorized according to fruit maturity range in caged trials. Fruit that were not attacked by fruit fly were assessed for resin or sap pressure in fruit skin and efficacy of sap to kill fruit fly eggs.

The study suggests that two of the processes – transport fruit to disinfestation facility and disinfestation process can be eliminated if fruits were not attacked at harvest stage. This will further facilitate export and quality of fruit.

More research is recommended in this aspect in order to convince importing countries that although fruits are exported from fruit fly prone countries the fruits at mature green firm stage will not be infested and therefore unnecessary to undergo disinfestation treatments.

RESEARCH AND DEVELOPMENT IN ADDRESSING THE CHALLENGES IN MARKET EXPANSION OF MALAYSIAN FRUITS

Zabedah Mahmood, Tengku Ab. Malik T. M., Pauziah Muda, Rozlaily Zainol, Rozeita Labuh, M. Hafiz Hassan and Ganisan, K

Horticulture Research Center, Malaysian Agriculture Research and Development Institute (MARDI), Malaysia

Popular Malaysian fruits: (from left to right) Papaya, Starfruit, Pineapple, Durian

The demand for Malaysian tropical fruits in the international markets has shown an increasing trend over the past decades. Tropical fruits are popular for their peculiar taste, flavour, unique features and nutritious value. Our fruits are mainly exported to ASEAN countries, Europe, China and Middle East countries. The fruit hectrage in Peninsular Malaysia is estimated around 300,000 ha. with production of >500,000 Metric Tonnes in 2012.

The main export fruits are melon, pineapple, starfruit, papaya, banana, jackfruit and durian. Realizing the potential and importance of the fruit industry, the Ministry of Agriculture has made strategic plans in technology developments to increase viability and productivity of the fruit industry not only for export expansion but also in meeting the demand of high quality fruits for local consumption. Thus, in the Economic (ETP) launched in 2011, development of selected fruits are addressed in the Entry Point Project (EPP7): Upgrading capabilities to produce fruit and vegetables for premium markets.

The fruits are mainly produced for fresh consumption either for local or export market except for pineapple and guava where a small percentage are being processed. The Malaysian fruit industry nevertheless faces various challenges in its development but at the same time the future provides golden opportunities to be grabbed.

Some of the problems that have affected our fruit industry are the new emerging disease that attacked the papayas and bananas namely the papaya bacteria dieback (PBD), the bacteria blood disease of banana and also the fusarium wilt where most of our banana varieties are susceptible to. Besides there are also areas of research to be given concerted effort in order to enhance the fruit industry such as breeding for resistance to diseases and quality improvement to be more competitive especially in the export market, improve the crop production technique to reduce labour and input cost and post harvest handling and development of quarantine protocols to meet the requirements of various export markets.

MARDI as the main agriculture research institute is thus mandated to conduct research, develop and promote leading edge technologies for the advancement of the fruit industry.

The Fruit Breeding Program

The fruit breeding of MARDI covers various fruit types but priority is give to solve pressing problems that affected the industry. Some of the varieties produced by MARDI are the Josapine and Maspine pineapples. Josapine is now a popular commercial variety for both local and export markets.

Both the Eksotika and Eksotika ll varieties developed by MARDI were popular for the local and export markets where our export mainly to China exceeded USD 30 million from late 1997 until 2004, when the PBD wiped out most plantings. Export reduced to less than US 30 million and at the same time the Eksotika is not available for the locals to consume. The present breeding program for papaya is mainly to develop varieties resistant / tolerant to PBD, high yielding with good quality fruits. Several local varieties identified as resistant to PBD are being

Eksotika II papaya developed by MARDI has higher Brix, better flesh color, and has a long storage life.

Starfruit grown in netted structures do not need to be wrapped individually, reducing labor costs

utilised in the breeding program.

For a revival of the Starfruit market in Europe, there is a need for a new variety of starfruit to give a new dimension for the consumption. The new variety should look characteristically different from the current fruit, such as attractive bright orange colour especially for the export market and should be promoted as fresh eating besides the present way of using it as garnishing in salads (Zabedah, 2012). This new variety of 'golden starfruit' is in the pipeline and will be released soon.

The Fruit Production Technology

The local labour for agriculture is getting rather scarce. Coupled with the rising cost of petroleum, transport and input costs the production cost of agriculture commodities including fruits is rather high. Research priority is also to address current issue such as sustainable disease and pest management, optimising input cost to maximise production without sacrificing fruit quality, mass propagation of disease free, true to type, quality planting materials, and also reducing labour cost through mechanization.

For the management of PBD the Induced Systemic Resistance (ISR) approach showed rather encouraging results. In a recent study, eight plant growth promoting rhizobacterial (PGPR) were found to induce systemic resistance against PBD. All the selected PGRs demonstrated dual role, as disease suppressor and plant's growth promoter (Ganisan et. al, 2013). To date, one year after planting on hot spot, in a comparison study of ISR treated and untreated seedlings, showed that plants from untreated seedlings could withstand the disease only up to 10 months while there is no disease incidence on the ISR treated plants.

At the same time the Eksotika seedlings faces problem of contamination and high percentage of female population and off shape fruits which are not exportable and fetches lower price. To address this issue, mass propagation of 100% elite hermaphrodite using micro cutting technique was developed with success rate exceeding 95% (Hafiz et. al, 2012; Hafiz et. al, 2013; Hafiz et. al; 2014, Hafiz et al, 2014). The elite hermaphrodite was selected based on high yield, uniform shape with good qualities characteristic of Eksotika variety. The package technology of 100% elite hermaphrodite –ISR cuttings will be made available in the market soon.

