REPORT

WORKSHOP ON

Enhancing Market Access for Tropical Fruits in East Africa and GCC countries through Quality Improvement, Proper Postharvest Handling and Pest & Disease Management

4-5 March 2015 - Khartoum, Sudan

Ministry of Agriculture and Irrigation, Sudan

International Tropical Fruits Network

Food and Agriculture Organization of the United Nations, Kingdom of Saudi Arabia




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Introduction

In 2011, the estimated world banana and other tropical fruit production were 183.0 million tonnes and 95.0 million tonnes respectively. Besides banana, mango was the main fruit produced accounting for almost 40 percent of total production followed by pineapple 25 percent, papaya 10 percent and avocado at 4 percent. Other minor tropical fruits such as durian, rambutan, litchi, guava, and mangosteen made up about 20 percent of total tropical fruit production. Asia remains the main producer of tropical fruits, followed by Latin America and the Caribbean, Africa, and Oceania. Generally 90 percent of the fruits produced are consumed domestically with only an estimated 5 percent traded as fresh fruits and another 5 percent are processed. In recent years, there has been an increase in the export of tropical fruits, due to changing consumer trends and demands in the importing countries for fresh, safe, and quality produce.

The main tropical fruit producing countries in Africa are S. Africa, Kenya, Tanzania, Nigeria, Ethiopia and Congo. In 2011, the main tropical fruit produced in Africa were bananas (15,396,357 tonnes), mangoes (3,944,303 tonnes), papayas (1,461,441 tonnes), and pineapples (2,896,040 tonnes).

In the same year, the main producers of bananas were Tanzania (3,143,840 tonnes), Angola (2,646,070 tonnes), Burundi (1,848,730 tonnes), Cameroon (1,376,000 tonnes), Kenya (1,197,990 tonnes), Egypt (1,054,240 tonnes), and Uganda at (522,945 tonnes).

The main countries producing mangoes were Nigeria (795,000 tonnes), Kenya (636,585 tonnes), Egypt (598,084 tonnes), and (Tanzania 330,000 tonnes), while the main pineapples producers were Nigeria (705,000 tonnes), Ethiopia (340,239 tonnes), Congo (280,330 tonnes), and Mozambique (43,245 tonnes).

Meanwhile, the main producers of papayas were Nigeria at 705,000 tonnes, Ethiopia (340,239 tonnes), Congo (280,330 tonnes), and Mozambique at (43,245 tonnes).

The main tropical fruits produced in Sudan were mangoes (27,500 ha), bananas (23,000 ha), citrus (27,000 ha), guavas (6000 ha), and there had been increasing areas of papayas and pineapples.

Tropical fruits are also produced in other Arab States and GCC countries including Egypt, Sultanate of Oman, Kingdom of Saudi Arabia, United Arab Emirates and Yemen, where mangoes, bananas, papayas and pineapple are popular. Generally, the production of tropical fruits increased up to 40 percent in the period from 2000 to 2011, in these States.

As in main tropical fruit growing countries in Asia and Latin America, smallholders in Africa are also faced with issues of low quality produce, pest and diseases incidences, and poor postharvest management resulting in limited access to the market.

Besides institutional and policy support, lack in appropriate production technologies at the pre harvest, harvest and post-harvest stages along the value chain, are challenges that have to be overcome to reduce losses and poor fruit quality. A major problem with fruit production is damage caused by fruit flies, which have been identified as major pests to fresh fruit and can impact production, food security and trade in Africa. Besides this, recently there has been an initiative by FAO to mitigate and manage Panama wilt disease on bananas caused by a fungus Fusarium oxysporium cubense TR 4. This disease which has affected many countries in Asia

including China, Philippines, Malaysia and Indonesia, can be devastating to the whole banana industry if not contained. It has already been identified to affect bananas in Mozambique.

There is also the need to look at the various levels of smallholder involvement in the tropical fruit value chain to show the links between producers and buyers, identify gaps and constraints and to recommend interventions to distribute the benefits among producers and buyers.

Smallholders integration can be improved through capacity building in areas such as quality assurance, food safety, good agricultural practice, phyto-sanitary regulations, pest & diseases and postharvest management to improve competitiveness for better market access.

Cognizant of the various issues relating to tropical fruit production and market, International Tropical Fruit Network (TFNet), together with the Horticultural Section Administration, Federal Ministry of Agriculture and Irrigation, Sudan and Food and Agriculture Organization, Kingdom of Saudi Arabia, planned to organize a workshop on 'Enhancing Market Access for Tropical Fruits in East Africa and GCC countries through Quality Improvement, Proper Postharvest Handling and Pest & Disease Management'. The workshop was held at the Grand Holiday Villa Hotel, Khartoum, Sudan from 4 to 5 March 2015.

The workshop was officially opened by Dr. Jaffar Ahmad Abdullah State Minister, Ministry of Agriculture and Irrigation, Republic of Sudan.

Fifty six participants attended the workshop comprising representatives from Ethiopia, Uganda, Kenya, Officials from the Federal Ministry of Agriculture and Irrigation Sudan, Universities, Sudan Agriculture Research Corporation, private companies and resource persons from Australia, Eygpt, South Africa, Sudan, FAO Kingdom of Saudi Arabia and TFNet.

During the second day of the workshop, a field visit was organised to observe the efforts of a local company, Zadna Corporation , which is involved in the production of planting materials including mango, grapefruit and other citruses, date palm and banana.

The main objectives of the workshop are to:

- Assess issues and challenges in developing the tropical fruit industry, taking into account the impact on food security, income generation for smallholders and market access.
- Share recent information on pest and disease management in tropical fruits, especially on awareness of the impact of the wilt disease caused by Fusarium sp in bananas, including the strategies to mitigate and manage the disease
- Share recent information on the effect of fruit flies infestation in tropical fruits, including the strategies to control and manage the pest.
- Share information on the current postharvest technologies that can improve quality and marketability of tropical fruits, as the same time, conform to quality and safety standards to meet consumer's preferences.
- Develop a strategy and action plan including policy implementation to improve postharvest and quality management and to mitigate effects of pests and diseases (including fruit fly management and Fusarium sp. banana wilt disease), incorporating sanitary and phytosanitary (SPS) and quarantine regulations.

Paper presentations

The seven papers presented focussed on issues that characterise tropical fruit development in the region. Emphasis was given to the threat of the Fusarium wilt disease on bananas, fruit fly infestation, good practices for mango and the requirements for good quality and safe fruits for market access.

Paper 1: Global production and market of Tropical fruits: issues and challenges
by Yacob Ahmad, TFNet Chief Executive Officer

Yacob Ahmad provided the global scenario including main fruit types, production and the amount traded. He highlighted that banana remains the main tropical fruit produced followed by mango, pineapple, papaya and avocado and other minor fruits, with Asia as the leading producer followed by Latin America and Africa, where generally 90 percent of the fruits produced are consumed domestically with only an estimated 5 percent traded as fresh fruits and another 5 percent are processed. Even though there has not being a drastic increase in production, in recent years, there is an increase in the export of tropical fruits, due to changing consumer trends and demands in the importing countries for fresh, safe, and quality produce. The speaker listed the common issues in the production of tropical fruits such as, traditional agriculture and outdated technologies, Low quality produce and lack of infrastructure, especially access to production areas and post harvest facilities. Other related issues are lack of access to technology, pests and diseases, traditional market systems and smallholder inclusion into the value chain.

He also mentioned that the main enabling factors to improve tropical fruit production and trade are to institutionalize growers into groups, prioritize research and development, effective capacity building and extension system, private sector involvement to assist farmers and providing credit facilities for smallholder. As in other agricultural commodities, to improve international trade, emphasis has to be given to issues concerning Sanitary and Phytosanitary regulations, standards and market access through bilateral or regional agreements.

Paper 2: Quality Assurance, Food Safety and Standards for Market Opportunities in Tropical Fruits
by Prof. Abu-Bakr Ali Abu-Gough, University of Khartoum

Prof. Abu-Bakr Ali Abu-Gough began by saying that postharvest technologies have already been developed for ensuring quality assurance, food safety and good market access for tropical fruits. He presented the various causes of postharvest losses from handling up to packaging and also the various practices available to reduce losses, including practices in packinghouse operations for exports. Dr. Abu-Bakr also discussed the effect of waxing and use of fungicide such as benomyl to improve quality and shelf life of fruits. The details of postharvest effects on produce such as temperature build up, humidity and respiration was discussed. He also stressed on the use of chemicals to hasten or slow down ripening such as ethylene absorbers.

Paper 3: Cultural practices, postharvest practices and IPM in mango
by Bob Williams, Department of Plant Industries, Australia

Bob Williams introduced the topic by giving an indication of the current global mango trade, when, even though, world production of mango is estimated to be around 35 million metric tonnes, the world export trade is only around 1.2 million metric tonne, around 2.5 percent of

world production. This clearly demonstrates the positive contribution of mangoes in domestic trade, the potential for growth in export trade, but also the difficulties of moving mangoes into the export trade. He said that Australia is a very small participant compared to the large producers such of India and Brazil, with only a total production of 60,000 tonnes but 8,000 tonnes (13%) are exported

Australian producers face the same generic mango problems like all other countries such as, low productivity, biennial bearing, inconsistent flowering, pest and disease, post-harvest quality losses and market access challenges. Even though there has been significant progress in addressing some of these issues, there are challenges quite unique to Australia including high cost of inputs such as land, labour and transport.

Mr. William's presentation provided an insight to how we should address many of the generic challenges as well as how they are minimising the impact of high inputs' costs.

Paper 4: The Development of the Tropical and Subtropical Fruit Sector in Kingdom of Saudi Arabia

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

Dr. Hassan M. Ali-Dinar gave a background of the development of the Horticulture sector in KSA through the Technical Cooperation between FAO and the Ministry of Agriculture, which began as early as 1950 and has made significant and qualitative changes through the Unilateral Trust Fund Agreement which was signed between the Ministry of Agriculture and FAO since 1981. The agreement since 1981 was renewed every 5 years until the current one (2011-2016).

It includes 15 development projects among which is the horticulture project: Development and Technology Transfer of the Horticulture Sector in Kingdom of Saudi Arabia with a budget of USD 4,514,508 through the five years. The horticulture project involves the development of crops such as citrus, , grapes and tropical fruits such as mango, pineapple, figs, pitaya, guava, papaya, and carambola. Other horticulture projects in the agreement with separate budgets include development of date palm and olive in the Kingdom.

The most common tropical fruits grown in the GCC countries are mango covering about 7,300 ha, papaya estimated at 625 ha and bananas at 4,350 ha which is mainly grown in Oman. Dr. Hassan mentioned that currently, GCC countries fruit production accounts for only 25.5 percent of domestic demands, while Saudi Arabia meets 35 – 46.8 percent of overall domestic demand. Fruits are imported from neighboring and other countries to satisfy demand. This evidently shows that there is more scope for development of fruits in these countries.

He also listed out the challenges in developing the fruit industry which includes restrictive water resources, increasing soil salinity and lack of suitable rootstocks, limited knowledge of appropriate harvest and post-harvest techniques, pests and diseases problems, limited research on good agricultural practices and lack to sufficient qualified national staff.

The speaker concluded that regional cooperation can be a way to jointly address common issues and share experiences, including developing projects through South-South cooperation. Collaboration with regional and international organisations is another avenue. Besides this technical initiatives including exploring other potential fruit types that are agro-climatically suitable and the exchange of genetic resources to build up a genetic pool to be used in research and development in the improvements of currently available species.

Paper 5: Banana Fusarium disease: the return of a catastrophic plant disease
by Altus Viljoen, Department of Plant Pathology, Stellenbosch University, South Africa

Dr. Altus Viljoen gave a background on one of the most destructive diseases in agricultural history which is threatening bananas again. In the early 1900s, Fusarium wilt destroyed Gros Michel bananas in Latin America to a point where they had to be replaced by Cavendish cultivars in order to save the international export trade.

Currently, Cavendish bananas make up more than 40% of all bananas grown globally in order to supply consumers worldwide. In most tropical countries, however, local banana varieties are mainly grown for food and income to small growers, thereby ensuring their livelihoods. The discovery of a new strain of the banana Fusarium wilt fungus in Asia in the 1990s, called *Fusarium oxysporum* f. sp. *cubense* (Foc) tropical race 4 (TR4), led to devastating losses of Cavendish bananas produced commercially in monoculture, but also to varieties planted by small growers.

Foc TR4 has a larger host range than any other race of Foc, and with a global replacement for Cavendish bananas not readily available, poses a significant threat to banana production worldwide. The fungus has been discovered in the Middle East in 2012 and soon thereafter in Mozambique.

The latter discovery was of significant concern, as banana serves as staple food to millions of people in Africa. Research efforts in Asia in the past two decades have developed somaclones of Cavendish bananas tolerant to Foc TR4 and have modified production systems to reduce the impact of the pathogen to small growers. It is, however, the intercontinental spread from Asia to Africa and the Middle East which urged the FAO and the international scientific community to develop a global programme to prevent a worldwide epidemic.

The objective of this programme is to manage Foc TR4 in areas where the disease is present, and to prevent its spread to unaffected areas by awareness raising, the introduction or legislation, and capacity development to deal with the disease. He also suggested that countries in the region be aware of the threat and formulate policies, conduct surveillances and other biosecurity activities to prevent the spread of this deadly disease.

Paper 6: Postharvest Management Practices in Tropical Fruits for Market Access
by Dr. Kahil S. Yousif, Alzaiem Alazhari University

Dr. Kahil S. Yousif began with mentioning that post harvest losses occur mainly through lack of appropriate technologies and their subsequent transfer to producers. Post harvest management is about reducing mechanical damage by appropriate harvesting methods and proper handling, slowing down respiration by refrigeration, and other practices that can reduce water loss including packaging.

Reducing losses through recommended pests and diseases control, besides proper cultural practices is key in ensuring good quality produce. Improving postharvest management practices, should also be less costly, effective and within the reach of small farmers. This will need the establishment of cooperatives and farmers group, with participation from the private sector. Infrastructural development to improve access to production areas and provision of suitable collection centers are also important in mitigating post harvest losses.

Paper 7: Fruit fly management practices on tropical fruit in Africa
by Dr. Talal S. El-Abbassi, Plant Protection Research Institute, Egypt

Dr. Talal S. El-Abbassi began by introducing the difference species of fruit flies present and their distribution in Africa. He stressed the importance of fruit fly control in producing countries as it is a major factor in the African export markets.

Bactrocera invadens and *Ceratitis cosyra* are of the major constraints that in general limit tropical fruit production in Africa and mango fruits in particular. They cause up to 40–80% direct damage to mango fruits and also restrict export to large lucrative markets in Europe, the Middle East, Japan and USA

A proposal of an international programme (a broad strategy) among African countries should be prepared to respond to the threat of these invasive pest species. Such programme must include a range of alternatives (exclusion, detection and prevention, and control.

Developing and implementing an integrated pest management (IPM) programme is highly requested to minimize the use of chemical pesticides to overcome these abovementioned problems and produce fruit fly-free and residue-free fruits to facilitate compliance with standards required for export markets. IPM is also dependant on information gathered from studies on the biology and ecology of any insect pest is key in the establishment of effective control measures that might enable us to win the battle against such pest.

Dr. Talal mentioned that the strategy of IPM programme is based on usage of all means of control procedures in a complementary way (legislative control, physical control, cultural control, biological control), Biotechnological Control sterile insect technique, wise use of pesticides and postharvest treatments). Before implementation of IPM, biological and ecological studies including geographical distribution, dominant species, life cycle and seasonal impact on insect population have to be conducted as prerequisites. Detecting or monitoring techniques normally used for fruit fly ecological assessment/studies include the use of traps and attractants.

Paper 8: A viable seed system is the basis for the successful banana postharvest value chain in Sudan
by Dr. Salah B. Bakhiet, Agricultural Research Corporation, Sudan

Dr. Salah B. Bakhiet provided information on most proper operations carried out in the production for export quality banana, starting from the seeds as basis for successful post harvest value chain. Planting material of high yielding banana cultivars suitable for export and local markets were obtained from international tissue culture laboratories. The existing plantings of these improved cultivars have shown, after being evaluated, that they can be grown and adopted by farmers successfully and provide a starting point for expansion. Each banana planting material has the potential to produce a bunch, which is identical to the mother plant. As with most of the vegetatively propagated crops, using poorly selected banana planting material can transmit serious pests and diseases, which can in turn result in considerable quantitative and qualitative yield losses.