Pre-cooling Josaphine pineapple before storage has been proven to exntend shelf life to 4-5 weeks at 5°C, one week longer than those that were not pre-cooled.

A mechanized durian opener ensures uniform and sanitary mimimal processed products for export

MARDI has also recently developed the fertilizer formulation for pineapple on mineral soil. This formulation has been commercialised in collaboration with PK fertilizer Msia Sdn. Bhd. with the trade name GROWPINE™ and are available in two forms; nugget and compacted . The nugget formulation enables single application around planting holes during field preparation thus making fertilizer application more uniform, efficient and less laborious (Hartinee et. al, 2012).

To overcome the problem of contamination of pineapple planting materials, selection of true to type and conventional mass propagation using crown leaf budding were successfully improved ((95-100% success).

Postharvest and Quarantine Protocol Development

Research achievement on post harvest handling of fruits covers harvesting, grading, packaging, storage, ripening and transportation. MARDI developed most of the post harvest handling and storage requirements especially of the fresh fruits for export market to various destinations such as pineapple, starfruit, melons, papaya, durian and jackfruit. MARDI successfully conducted trial shipments to Dubai, Hong Kong, Rotterdam, Germany and the Middle East countries. Besides fresh fruits MARDI also developed technologies for minimally processed fruits such as pineapple, jackfruit and also frozen durian to destinations such as Australia, Amsterdam and China. Quarantine protocols for fruits such as pineapple, papaya, mango and starfruit have been developed to meet the quarantine requirement of various countries.

Mechanization inputs for minimally processed pineapple

A CHALLENGE OF ADOPTION TECHNOLOGY FOR EXPORTED FRUITS IN INDONESIA

Dr. Ir. Hasanuddin Ibrahim, Sp. I
Director General, Department of Horticulture, Indonesia

The Indonesian archipelago is home to some of the diverse tropical fruits in the region. However, a few have been developed for the domestic and export market. The fruits that were produced in Indonesia from 2008 to 2012, where generally production has been consistent throughout except for increases in salacca, mangosteens and a slight increase in mango production.

Three fruits, mangoes, mangosteens and salacca make up the main exported fruits to China, Middle East and the ASEAN countries. Other countries are in the process of applying for importation of the fruits.

Salacca fruit has been exported to China, Malaysia and Singapore since 2008 and Australia is now in the process of signing the export protocol.

Another popular export fruit, Mangosteen has also been exported to the same countries as above. Australia and New Zealand have now signed export protocols. However the methyl bromide fumigation requirement for exports to Australia and New Zealand reduces the quality and shelf life of mangosteens.

Indonesian fruits: Salak, Mango, Rambutan, Mangosteen, Sugar Apple, and Guava

No	Commodity	Production (ton)				
		2008	2009	2010	2011	2012
1.	Banana	6.004.615	6.373.533	5.755.073	6.132.695	6.189.043
2.	Citrus	2.391.011	2.025.840	1.937.773	1.721.880	1.498.394
3.	Mangoes	2.105.085	2.243.440	1.287.287	2.131.139	2.376.333
4.	Pineapple	1.433.133	1.558.196	1.406.445	1.540.636	1.781.894
5	Rambutan	978.250	966.841	522.652	811.909	757.336
6.	Salacca Fruit	862.465	829.014	749.876	1.082.125	1.035.406
7	Papaya	717.800	772.844	675.801	958.251	906.305
8	Durian	682.323	797.798	492.139	883.969	888.127
9.	Mangosteen	78.674	105.558	84.538	117.595	190.287
10.	Other Fruits	2.774.533	2.980.834	2.578.789	2.933.308	3.293.278
	Total	18.027.889	18.653.898	15.490.373	18.313.507	18.916.403

Fruit production in Indonesia 2008 - 2012

The many challenges and issues in the tropical fruit industry include poor planting materials, too many and diverse varieties, and grown as a mixed crop in backyard orchards. More than 70% of the perennial fruit crop is backyard plant which are scattered using poor planting materials that have been sourced from the forest. This has resulted in low level production, low quality produce.

Other issues include consistency of production in volume and quality throughout the year, and finally the percentage of post harvest losses.

High losses occur as a result of inappropriate postharvest management, especially poor packing designs, grading, marketing network and distribution. As Indonesia is an archipelago, logistic costs become very costly due to the low accessibility and long distance to ports and markets. Population of 145 million and low income per capita (US$ 2,700 per year, 2013) is another factor. Growers also do not get easy access to credit facilities to expand their agricultural activities due to high interest rates and low bank accessibility.

Due to stringent export requirements from importing countries requiring product traceability, high quality fruit, competitive price, continuous supply of the fruit which are free from damage, contaminants and quarantine pests and produces from GAP registered farms and packing houses, Indonesia is looking toward developing new production areas. These areas will use competitive commercial high yielding, high quality planting materials or clones in order to obtain high quality and attractive fruits using GAP and GAHP certifications and also environmentally friendly agricultural practices. Orchards will introduce seasonal fruits.

The government also intends to carry out widespread promotions while opening new markets. Efforts will include technical assistance and capacity building, improved postharvest handling, processing, packing and labelling. The cold chain system should also be in place to ensure fruits remain in good quality until they reach the retail shelves.