Banana production for export in Sudan is at the threshold of new international markets in which the industry has to consistently increase productivity, export high quality fruits and reduce the high levels of fruit rejects if it is to compete on global markets and make considerable profit. He suggested recommendations which were based on the experience of the CFC banana funded project which was implemented since 2008, to promote banana production for export in Sudan.

Workshop discussion

The discussion session to deliberate on the papers presented was moderated by Dr. Sadig Hassan Omara, former State Minister of Ministry of Agriculture, Sudan, Dr. Abdul Latif Ijami, former Undersecretary of Ministry of Agriculture and Irrigation, Dr. Badreldin El-Sheikh, Director General, Horticulture Administration, Ministry of Agriculture and Irrigation, Dr. Hassan Ali Dinar, Chief Technical Advisor, FAO, Kingdom of Saudi Arabia and Yacob Ahmad, CEO, TFNet.

Generally, the discussion centred on implementation issues and financing of the various programmes in tropical fruit development in the region. Participants also suggested approaches to enhance the areas in research and development, biosecurity and sanitary and phytosanitary requirements (SPS) and capacity building in aspects of production and reduction of postharvest losses. The salient points which were raised and deliberated during the discussion session were as follows:

1. Strategic directions and plans can be listed down, but the total administrative and implementation mechanisms have to be included as part of the plan. For example in the case of prevention of the banana fusarium diseases, has to be a concerted effort with involvement of the various departments and agencies to act as a single entity. This is where having a coordinating mechanism is recommended. The private sector should also be invited for a more complete action plan.

2. Transfer of technology or extension services need to be improved with support from local research institutions such as universities, research centres and the private sector.

3. Sudan has ample natural resources such as land and water, plus human resources that can be mobilized to increase production of horticulture products for export. However, other external factors may negatively impact and reduce opportunities to further expand production both for domestic and export markets. Assistance in the form of collaborative projects between the country and international organisations should be considered and enhanced.

4. Infrastructure development to improve postharvest conditions to mitigate losses should be a continuous effort.

5. Dr. Altus reiterated that the threat of banana Fusarium disease is real and should be taken seriously. He continued by explaining the important steps that should be taken to combat the disease. Governments in the region, including Sudan, which is a high risk country, even though not affected, should take all steps to minimise the risk of the disease being introduced. He reminded that there should be a concerted effort including training of ground staff and farmers to recognise the disease, awareness campaign and formulation of policies related to enforcement of strict quarantine regulations, especially the movement of planting materials into the country. Agricultural technicians should be trained on the symptoms and visual identification of affected plants. Dr. Viljoen suggested that from now on, information on the disease should be shared among researchers, technicians and farmers with information notes, training programmes and workshops.

6. Mr. Bob Williams summarised by referring to the importance of a detailed analysis of the production system of tropical fruits. He cited that planting materials whether tissue cultured or grafted ones are important in the selection of demanded and marketable

cultivars. Ample water resources, good soil types and reduced incidences of soil borne disease are important prerequisites when selecting a commercial planting area or zone.

7. Dr. Talal emphasised on a survey to identify the different species of fruit flies in Sudan and that a National programme is needed for a holistic approach to mitigate fruit flies infestation.

8. Prof. Abu Bakar Abu Gough reiterated the need for good postharvest management practices in the production of quality and safe fruits including good infrastructure, harvesting method, time of harvest, temperature control, storage and packing. He also mentioned about pre-harvest practices that can reduce postharvest losses.

Summary and Recommendations

1. Countries in the region need to be aware and vigilant of the threat of the Fusarium wilt disease on bananas. Biosecurity measures such as movement of planting materials, equipment and personnel should be monitored and checked, since the disease has already been confirmed in Mozambique.

2. Emphasis has also to be given in the management of fruit flies through surveillance, monitoring and control including use of baits, and proper field management.

3. Preharvest and postharvest activities especially for mango need to be improved for better productivity and reducing losses, through targeted research and development, suitable varieties and enhance capacity building activities to address issues in production and integrated pest management.

4. Action plan in Sudan to reduce risk from banana Fusarium wilt disease. This includes the surveillance and enhanced quarantine and use of disease resistant planting materials. The Horticulture Sector Administration of the Ministry of Agriculture and Irrigation will be responsible in the charting of this action plan as soon as possible.

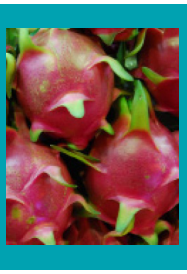
5. Expansion of a Gene Bank for tropical fruits in Sudan, for future use in evaluation of suitable cultivars and potential use in breeding programmes.

6. There has to be strengthening of the relevant institutions in Sudan especially the Horticulture Sector Administration, Ministry of Agriculture and Irrigation and the formation of a committee on commodity problems. There should also be a strong link between the Federal and State Agencies.

7. As funding appears to be a major concern, TFNet can take the lead to collaborate with other networks, FAO, countries and agencies in the region to propose projects pertaining to the issues discussed, and source for funds for implementation.

8. TFNet membership of African countries such as Ethiopia, Ghana, Kenya, Egypt and other countries in the region should be encouraged and sought.

APPENDIX 1



Programme Schedule

Day 1 - 04.03.2015 (Wednesday)

Time	Activities
0830 - 0900	Registration of Participants Introduction of Participants and Workshop Coordinators
0900 - 0930	Workshop Official Opening - Welcome address by TFNet - Welcome address by FAO, Kingdom of Saudi Arabia - Opening address by State Minister, Ministry of Agriculture and Irrigation, Sudan
0930 - 1000	Tea / Coffee
1000 - 1030	Paper 1: Global tropical fruit production and trade – issues and challenges - TFNet
1030 - 1100	Paper 2: Quality assurance, food safety and standards for market access opportunities in the tropical fruits market - Prof. Abubaker Abugough, Sudan
1100 - 1130	Paper 3: Cultural and postharvest practices and IPM in mango – Mr. Bob Williams
1130 - 1200	Paper 4: Development of tropical and subtropical fruit in the Kingdom of Saudi Arabia – Dr. Hassan Ali-Dinar, FAO, Kingdom of Saudi Arabia
1200 - 1230	Paper 5: Banana Fusarium disease: the return of a catastrophic plant disease – Dr. Altus Viljoen, Stellenborsch University, South Africa
1230 - 1400	Lunch
1400 - 1430	Paper 6: Post-harvest management practices in tropical fruits for better market access - Prof. Kahil Sobahi, Sudan
1430 - 1500	Paper 7: Fruit fly management practices n tropical fruits in Africa – Dr. Talal El- Abbassi, Plant protection research institute,Egypt.
2000 - 2200	Welcome Dinner

Day 2 - 05.03.2015 (Thursday)

Time	Activities
0830 - 0850	Paper 8: A viable system for planting materials as the basis for successful banana postharvest value chain in Sudan – Dr. Salah B. Bakhiet.
0930 - 1000	Workshop brief
1000 - 1030	Tea / Coffee
1030 - 1130	Workshop conclusion session and recommendations
1130 - 1430	Field trip to Zadna Agricultural Corporate.
1430 - 1530	Lunch
2000 - 2200	Private Company Dinner and Host Country Awards

APPENDIX 2

List of Participants

Name	Organization
Pro. Hassan Ali Dinar	Food and Agriculture Organization of the United Nations – Kingdom of Saudi Arabia
A. Dafalla	Zadna Agricultural Services, Sudan
A. Prof Egameldin B .M.Kabbasli	Food Research Center, Shamlct, Sudan
Abdelatef Ahmed Ijaimi	Private sector, Sudan
Abu.Baker Ali Abu -Goukh	Dept. of Hort., University of Khartoum, Sudan
Adil Ahmed Omer	Zadna Agricultural Services, Sudan
Afrah Osman Mahgoub	Irrigation Sector, Sudan
Ahmed Elhag	United Nations Development Program
Altus Yiljoen	Stellenbosch University, South Africa
Amel Babiker Mohamed	Agricultural Research Corporation - Shurbal, Sudan
Asma Khidir Mekkii	Ministry of Agriculture, Sudan
Awatif Abdalla Orsud	Horticultural Sector Administration, Sudan
Awatif Ahmed Abdalla	Plant Protection Directory, Sudan
Badreldin Elshieekh Elhassan	Horticultural Sector Administration, Sudan
Bahaeldin Mohamed Khamis	Ministry of Agriculture, Sudan
Bob Williams	Department of Plant Industries, Australia
Daralsalam Abd .Algadir	Ministry of Agriculture, Sudan
Dr .Afaf Elgozouli	Ministry of Agriculture, Sudan
Dr .Salah M.Taha	Wheat production Project
Dr. Awadalla Abdalla	University of Khartoum, Sudan
DR. GAAFAR Aitmed	Ministry of Agriculture, Sudan
Dr. Salah Babiker Bakhiet	Agricultural Research Corporation, Sudan
Dr.Mahdi Abdelrahman Ahmed	Agricultural Research Corporation, Sudan
Dr.Salah.M.Elawad	Department of Agricultural Economics
Ekhlas Altayb	Agricultural Research Corporation, Sudan
Esameldin B.M.Kabbashi	Food Research Centre, Shambat, Sudan
Fadwa Galaleldein Bashir Abdalla	Horticultural Sector Administration
Fahmi Mohmed	Agriculture, Sudan
Faiza Mohamed Mostfa	Irrigation Sector, Sudan
Hanan Hassan Mohamed	Plant protection Directory, Sudan
Haniosman	Radio Economique, Sudan
Ibrahim Hassan	Ministry of Agriculture, Sudan

Name	Organization
Joyce Dnek	Uganda Embassy kht
Kamal .A.Amein	Plant Protection Directory, Sudan
Lubna Mohammed Sidahmed	Horticultural Sector Administration, Sudan
Moawia .e. Mohamed	ARC, Shambat. R.
Mobasher Ahmed Elnore Ahmed	Ministry of Agriculture, Sudan
Mohamed Yahia Mohamed Mahgoub	Horticultural Sector Administration, Sudan
Mohammed Bakry Awad Eltaher	
Mustafa Gama Ali	Ministry of Agriculture, Sudan
Mustoura Eldoma	Ministry of Agriculture, Sudan
Mutaz Abdelrahman Ali	Elnefeidi Agriculture, Sudan
Nafisa Hussein Baldo	Horticultural Sector Administration, Sudan
Omayma Yousif Ahmed	International cooperation
Osman Abukar Hassan	Horticultural Sector Administration, Sudan
Prof . Hassan M .Ali Dinar	Food and Agriculture Organization of the United Nations, Kingdom of Saudi Arabia
Prof Dr.Talal salaheidin ELABBASSI	Qlamt Protection Ros Inst Cano Eqypt
Prof ELSadig Hassan ELSadig	Sudan Unity Softech, Sudan
Salah Dafalla Ahmed	Horticultural Sector Administration, Sudan
Samia Abdallah Mohamed	Horticultural Sector Administration, Sudan
Shaden Ameeri Hassan	Ministry of Agriculture, Sudan
Sitelnafar Ibrahim	Ministry of Agriculture, Sudan
Suhaira Mohaned ELamin	Horticultural Sector Administration, Sudan
Wamda Awad Altayb	Horticultural Sector Administration, Sudan
Yacob Ahmad	International Tropical Fruits Network
Zeinab Elsayed Eldoush	Horticultural Sector Administration, Sudan

APPENDIX 3

Slide presentations

Paper 1: Global production and market of Tropical fruits: issues and challenges

by Yacob Ahmad, TFNet Chief Executive Officer

OVERVIEW ON GLOBAL TROPICAL FRUIT PRODUCTION AND TRADE : ISSUES AND CHALLENGES

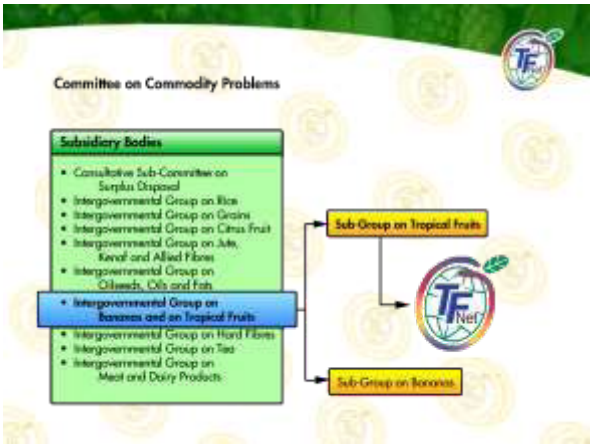
By
yacob@itfnet.org
International Tropical Fruits Network (TFNet)

www.itfnet.org
Linking people, technology and market

What is TFNet....

International Tropical Fruits Network (TFNet) is an autonomous and self financing global network established under the auspices of the Food and Agriculture Organization of the United Nations whose mandate is to promote sustainable development of the tropical fruit Industry globally in relation to production, consumption and trade.

- **Established in 2000**
- **It is both intergovernmental and inter-institutional in nature.**
- **Membership based – County, Associate and Ordinary**
- **Based in Serdang, Malaysia**



Objectives of TFNet

- ✓ **To act as a repository and exchange of information on tropical fruits;**
- ✓ **To promote, co-ordinate and support research and development as well as transfer of technology;**
- ✓ **To facilitate the expansion of international trade of tropical fruits;**
- ✓ **To enhance human resource development;**
- ✓ **To organize generic market promotion and strengthen consumer knowledge on the nutritional value of tropical fruits;**
- ✓ **To sensitize and facilitate implementation of international and regional agreements on tropical fruits;**
- ✓ **To promote technical and economic exchanges in the tropical fruit sector.**

Membership categories

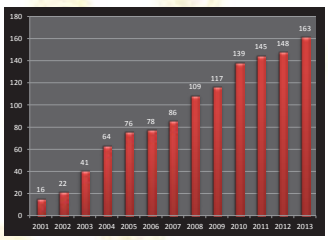
Country Members:
- Open to all member countries of the FAO who are signatories to the Agreement on the Establishment of the Tropical Fruits Network or who has acceded to the said Agreement.
- Country members shall have voting rights in the General Assembly.
- A one-time membership registration fees shall be at USD5,000.00.
- No annual membership fees shall be levied.

Associate Members:
- Open to any international, regional or national organisation, institute, association or business entity in both public and private sectors that can contribute positively to the objectives and operations of TFNet.
- Associate members shall have voting rights in the General Assembly.
- Annual membership fees shall be at USD500.00.

Ordinary Members:
- Open to any individual or non-profit organisation that can contribute positively to the objectives and operations of TFNet.
- Ordinary members shall have no voting rights in the General Assembly.
- Annual membership fees shall be at USD50.00.

TFNet Membership status 2001 - 2014

Country Members (14):
Bangladesh, China, Fiji, India, Indonesia, Malaysia, Nigeria, Philippines, Sudan, Syria, Vietnam, Australia, Sri Lanka, and Saudi Arabia



What do we do…

- Studies, projects and consultancies
- Capacity development – workshops, symposiums, conferences etc
- Information dissemination, knowledge sharing

TFNet Website : www.itfnet.org

Background

- Tropical fruits – important to developing for nutrition, income generation, for food security, another export option
- Banana – top five commonly eaten fruit and fourth most important food crop after rice, wheat and maize
- World production in 2012 – 101 million tonnes
- Exported 17.2 million tonnes valued at USD 8.4 million
- More for domestic production, 17% (Cavendish) is internationally traded
- 80 % of International trade of Cavendish banana controlled 5 multinational companies
- Now supermarket chains control 60% of trade

Source: FAO

Background

- Other major tropical fruits – 71 million tonnes in 2012
- Mangoes (39%), pineapples (23%), papaya (12%) avocado (4%), Minor fruits (22 %)
- On basis of trade, the minor ones are guava, mangosteen, rambutan, durian, passionfruit, litchi, pomelo.
- 90% domestically consumed, 5% traded fresh and 5% processed.
- Global trade estimated at 8.1 million tonnes valued at USD 7.7 billion
- Additional USD 4 billion as processed products
- Asia is the main producer of tropical fruits mainly by smallholders


VIETNAM: Ministry consults about promoting agro-produce in global market


INDIA: Farmers in despair as pineapple prices dip
Price of pineapple
(Ripe fruit per kg)
February 9, 2015 Rs. 13
January 3, 2015 Rs. 17
December 3, 2014 Rs. 30
November 3, 2014 Rs. 36
October 3, 2014 Rs. 39
September 3, 2014 Rs. 36
August 3, 2014 Rs. 33
July 3, 2014 Rs. 43
June 30, 2014 Rs. 47


INDIA: No ripening chamber, mango traders brace for another bad season


TotalExotics
Mango


TotalExotics
Avocado


Avocados more expensive in Chile than in the Netherlands

KENYA: Pioneer of grafted mango now enjoying boosted income

NEPAL: Banana production drops due to plant disease

AUSTRALIA: Researchers work to wipe out virus crippling banana industry

UGANDA: How mobile phones saved bananas from bacterial wilt

Vietnam importer 'regrets' Australian fresh fruit ban

One of Vietnam's key importers of fresh fruit has expressed its 'regret' at being unable to accept fruit from any Australian states since January 1.