Indonesia plans to improve their marketing strategy by promoting freshly cut fruits through street vendor facilities that keep quality of fruits. Promotions in supermarkets will be done as well. Plans will also strengthen investments especially with processed and semi processed fruit. Efforts will help strengthen Farmers' Institution.

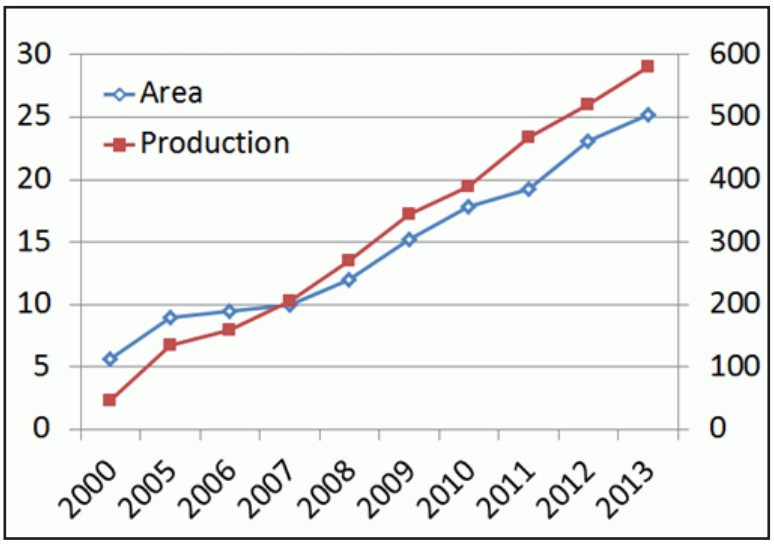
Mangoes, Citrus and Durian have been selected to undergo the complete food chain process. They also include downstream products from the three fruits.

RESEARCH DEVELOPMENTS IN ENHANCING THE EXPORT OF PITAYA (DRAGONFRUIT) IN VIETNAM

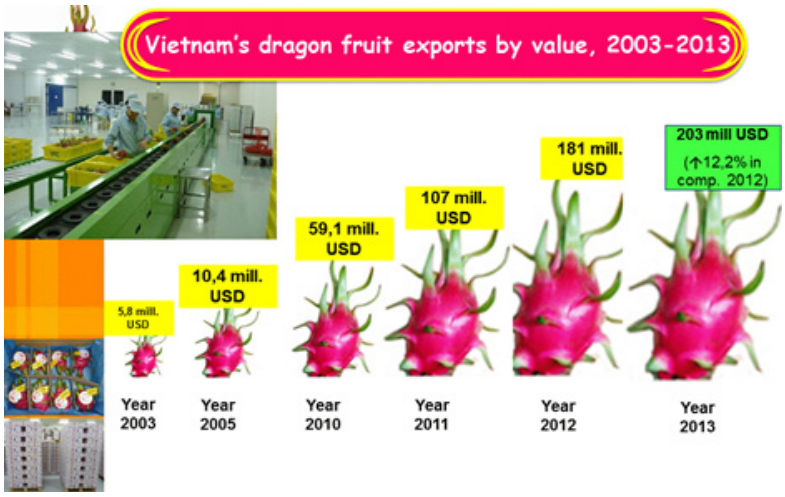
Nguyen Van Hoa, Nguyen Minh Chau, Nguyen Quoc Hung, and Trinh Khac Quang
Vietnam Academy Agriculture Science, Viet Nam

Vietnam is currently the leading pitaya exporter in the world. Dragonfruit production area has increased to 28,700 ha in 2014, with the increase in production to 580,000 tonnes. There has been a dramatic increase in pitaya area and production from 2000 to 2013.

Vietnam has a well-established supply chain for dragonfruit from farm to export. It has in place the postharvest disinfestation treatments like Vapour Heat Treatment plant and Irradiation plant to cater for import requirements from Japan, Australia, New Zealand, China, the EU countries, US and the ASEAN countries. Vietnam exports dragonfruit to 33 countries and regions in the world. In 2013, six new markets destinations were identified, namely Philippines, Myanmar, Australia, India and Denmark and later in 2014 New Zealand was included.



Dragonfruit (pitaya) production in Vietnam (2000-2013)



Vietnam's pitaya (dragonfruit) exports 2003-2013

Cultivar improvements

Towards this many studies have been conducted to enhance Pitaya exports by Southern Horticultural Research Institute (SOFRI) and Fruit and Vegetable Research Institute (FAVRI). New varieties have been developed through more than 10 years breeding programmes in SOFRI.

One such variety is the Red Flesh Dragonfruit Long Dinh No. 1 (SOFRI) a cross between local White flesh and Red flesh from Colombia which has been released for commercialization in the year 2005. There are also new promising lines the red flesh Dragonfruit developed by SOFRI and FAVRI.

SOFRI has conducted research to enhance flowering, fruiting and pest control measures of pitaya. Studies on increasing light hours in field during flowering stage favoured better flowering which increased the yield.

Pests and disease management

Fruit fly can be a problem in dragonfruit cultivation and there

are mainly two fruit fly species which are of concern, namely, Bactrocera dorsalia and B. correcta. SOFRI has worked together with Griffith University in Australia to produce SOFRI developed Protein bait for large scale field control of fruit fly.

Integrated Pest Control methods for fruit fly control has been in place in the field such as proper sanitation, cultural practices, fruit bagging, use of pheromone bait, insecticides, and postharvest treatments.