"Vietnam has appreciated for years the good quality of Australian fruits: Midnight Beauty, Thompson, Crimson and Red Globe grapes [in particular]," notes Nghia Pham, head of sales with the NC Group, Ltd (www.thisisncc.com). These are specific early season black grapes traditionally popular with the Vietnamese market. But the import of fruit from Australia has not been allowed since early January, due to concern from the Vietnam government over the presence of fruitfly in Australian crops.

The Vietnamese market base has been discouraged, and consequently consumers in general have been put off, according to Mr Nghia. While a number of fruits have been impacted by the ban, table grapes and cherries are two of the hardest hit. The table grape industry within Australia stands to lose as much as $33 million, thanks to the ban, while only about a third of intended of exports of cherries to Vietnam was able to go to its intended home in Vietnam before the ban came into effect. That means an opportunity loss of around $2.3 million.

When it comes to cherries, New Zealand growers have "won the advantage," through exclusive supply while both Australian and Chilean cherries are out of the game due to there being no import permit, unfortunately for them, admits Mr Nghia. South Africa and Peru are supplying the missing grapes that would come from Australia.

FOR DETAILS

Produce of U.S.A.

NZ: Growers confident fruit fly an isolated case

The latest outbreak of Queensland fruit fly has Waikato fruit growers worried, but they are confident the pest will remain contained in Auckland and eradicated.The region grows a wide range of fruits and vegetables on which the fly feeds, including blueberries, apples, avocados and kiwifruit.While the....,

North America

PERU: Organic bananas afraid of Euro situation

"Last year, we exported 92% of what we produced to Europe, but this year we are reducing our volume of shipments to European destinations to 75% because we are afraid of what might happen to the Euro," said Aingeru García, manager of APPBOSA.

PERU: Mangoes, asparagus undergo phytosanitary controls to enter Korea, China

Peru's Agriculture Ministry welcomed South Korean and Chinese delegations of phytosanitary organizations to discuss the entry of Peruvian mangoes and asparagus, respectively, into their markets.

USA: Binational committee formed to open for South African avocados

Executives representing the top Hass avocado companies in the United States and South Africa announced during Fruit Logistica in Berlin the establishment of the U.S.-South Africa Avocado Committee.

AUSTRALIA: Hot water dips offer hope in battle against post-harvest papaya disease

Postharvest handling – banana export market

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Packaging for the export market


Packaging – Chinese retail market

Niche market – immature jackfruit

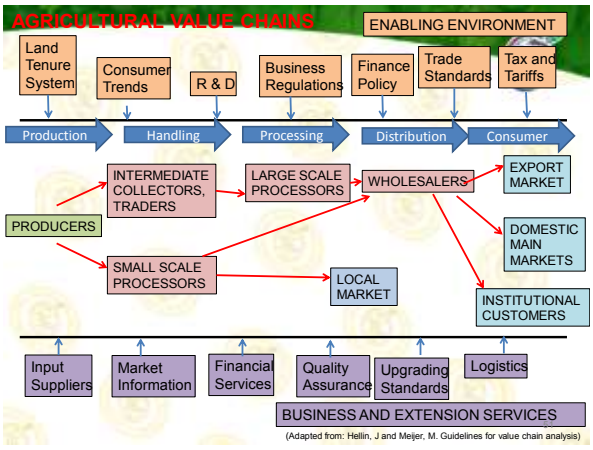
Reduction of post harvest losses – On farm packaging, good Handling

- On farm packaging to minimize handling
- Direct contract with supermarkets
- Farmers groups involved
- Quality assurance - premium

Reduction of post harvest losses
– Good handling,
- on-farm packaging

- On farm packaging to minimize handling
- Direct contract with exporter
- Exported to Singapore – air
- Quality assurance - premium

Training on vacuum fry tropical fruit chip production for Fijian participants in Indonesia



Observations:

- The market factor – products targeted to consumer group, market segmentation, expanding middle class
- Smallholders' inclusion into the value chain and the market system
- Element of price determination and market
- Postharvest losses throughout the value chain …30 - 40% ?
- Seasonal production – glut , go for mixed crop ?
- Lack of appropriate technologies – varieties, production methods
- Increased incidences of pests and diseases
- Export markets – SPS requirements
- Competitiveness

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Key issues in tropical fruit development

- Infrastructure development
- Requirements for certifiable international production, food safety and quality standards
- Smallholders integration into value chain
- Post harvest losses
- Pest and disease outbreaks – related to climate change
- Lack of appropriate production technologies
- Transfer of technology
- Compliance to Sanitary and phytosanitary regulations for the export market
- Economic viability - competitiveness

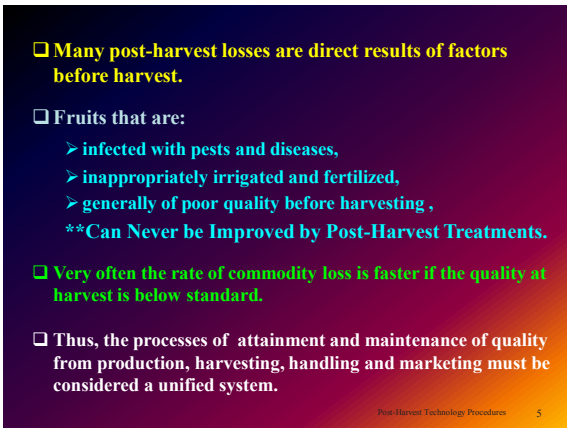
CONCLUSION

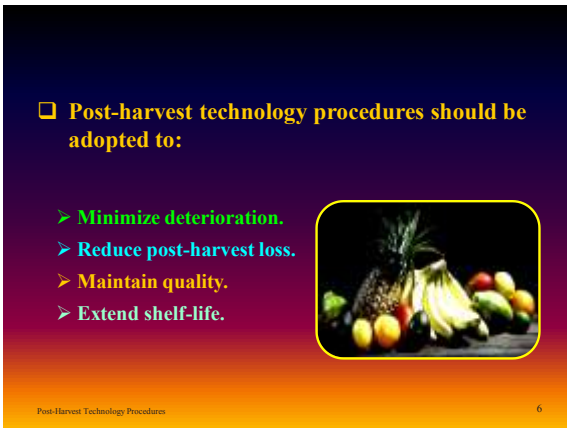
- Institutionalize growers – cooperatives, farmers groups
- Participatory approach for stakeholders
- Prioritize research and development
- Direct private sector linkage
- Capacity building for growers and other stakeholders – transfer of technology
- Availability of market information
- Credit facilities for equipment, technology
- Appropriate policy formulation – especially on SPS quarantine and biosecurity issues
- Infrastructure development


INTERNATIONAL TROPICAL FRUITS NETWORK
THANK YOU…
Linking
People,
Technology
& Market

Paper 2: Quality Assurance, Food Safety and Standards for Market Opportunities in Tropical Fruits

by Prof. Abu-Bakr Ali Abu-Gough, University of Khartoum





2. Harvesting:

- Harvesting refers to the gathering of the fruits from the orchard:
  - at the proper level of maturity,
  - with a minimum of damage,
  - as rapidly as possible,
  - at a minimum cost.

- Harvesting at the proper level of maturity is essential for good quality produce.
- Over-maturity or under-maturity will affect the quality adversity, and should be avoided.

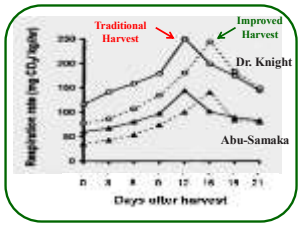
- Method of harvest should protect the produce from any injuries or bruises.
- Suitable harvesting tools, hand gloves, containers and supplies are needed by the harvesters.
- Careful field supervision is the most critical factor in protecting fruits from injuries.

- Most fresh market tropical fruits are now harvested by hand, because human can accurately select for maturity and can handle the fruits with a minimum of damage.

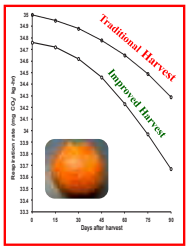
Poor harvesting methods lead to deterioration of the Crop

Improvement of harvesting method reduces post-harvest losses and maintains quality

- The improved harvesting method decreased respiration rate, reduced weight loss, delayed fruit ripening and senescence, improved quality and extended shelf-life of mangoes, papayas and grapefruits.



Abu-Goukh and Mohamed (2004)



(Elshiekh and Abu-Goukh, 2008)

Papaya fruits in the different quality grades harvested by the traditional and improved harvesting methods

Harvesting Method	Quality Grades				
	V. Good	Good	Fair	Poor	Unmarketable
Traditional	0	3.3	50.0	36.7	10.0
Improved	21.6	43.4	25.0	6.7	3.3

Abu-Goukh, A. A. (1988). *Assessment of Post-Harvest Losses in Perishables.* Post-Harvest Center (PDY/ 86/ 003). FAO, Rome, Italy. 20 p.

Mango fruits in the different quality grades harvested by the traditional and improved harvesting methods

Cultivar	Harvesting Method	Quality Grades				
		V. Good	Good	Fair	Poor	Unmarketable
Dr. Knight	Traditional	0	6.5	50.5	36.5	7.0
	Improved	21.4	46.5	25.1	6.7	0.3
Abu-Samaka	Traditional	0	6.3	49.7	34.7	9.7
	Improved	20.3	42.7	26.6	8.3	2.1

Abu-Goukh, A. A. and Mohamed, H. I. (2004). Effect of harvesting method on quality and shelf-life of mango fruits. *Journal of Tropical Science,* 44 (2): 73-76.

Grapefruits in the different quality grades harvested by the traditional and improved harvesting methods

Harvesting Method	Quality Grades				
	V. Good	Good	Fair	Poor	Unmarketable
Traditional	1.5	12.4	23.3	42.3	20.5
Improved	21.8	27.7	30.1	17.0	3.9

Elshiekh, F. A. and Abu-Goukh, A. A. (2008). Effect of harvesting method on quality and storability of grapefruits. *University of Khartoum Journal of Agricultural Sciences,* 16 (1): 1-14.

3. Gentle Handling:

- Horticultural products due to their soft texture should be handled gently to minimize bruising and breaking of the skin.
- The skin of horticultural products is an effective barrier to most pathogenic bacteria and fungi that cause rotting of the tissue.

- Gentle handling of horticultural products should be promoted at all stages of the marketing channel as means for reducing post - harvest losses and imaintaining the quality of the produce.

4. Temperature Management:

- Good temperature management is the single most important tool that we have to maintain post- harvest quality and to extend shelf-life horticultural products.
- Proper temperature management begins with temperature protection in the field, which involves:
  1. Harvest during the cool early morning hours.
  2. Shading the harvested fruits to minimize warming and sunscald.
  3. Quick handling and cooling to minimize high temperature exposure.

5. Control of Relative Humidity :

- Most horticultural crops store best in an environment that has a relative humidity of 85-95%.
- Such high humidity retards wilting and maintains the better conditions.
- Relative humidity can influence:
  1. Water loss.
  2. Decay development.
  3. Some physiological disorders.
  4. Fruit ripening.

- Relative humidity control can be achieved by one or more of the following procedures:
  1. Addition of moisture to the air by use of humidifiers.
  2. Regulation of air movement and ventilation.
  3. Use of moisture barriers; such as :
     - ✓ Insulation of storage rooms.
     - ✓ Polyethylene liners in containers.
     - ✓ Plastic films for packaging.
     - ✓ Waxing of fruit.

Topics:

1. Introduction.
2. Harvesting.
3. Gentle Handling.
3. Temperature Management.
5. Control of Relative Humidity.
6. Preparation of Tropical Fruits for Marketing.

6. Preparation of Tropical Fruits for Marketing :

- Horticultural commodities may be prepared for market and packed:
  1. In the field (Field packing).
  2. In simple packing stations.
  3. In packinghouses.

- Packinghouse Operations include:
  1. Receiving. 2. Washing. 3. Drying.
  4. Waxing. 5. Sorting. 6. Grading.
  7. Sizing. 8. Packaging.

Preparation of Mangoes for Marketing

Heat Treatment

Dumping

Washing

Sorting

Electronic Sizing

7. Control of Pest and Diseases

- Post-harvest procedures, leading to the maximum physiological life of a commodity, are often those which minimize fungal rots.
- Maintaining a fruit at high vitality, enhances its natural disease resistance and ability to heal wounds.

❑ Principles of disease control include:

- Prevention:

  "Prevention is better than cure".

- In most instances, control of post-harvest wastages should commence before harvest, in the field or orchard.
  - ✓ Propagating materials should be virus free and bacterial free.
  - ✓ Sources of infection should be eliminated and sprays for the control of the causal organisms or vector should be applied.

- Careful handling during harvesting can minimize mechanical injury and can reduce subsequent wastage due to microbial attack.

- Chemical protection by using fumigation or fungicide treatment.
- Heat treatment in the form of either moist hot air or hot water dips (50 – 55 °C) have some commercial application for control post-harvest pest and diseases in papayas and mangoes.

- Retardation of Microbial Growth can be employed through:

a. Temperature Control:

- ✓ Low temperature handling and storage is the most important physical method of post-harvest wastage control.

b. Modified Atmosphere:

- ✓ Very low O_2 and high CO_2 can slow down and control fungal growth.

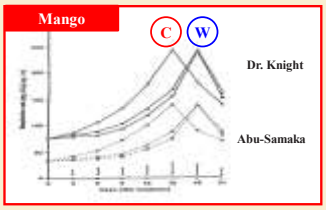
c. Fumigation: [Such as sulfur dioxide (SO2)].

d. Radiation:

- ✓ Ionizing radiation are effective in inhibiting microbial growth, but can cause physiological damage.

- ❑ The effect of waxing and fungicide treatment (Benomyl) on quality and shelf-life of mangoes and grapefruits was evaluated.

❑ **Waxing the fruits decreased respiration rate, reduced weight loss, delayed fruit ripening and senescence, retained ascorbic acid, improved quality and extended shelf-life of mangoes, guavas, papayas, limes and grapefruits.**



Mohamed, H.I.; and Abu-Goukh, A.A. (2003). Effect of waxing and fungicide treatment on quality and shelf-life of mango fruits. *University of Khartoum Journal of Agricultural Sciences*, 11(3): 322-339

Effect of waxing and fungicide treatment on quality of mango fruits

Cultivar	Treatment	Quality Grades				
		V. Good (%)	Good (%)	Fair (%)	Poor (%)	Unmarketable (%)
Dr. Knight	Untreated	4.3	17.8	37.0	33.2	7.7
	Waxed	19.7	31.0	31.8	13.9	3.6
	Waxed + Fungicide	22.3	36.5	28.6	11.4	1.2
Abu-Samaka	Untreated	2.9	20.9	31.2	39.6	10.2
	Waxed	21.6	32.7	25.3	16.3	4.1
	Waxed + Fungicide	24.1	36.1	23.4	14.7	1.7

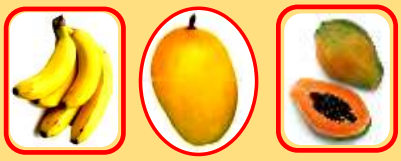
Mohamed and Abu-Goukh, (2003)

Effect of waxing and fungicide treatment on quality of '*Foster*' grapefruits

Treatment	Quality Grades				
	V. Good (%)	Good (%)	Fair (%)	Poor (%)	Unmarketable (%)
Untreated	5.0	17.0	28.5	29.5	20.0
Fungicide	5.5	20.0	30.5	27.0	17.0
Waxed	13.5	22.5	30.5	23.0	10.5
Waxed + Fungicide	14.0	23.0	31.0	22.0	10.0

Abu-Goukh, A.A. and Elshiekh, F.A. (2008). Effect of waxing and fungicide treatment on quality and storability of grapefruits. *Gezira Journal of Agricultural Science*, 6(1): 31-42.