SOFRI has also conducted studies on the use of Trichoderma in the control of root rot disease on Dragonfruit. Study on Anthracnose disease caused by *Colletotrichum gloeosporiodes* and disease cycle and development and its control protocol was also conducted. A protocol was developed in controlling of the disease using Integrated disease management.

Neoscytalidium dimidiatum was identified as the causal agent (2011) for canker, through the use of morphology and molecular tools. The development of the disease and influence of temperature and pH was studied. The control measures for canker disease are using fungicides in-vitro and field conditions, using biological tools, sanitation, cultural practices such as pruning and training of the canopy, to improve ventilation.

Field sanitation is done by pruning and cutting the pruned cladodes to small pieces to facilitate decomposition.

VHT standardization for postharvest treatment and export protocols

Vapor heat treatment is the standard pre-export treatment for fruit flies. Optimum temperature that are recommended is 45 – 60° C for 20 minutes with wind speed of 2m/sec. With this protocol dragonfruit is now able to be exported to Japan, Korea and New Zealand.

Shelf life of the fruit can also be extended with the modified dose of Umikai (natural Calcium) for post harvest treatment. There has also been improvements in the protocol to ship dragonfruit to the EU with an increase in shelf life from 4 to 8 weeks.

Dragonfruit infected with fruit rot and its causal agent, *Erwinia chrysanthemi*

Canker disease caused by fungi *Neoscytalidium dimidiatum* lowers productivity

Anthracnose caused by *Colletotrichum gloeosporiodes* affects the leaves and fruit, leading to lesions and rot

The manual on GlobalGAP for large scale Dragonfruit production was developed and is currently being used. BRC manual for packing house is also being used.

The dragonfruit picture manual is a guideline for farmers to adhere to GAP standards certified for pitaya production and are meant to facilitate entry into international markets. Vietnam has implemented GAP standard for dragonfruit since 2005.

At the end of 2012, the GAP certified areas of production reached 6,800 ha, involving 8,200 famers. Capacity building exercises such as training, farm field schools and the plant doctor approach have been implemented to expand and sustain Vietnam's pitaya industry.

Long Dinh No.1 red flesh variety released in 2005

Red Flesh Dragonfruit Long Dinh No 1 x White flesh GC-005 (line T9). Released for commercialization in 2010

Red Flesh Dragonfruit TL4 from the Fruit and Vegetable Research Institute, Vietnam, released for commercialization in 2012

PRODUCTION AND MARKET POTENTIAL OF TROPICAL FRUITS IN THE GCC COUNTRIES

Hassan M. Ali-Dinar
Food and Agriculture Organization of the United Nations, Saudi Arabia

Average annual production of mango and papaya in KSA reached 30000 and 6314 MT, respectively. Sultanate of Oman on the other hand, produces 10,199 and 1,760 MT of mango and papaya, respectively. In GCC countries domestic production of fruits generally accounts for 25.5% of total domestic demands.

KSA currently meets 46.8% of its overall domestic demand for fruits. All other GCC countries depend on imports for approximately 74.6% of their domestic demand for fruits.

The global imports of mango alone during 2011 show 3.9% share for KSA and 5.2% for UAE. Imports of mango and banana during 2011-2012 to KSA amounted to 62,279 and 306,173 MT, respectively.

Most imports of mango during the same year to KSA were from Yemen (59.29%), Pakistan (20.29%), India (9.61%), Egypt (4.21%) and Kenya (3.94%). KSA and SO have made considerable substantial support to develop the tropical fruit crops sector in their countries.

Since 1982, KSA through its Trust Fund and Technical Cooperation Programme with FAO has made considerable progress in developing the tropical fruit sector. Development projects were formulated in successive 5-year-phases in collaboration with FAO.

Funds were made available by the Saudi Government for each phase to promote the tropical fruit sector. A major Research Centre (Jazan Agricultural Research Centre) was established to lead the development

Saudi Arabia has successfully produced tropical fruits such as mango, sugar apple, starfruit, pineapple, sapote, and papaya

of this sector. Emphasis was centred on building the capacity of nationals, support the development of infrastructure (laboratories, nurseries, experimental fields, germplasm collections, demonstration fields etc.).

More than 52 commercial mango cultivars were introduced worldwide to Saudi Arabia since 1982 and collected in well-established gene banks. About 34 mango cultivars are released to fruit growers after field evaluation. Introduction and field collections in Kingdom of Saudi Arabia also included other tropical fruit crops.

Sultanate of Oman has developed the mango sector through a well- designed programme that included survey and evaluation of more than 32 local selections and introduction and evaluation of more than 50 mango cultivars from Australia, Brazil and India.

The country keeps the mango genetic resources in well-established germplasm collections/ genebanks. Furthermore,

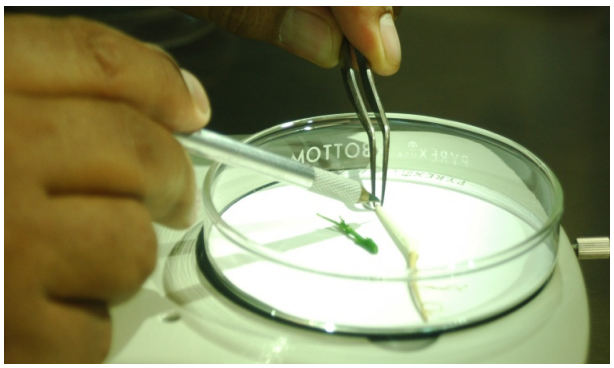
The mango gene bank in Saudi Arabia has 52 mango cultivars introduced from around the world to improve genetic resources.