❑ **The effect of paper and polyethylene package lining on quality and shelf-life of bananas, mangoes and papayas was evaluated.**



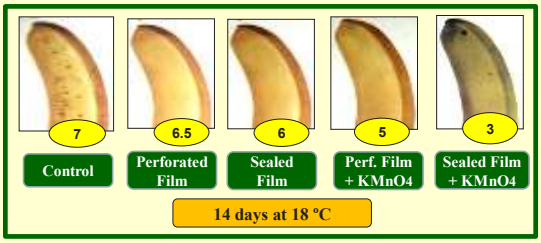
➢ **Package lining significantly delayed fruit ripening, maintained quality and extended shelf-life of banana, mango and papaya fruits.**

➢ **Weight loss was reduced in papayas by:**

- ✓ **Paper lining …… 9.5 %.**
- ✓ **Film lining …… 20.8 %.**

➢ **Banana fruit ripening was delayed by 6 - 7 days in the perforated and sealed polyethylene film package lining with GA3 treatment (100 ppm). (Osman and Abu-Goukh, 2008).**

➢ **Banana fruit ripening was delayed by 8 - 12 days in the perforated and sealed polyethylene film package lining with $KMnO_4$ (0.5 g).**



Elamin, M. A. and Abu-Goukh, A. A. (2009). Effect of polyethylene film lining and potassium permanganate on quality and shelf-life of banana fruits. *Gezira Journal of Agricultural Science*, 7(2): 217-230.

➢ **Package lining and KMnO4 significantly delayed fruit ripening, maintained quality and extended shelf-life of mango fruits.**

4. Elzubeir, Mohamed Magzoub. (2012). *Post-Harvest Studies on Mango (Mangifera indica L.) Fruits in 'Abu-Gebeha' Area, Southern Kordofan.* Ph. D. (Agriculture) Thesis. University of Khartoum, Sudan.

Topics:

1. Introduction.
2. Harvesting.
3. Gentle Handling.
3. Temperature Management.
5. Control of Relative Humidity.
6. Preparation of Horticultural Commodities for Marketing
7. Control of Pest and Diseases.
8. Special Chemical Treatments.

8. Special Chemical Treatments:

❑ **A number of chemicals may be applied to fruits in order to obtain a desirable post-harvest effect.**

1. Chemicals that hasten ripening.

- **Ethylene and compounds that release ethylene, such as Ethrel (Ethaphon).**

2. Growth retardants that inhibit growth and ripening.

- **Such as: Gibberellins (GA_3), Maleic hydrazide, 2,4,5-T.**

3. Ethylene absorbents and Inhibitors.

- **Such as: KMnO4, 'Purafil'. 1-MCP.**

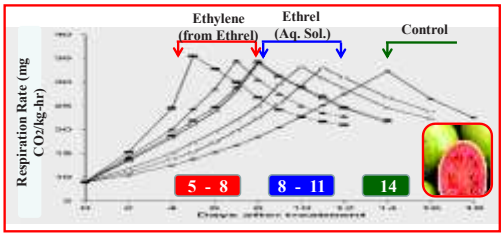
1. Chemicals that hasten ripening:

➢ **Effect of Ethylene, Acetylene, Ethrel in aqueous solution and Ethylene released from Ethrel on fruit ripening and quality of bananas, mangoes and guavas was evaluated.**

➢ **Ethylene gas was 100 times more effective than acetylene in inducing fruit ripening of bananas.**

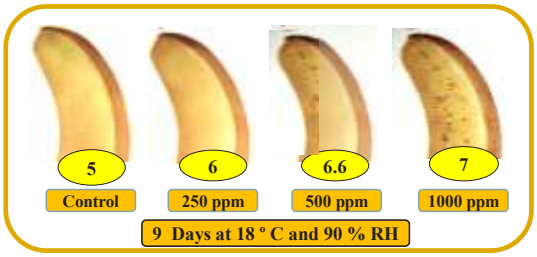
Ibrahim, K. E.; Abu-Goukh, A.A. and Yusuf, K. S. (1994). Use of ethylene, acetylene and ethrel on banana fruit ripening. *University of Khartoum Journal of Agricultural Sciences*, 2(1): 73-92.

➢ **Ethylene gas released from ethrel was more effective than ethrel in aqueous solution in enhancing the climacteric peak and inducing fruit ripening in bananas, mangoes and guavas.**



Mohamed-Nour, I. A. and Abu-Goukh, A.A. (2010). Effect of ethrel in aqueous solution and ethylene released from ethrel on guava fruit ripening. *Agriculture and Biology Journal of North America*, 1(3): 232-237.

Effect of ethylene gas released from Ethrel on banana fruit ripening

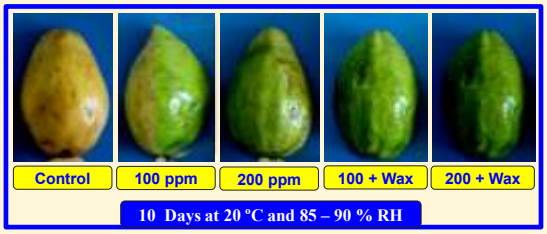


Arabi, Mamoun Ahmed . 2012) . *Effect of Ethylene Released from Ethrel on Banana Fruit Ripening.* M.Sc. (Horticulture) Thesis. University of Khartoum, Sudan.

2. Growth retardants that inhibit growth and ripening.

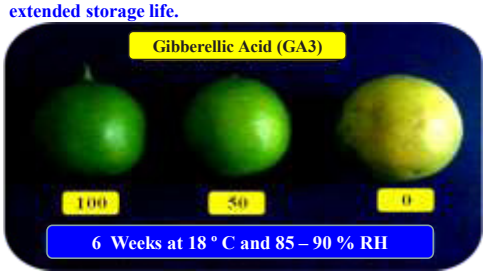
- Effect of Gibberellins (GA_3), Maleic hydrazide, 2,4,5-T and waxing on quality and shelf-life of papayas, mangoes, guavas and limes was evaluated.

- GA_3 (100 & 200 ppm) and waxing on guavas reduced respiration rate, weight loss, fruit softening, peel color development, maintained quality, delayed fruit ripening and extended shelf-life 6 - 8 days.



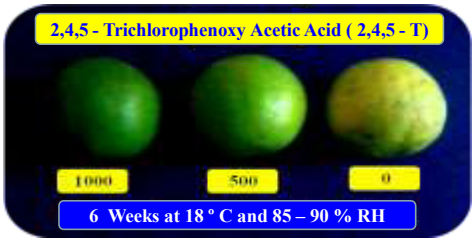
Mohamed-Nour, Ibtissam Abdalla. (2007). *Chemical Control of Ripening of Guava Fruits.* M. Sc. (Agriculture) Thesis. University of Khartoum, Sudan.

- GA3 (50 & 100 ppm) and waxing on limes reduced respiration rate, weight loss, fruit softening and degreening, retained ascorbic acid, maintained quality, delayed senescence and extended storage life.



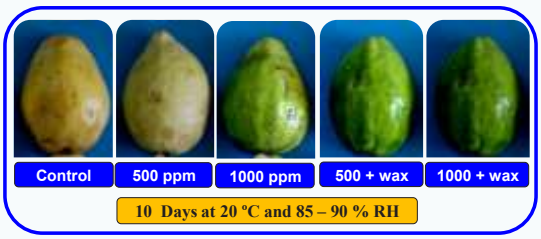
Abdallah, E.H. and Abu-Goukh, A.A. (2010). Effect of gibberellic acid and waxing on quality and storability of lime fruits. *University of Khartoum Journal of Agricultural Sciences*, 18(3):349-362.

- 2,4,5-T (500 & 1000 ppm) and waxing on limes reduced respiration rate, weight loss, fruit softening and degreening, retained ascorbic acid, maintained quality, delayed senescence and extended storage life.