Sultanate of Oman is currently working on the largest international encyclopaedia in collaboration with many mango producing countries. The encyclopaedia will include 5 editions, namely: 1st edt. Mango production in Sultanate of Oman; 2nd edt. Cultivation and utilization of mango; 3rd edt. Pest and diseases of mango; 4th edt. Production of mango in the world and 5th edt. Mango varieties in the world.

The GCC countries in addition to Yemen have common issues and constrains that need to be addressed jointly to effectively develop this sector. Among these major constraints and challenges are: restricted water resources, increasing soil salinity, lack of proper rootstocks to reduce salinity hazards, need for appropriate harvest and post-harvest techniques, pests and diseases particularly the fruit fly and mango die back, limited research and good agricultural practices.

FAO technical cooperation programme in KSA has recently taken the initiative to coordinate the efforts among GCC countries and Yemen to address certain common agricultural constraints taking into consideration the limited natural resources, particularly water and pests and diseases e.g: the red palm weevil. Collaboration with TFNet was recently initiated and the expected joint programmes is expected to expand in the coming few years.

Soil and water control research is important to improve crop production in arid areas



Protection and micropropagation measures to improve fruit crops

DEVELOPING RESEARCH TO ENHANCE MARKET DEMAND AND PROFITABILITY OF TROPICAL FRUITS: MANGO FROM SRI LANKA

Dr. D.B.T. Wijeratne
Additional Secretary (Agricultural Technology), Ministry of Agriculture, Sri Lanka

Mango is one of most exported fruits form Sri Lanka for the last few years. However, the value of the product is low because of low fruit quality and is used mainly for cooking.

Few years back, mango cultivation in Sri Lanka was limited to the household level and commercial cultivation of fruit orchards were almost non-existent. Due to small scale of cultivation and poor management practices, quality and the quantity of the fruits could not be maintained at a satisfactory level.

Other problems include the lack of fruit orchards, diverse varieties grown by small farmers, low value of fruits, and poor management practices in cultivation, postharvest, and supply chains.

Development of Mango varieties

Recently, the Department of Agriculture selected and developed high quality varieties that are suitable for different agro-climatic zones. Hence commercial cultivation of mango has initiated during last 10 years and now it is a popular and profitable venture.

The programme aims to improve varieties, management practices, cultivation in different agro-climactic zones, availability of planting materials, and initiation of fruit orchards.

Quality & Varieties

However, developing varieties for export market, cultivating using good agricultural practices, complying with export regulations, and maintaning a sustainable business venture have many barriers to overcome by all stakeholders of the supply chain. During the process of selection and development of varieties for export market, due attention was paid to obtain varieties with even sized fruits with small seeds, bright yellow colored skin and high brix to acid ratio in addition to good appearance.

Management practices

During cultivation, good hygienic condition of the orchards were maintained to avoid anthracnose contaminations and the fruits were bagged to avoid fruit-fly and pulp-weevil contaminations. Also, the fruits were harvested properly to avoid latex contaminations. The practices that were implemented were canopy management, fertilizer application, and management of pests and diseases such as anthracnose, fruit flies, seed weevils.

The Sri Lanka Department of Agriculture has implemented measures to improve mango production

Postharvest activities

As a regulatory measure, the quarantine service of the Department of Agriculture started caring out regular field visits to confirm the proper conduction of control measures of the pest and diseases. These include a harvesting index that allows for selected harvesting, preventing latex contamination, induced ripening, and improvement of marketing.

Postharvest developments have also been implemented to improve export such as compliance with European Union regulations, field inspections, hot water treatment, and gamma radiation.

Also, the quarantine service is in the process of development of proper postharvest treatments, especially hot water treatment and gamma radiation treatment as a precautionary measures. Several large scale cultivators are working with the small scale growers in this export venture. The private sector is not only providing the planting material and collecting the harvest, but also provide the extension services for their contract growers. These mangoes are exported to the high end market of Europe and even the contract farmers are getting more than three US dollars per kilogram of mango.

RECENT ADVANCES IN TROPICAL FRUIT RESEARCH IN INDIA

Prakash Patil
Project Coordinator (Fruits), Indian Institute of Horticultural Research, Bengaluru, India

India is the largest producer of mango and guava (44%), papaya (42.6%) and banana (25.6%), and is known as the fruit basket of the world. India is the second largest producer of fruits (81.28 million MT) that are cultivated on 6.98 million ha area, with approximately 12.6 per cent share in global fruit production arising from the 12.2 per cent area that is under horticultural crops.

Among the horticulture crops, the fruit crops recorded a two-fold increase in area and production in 2012–13 as compared to 1991–92. Export of fresh fruits and vegetables in terms of value is 14 per cent and of processed fruits and vegetables is 16.3%, indicating the low share of fruits and vegetables trade in the world.

India ranks highest in the world in the productivity (21.1 MT/ha) of grapes. It has higher national average productivity for banana and sapota as compared to world average productivity, whereas for citrus, mango, guava, pineapple and papaya, the country has recorded lower productivity.

Fruits	India	World	Highest
Banana	34.2	20.7	1. Indonesia (58.9); 2. Guatemala (40.9); **3. India (34.2);** 4. Ecuador (33.3); 5. Mexico (30.3)
Grapes	21.1	9.8	**1. India (21.1);** 2. USA (17.1); 3. China (16.0); 4. Chile (15.7); 5. Argentina (12.7)
Mango	7.2	7.7	1. Brazil; (15.8) 2. Pakistan (10.7); 3. Indonesia (9.7) 4. China (9.4); 5. Mexico (9.3)
Orange	9.3	18.2	1. Turkey (36.3); South Africa (35.8); 3. USA (32.6); 4. Brazil (24.7); 5. Egypt (23.5)
Papaya	40.7	28.9	1. Dominican Republic (312.7) 2. Guatemala (89.8); 3. Indonesia (86.7); 4. Taiwan (58.4); 5. Mexico (50.1)
Pineapple	14.9	23.2	1. Indonesia (124.5); 2. Costa Rica (59.2); 4. Philippines (41.0); 5. Brazil (40.9)
All fruits	11.6	11.3	1. Indonesia (22.3); 2. USA (23.3); 3. Brazil (16.5) 4. Turkey (13.6); 5. Philippines (13.2)

Top fruit producers from around the globe

Recent research focus

New varieties or hybrids of fruit crops are being developed against biotic and abiotic stress. Advance generation gynodioecious lines with semi-vigorous growth patterns are alsoin the pipeline.

The institute is also finding efficient ways and means to conserve and effectively use plant genetic resources

For perennial fruit tree breeding, maker-assisted selections are being adopted. The institute is also associating with a global partner in the genome sequencing of mango and banana,

Manipulating the growth and development of fruit crops through crop-specific management of canopy architecture and also through the use of various chemicals and growth regulators are also being developed.

Mango rootstocks are being developed to adapt in problematic soils. Dwarfing types of sapota are also being created.

Canopy management, and high-density planting are being perfected for mango and guava.

For papaya, molecular approaches are being designed through conventional breeding and with biotechnological tools for biotic resistance. Tissue culture and vegetative propagation techniques are also under development.

For guavas, rootstocks varieties are being identified that are resistant to wilt. Varieties are also being bred that have high lycopene content with soft seeds and semi-vigorous type of growth.

Other research are region- and crop-specific fertigation schedule for major tropical fruit crops, ensuring eco-friendly management of pests through bio-rationales, perfected safe ripening methods, and improved handling and packing methods for reducing losses in these practices, and popularizing jackfruit in India.

To mitigate climate change effects, basic and applied research related to climate resilient horticulture is another area that has attained greater focus and interest among the researchers in the recent years.
The potential for development of tropical fruits research lies in continuous technological improvement in the areas of production and post-harvest management. Tropical fruits have a wide variety of challenges and opportunities, and in many countries, these fruits are faced with serious problems of biotic and abiotic stress. The issue of supply chain management is also critical for improved grower profitability. Replacement with new hybrids or varieties of tropical fruit species is a time-consuming process; therefore, focused approach on improving productivity through crop production and protection has been the immediate goal. Varietal improvement, on the other hand, has been a long-term objective in all research undertaken.

Consequently, research priorities have been development of hybrids empowered with genes for higher yield and resistance to biotic and abiotic stress, which respond to climate change; improved production technology for mitigating problematic soil and enabling efficient use of water, nutrients and solar energy; technology for safe management of insect pests and diseases; reduction in post-harvest losses and value addition. New areas such as organic farming, precision farming, protected cultivation and biotechnology have also been given greater emphasis.

In future, the tropical fruits industry must be expanded to include semi-arid areas and underutilized crops. Such progress requires imperative global partnerships in order to integrate scientific and technological innovation and the sharing of knowledge among partner countries. This is what is highlighted under the TFNet programmes.

Research on tropical fruit crops in India comes under the Indian Council of Agricultural Research (ICAR), which is a premier research organization with a vast network of commodity-based national institutes and centres and regional universities that are engaged in teaching, research and extension activities. In addition to these centres, the Krishi Vigyan Kendras act as a link between researchers and farmers. Despite the distributed research, the coordinated programmes are constantly involved in multi-locational testing of technologies and varieties for identifying its suitability and ensuring greater use.

Initial canopy management is essential to maximize fruiting under high density planting in guava

Paracoccus marginatus **(LEFT), an invasive mealy bug, is biologically controlled by parasitoid** ***Acerophagus papaye*** **(RIGHT).**

Hot water treatment is used to control fruit flies.

SOLUTIONS TO IMPROVE THE MARKETING OF TROPICAL FRUITS IN MYANMAR

Than Than Sein
Myanmar Fruit and Vegetable Producer and Exporter Association

The geological landscape of Myanmar varies in topography, enabling the cultivation of different tropical and temperate fruits and vegetables.

The Myanmar Fruit, Flower And Vegetable Producer And Exporter Association (MFFVPEA) is a group that aims to improve fruit quality and quantities in pre-harvest management, improve postharvest management, implement food safety standards, and link farmers to markets.

Pre-harvest Factors

The cultivar selection plays an important role in quality and quantity of fruit production. It is key to select cultivars that have desirable traits for the market. MFFVPEA has conducted rootstock selection, adjusting to light and temperature, disease treatment, and cultural practices such as pruning, irrigation, fertilization, and orchard floor management.

Orchard floor management practices include cultivation between the rows, cover crops to maintain soil structure, mulching to retain moisture, and weed control. Phyto-hormones and other growth regulatorscan be used on the pre-harvest stage to fruit quality and shelf life.

Sorting and packing can be done in the farm after harvest.

Postharvest Management

The shelf life of fruits can be increased during postharvest by reducing metabolic rates and water loss, minimize damage, and prevent development os disorders.

Proper postharvest handling can greatly reduce losses. MFFVPEA has conducted training for fruit pickers and handlers, including tips such as picking from from the bottom to the top of the tree and not mixing fruits that fell on the ground.

Maturity indices for fruit varieties have been developed to identify fruits that are ready for picking. Harvesting early in the morning or later in the day can also prevent the fruits from being exposed to harsh sunlight that reduces shelf life.

After picking, use appropriate containers, bags and tools to prevent damage. Containers should be proper in size, no sharp edges, and have ventilation.

An evaporative cool storage can also be a low-cost, on farm storage structure that extends the shelf life of fruits and vegetables by

Consumers in export markets prefer high-quality fruits with an attractive appearance color, no blemishes, no disorders, good texture and flavor, and safe to eat.

Educating Farmers on Food Safety Standards

MFFVPEA conducts capacity development programmes to educate and train farmers on food safety standards and certifications,

Farmers need to understand the biological functions and the chemical

Processing during peak season can reduce the postharvest losses from glut.

Selling direct to consumers in a farmers market in Rangun, Myanmar.

consequences of the production systems to identify the next course of logical responses to any interferences to crop cycles. Farmers must also have linkage into the market.

Food safety hazards can be any chemical, biological, or physical substance that can cause fresh fruit to become an unacceptable health risk to consumers.

Chemical contaminants in fresh fruit and vegetables may occur naturally or may be added during production, harvesting, and postharvest handling of fresh produce. These can come from agrochemical residues, heavey metals, and non-agrochemical contaminants such as fuels, lubricants, and sanitizers.

Physical hazards are foreign objects that can cause illness or injury to consumers. Contamination can occur during production, harvesting, and postharvest handling. Physical contaminants can be soil, stones, sticks, weed seeds, wood, metal, plastic, paint flakes, jewelry, and personal items.

Biological hazards are pathogenic microorganisms affect consumers health and cause illness. Some types of pathogenic microorganisms are bacteria, parasites and viruses.

Management practices that reduce contamination include field sanitation practices such as clean and sanitary storage facilities before harvest, picking tools, harvest bins, packing area, equipment, and floors daily. Workers should be taught proper hand-washing, picking dry fruit, leaving fruits with damage and animal dropppings, and excluding animals from orchards.

Market Linkage and Contract Farming

Upon discussion with exporters, MFFVPEA found out that they are concerned with excess productive capacity, export-led growth policies, increasing employment opportunities, and building a globally competitive industry.

Meanwhile, importers value trade balance utilizing tariff controls and non-tariff barriers, protection of food safety, hygiene, and health of consumers.

Fruits Festivals and Farmers Market

With the support of the Union of Myanmar Federation of Chamber of Commerce and Industry, MFFVPEA has organized annual exhibitions, and discussion with growers, brokers, and traders. These include pomelo exhibitions, mango festivals, and development of packinghouses and farmer markets.

MANGO RESEARCH INTERVENTIONS FOR THE SUCCESSFUL POSTHARVEST VALUE CHAINS IN SUDAN

Badreldin E. M. Elhassan
Director General, Department of Horticulture, Sudan

Mango production in Sudan has been improving. Areas under mango cultivation has increased from 27.5 thousand hectares in 2003 to 29.9 thousand hectares in 2013. Accordingly, production has increased from 602 thousand tons in 2003 to 641 thousand tons in 2013.

Production is all year round, except for September to October. Export season is from December to August. The dominant variety in Sudan is Kitchener, also known as 'Baladi', which represents 90 percent of the total cultivated mango.

Cultivation is entirely on the fertile silt loamy soils irrigated by rivers or underground water using surface irrigation.

Twenty four mono-embryonic and seven poly-embryonic Indian cultivars are commonly available in Sudan. Other mango varieties were introduced from South Africa and evaluated recently including Tommy Atkins, Keitt, Kent and Sensation. These introduced varieties have shown the capacity of growing and have been successfully adopted by farmers, providing a starting point for expansion and export.

Different cultivars of mango in Sudan include Kitchener, Tommy Atkins, Keitt, Kent and Sensation

Research interventions: Propagation

Good operating procedures for nursery management is imperative to improve the vigor of mango rootstock seedlings for propagation and field planting. Selected poly-embryonic mango seeds for propagation should be freshly extracted from clean ripe fruit to ensure faster germination rates.

It is important to select seeds from trees that appear to have a low incidence of pests and disease in order to reduce the potential contamination of seedlings. Seed germination will be more efficient if the embryos are removed from the endocarp.

Healthy seeds should germinate within two weeks of planting. Germinating seeds should be protected from full sunlight by growing in 50–80% shade and the potting media must be kept moist by regular irrigation.

Mango rootstocks and scions can be joined using many grafting and budding techniques. The "cleft" and "whip-and-tongue" methods are among the most applied propagation techniques in Sudan. After the scion buds shoot, apical growth of the mango seedling is established

Grafting is a common vegetative propagation technique to ensure high-quality fruits.

Seclecting and grading fruits

Vapor hear treatment chamber

Selected and treated fruits for export

and the growth of auxiliary shoots on the rootstock is suppressed. Grafted trees should be separated sufficiently to allow adequate air flow and light penetration in order to lower the relative humidity and prevent the microclimatic conditions preferred by pests and diseases.

Research interventions: Agronomy and Irrigation

Grafted trees should be planted at a depth that keeps the graft union about 10–15 cm above ground level. Trees should be watered immediately after transplanting to compact the soil around the roots and to reduce water stress. The new plantations are irrigated by modern systems. Protection from wind by local barrier is required.

Research interventions: High-density Planting

The advantages of more densely planted mango orchards are increased canopy and productivity per unit area and efficient management operations. Higher density requires more skilled management to maintain productivity and fruit quality. In Sudan higher density planting is still limited practice under research evaluation.

Harvesting of mature fruits should be carefully done esspecially with high tree canopy to avoid skin injures. After picking off the fruit, harvested fruits should be kept under shade for primary sorting and before packing in carton boxes.
Work has also been done on cold storage for improving shelf life and fruit quality.

Research interventions: Evaluation of vapor heat treatment

Fruit flies are known worldwide as destructive pests of mango fruits. Thus the importing countries where such fruit flies do not occur are exercising every effort to prevent the entry of such pests by stringent phytosanitary measures. Vapor heat treatment (VHT) is now applying in Sudan as a quarantine safeguard to prevent spreading of fruit flies.

SITUATION ANALYSIS FOR PAPAYA INDUSTRY IN FIJI

Shalendra Prasad
Ministry of Agriculture, Fiji

The major crops in Fiji are sugarcane, taro, coconut, cassava, vegetables and fruits. Major fruits grown in Fiji are papaya, pineapple, banana, mango, and citrus. Papaya is Fiji's most important fruit export commodity and offers the prospect of becoming a major industry.

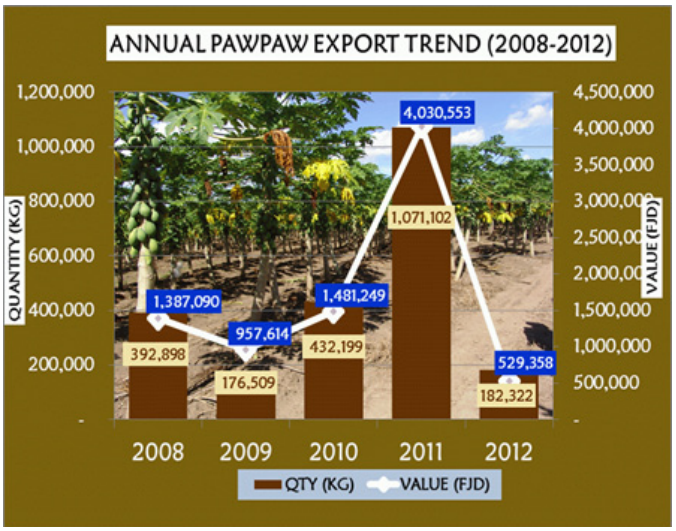
Fiji is well placed to become a substantial papaya producer based on a number of factors such as favorable soil and climate, favorable pest and disease status, a functioning commercial quarantine treatment, a strong export and local market demand.

The main cultivar grown in Fiji is the Sunrise Solo also know as Fijian Red. Currently, the Fiji papaya industry is comprised of nine exporters, 11 large farmers, 150 small farmers, and one industry-owned and operated quarantine treatment facility. The treatment facility is operated by Natures Way Cooperative (Fiji) Ltd (NWC), a registered cooperative of the Fiji fresh produce export industry. NWC's core business is the quarantine treatment of fruit fly host products, utilizing the Hot Temperature Forced Air Method (HTFA).

HTFA was developed in Hawaii as a quarantine treatment for papaya to replace the highly unsatisfactory double dip hot water treatment. The HTFA process involves slowly heating the fruit (5-6 hours) to a temperature that can kill fruit fly larvae and eggs (around 47.2 °C).

NWC is a service cooperative that treats and packs fruit on behalf of its members. It is not involved in exporting, which is handled by individual exporters. The exporters must be NWC shareholders to utilise the HTFA facilities and they should purchase their produce for treatment from farmers who are also shareholders. Exporters pay a fee per kg of fruit treated.

Over the last decade NWC has grown from a small business handling just 30 tonnes of papaya to an agribusiness treating 1,200 tonnes fruit (papaya, mango, eggplant and



Annual papaya export trend (2008-2012)

breadfruit) annually for export. About 87% of the exports are to New Zealand and only 13 % to Australia. NWC also treats eggplant, mango, and breadfruit.

Papaya in Fiji has somewhat complex value chain involving a large number of actors involving six seedling suppliers, 220 registered papaya farmers, research partners (Ministry of Agriculture Research Division– Sigatoka Research Station (SRS) and the ACIAR Fiji Papaya Project), extension partners (Ministry of Agriculture Extension Division, Taiwan Technical Mission), domestic traders (road side sellers, market vendors, middlemen), transporters and handlers (NWC staff, exporter staff, Air Terminal Services (ATS, freight companies), nine exporters, and the Biosecurity Authority of Fiji (BAF).

The success of NWC can be attributed to the quality and continuity of management, no government interference in the operations of the business, an appropriate public private sector partnership, and no shareholder interference in the day to day operations.

Quarantine treatment fees have been set at an economic rate from the outset. This has enabled the business to run profitably and retain a sufficient level of earning to fund repairs and maintenance, to invest in the expansion of the business and to make rainy day provisions for events such as cyclones and trade bans.

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