Ayoub, S.O. and Abu-Goukh, A.A. (2009). Effect of 2,4,5-Trichloro-phenoxy acetic acid and waxing on quality and storability of lime fruits. *University of Khartoum Journal of Agricultural Sciences*, 17(2):183-197.

- Maleic hydrazide (250, 500 & 1000 ppm) and waxing on guavas, delayed respiratory climacteric, reduced weight loss, fruit softening and peel color development, maintained quality, delayed fruit ripening and extended shelf-life 7 – 10 days.

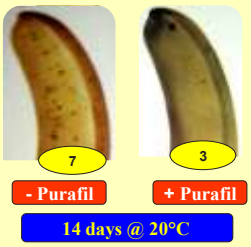


Mohamed-Nour, I.A. and Abu-Goukh, A.A. (2013). Effect of maleic hydrazide and waxing on ripening and quality of guava (*Psidium guajava* L.) fruit. *Gezira Journal of Agricultural Science*, 11(1): 91-101.

3. Ethylene absorbents and Inhibitors:

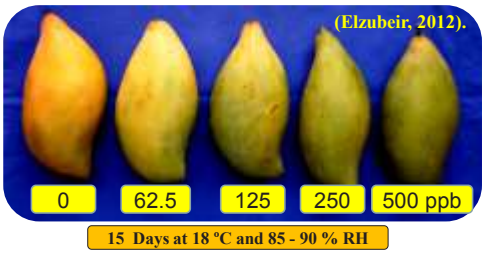
- These delay ripening and senescence because they remove the ethylene produced by the fruit or inhibit ethylene action.
- They are usually placed in close proximity to the commodity and leave no residue on it.
- Examples are:
  - Potassium permanganate.
  - 'Purafil' (Potassium permanganate-impregnated in alumina or verrmiculite).
  - 1 – Methylcyclopropene (1-MCP).

- 'Purafil' significantly reduced respiration rate and ethylene production and delayed degreening and subsequently banana fruit ripening,

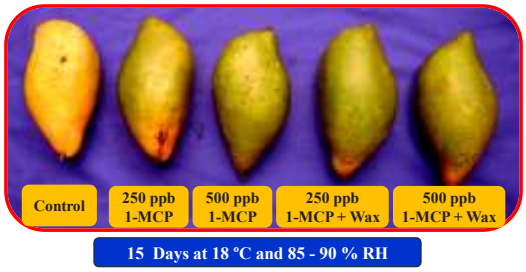


Abu-Goukh, A.A. (1986). Effect of low oxygen, reduced pressure and 'Purafil' on banana fruit ripening. *Sudan Agricultural Journal* , 11: 55-67.

- 1-Methylcyclopropene (1-MCP) significantly reduced respiration rate, weight loss, fruit softening, peel color development, retained ascorbic acid, maintained quality, delayed fruit ripening and extended shelf-life of mangoes and bananas.

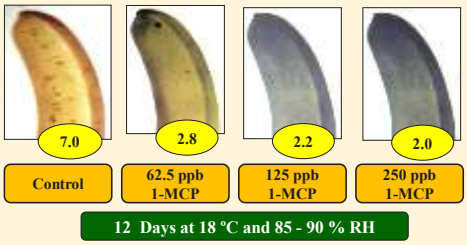


1-MCP (250 & 500 ppb) delayed mango fruit ripening 4 - 7 days (without waxing) and 6 – 9 days (with waxing).



Elzubeir, Mohamed Magzoub. (2012). *Post-Harvest Studies on Mango (Mangifera indica* L.*) Fruits in 'Abu-Gebeha' Area, Southern Kordofan.* Ph. D. (Agriculture) Thesis. University of Khartoum, Sudan.

1-MCP (62.5, 125 & 250 ppb) delayed banana fruit ripening 12, 16 and 20 days, respectively, compared with the control.



Saeed, I. K. and Abu-Goukh, A. A. (2014). Effect of 1-Methylcyclopropene (1-MCP) on quality and shelf-life of banana fruits. *University of Khartoum Journal of Agricultural Sciences*, 21 (2): 154-169.

Paper 3: Cultural practices, postharvest practices and IPM in mango

by Bob Williams, Department of Plant Industries, Australia

DEPARTMENT OF **PRIMARY INDUSTRY AND FISHERIES**

PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES

Cultural practices, postharvest practices and IPM in mango

Bob Williams

Director Plant Industries .

Department of Primary Industries and Fisheries – Northern Territory.

4th March, 2015

PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES PLANT INDUSTRIES

Presentation Overview

1. Global Picture of Mango Production and export
2. The Australian Mango Industry
3. Challenges
   a. Disease
   b. Productivity
   c. Market access

Global Mango production

Major Mango Varieties in Australia

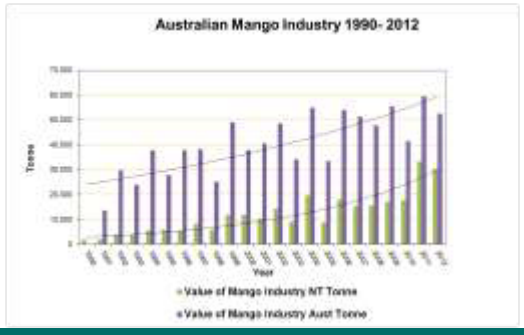
Kensington Pride

R2E2

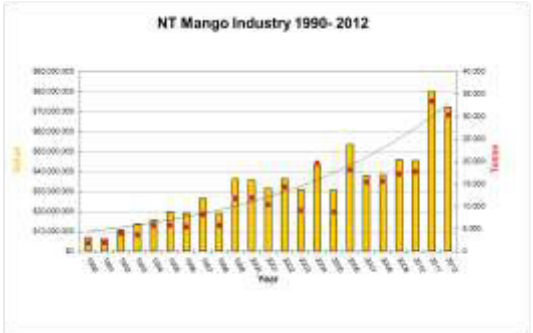
Honey Gold

Calypso

NT Production over Past 22 years



NT Production over Past 22 years



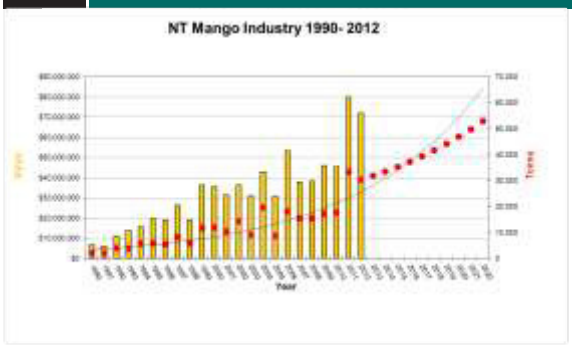
Significant influences over past 10 years

- Increased plants of new varieties
- Smaller growers moving out – larger growers becoming more professional.
- Improved infra-structure to attract and retain producers. Eg roads, transport, labour accommodation, agribusiness suppliers.
- Change of attitude of industry players.

Major Production Regions 2012

PLANT INDUSTRIES GROUP

Trends into the next 10 years



Current status of exports

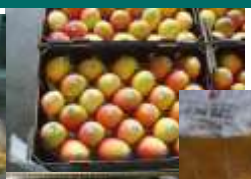
Partner Country	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12[r]	2012/13	2013/14
World	4,062,000	2,313,000	3,083,000	2,683,000	3,263,000	3,090,000	3,180,187	3,961,009	2,348,595	3,546,141		5,000,000
Hong Kong	1,380,000	733,000	831,000	926,000	1,209,000	1,353,000	1,216,982	1,619,703	1,008,441	1,552,491		
New Zealand	0	0	15,000	70,000	183,000	295,000	185,330	568,875	345,479	526,753		
Singapore	1,619,000	502,000	678,000	558,000	676,000	541,000	576,650	443,618	235,864	437,095		
United Arab Emirates	544,000	364,000	520,000	639,000	634,000	547,000	702,059	782,283	186,592	300,323		
Vietnam							0	27,986	704	124,380		
Malaysia	319,000	214,000	202,000	0	0	0	155,761	130,439	95,222	95,596		
Lebanon									137,345	91,331		
China							2,440	25,818	16,930	66,793		
Russia							11,348	28,817	58,055	62,945		
Japan	73,000	394,000	537,000	239,000	385,000	225,000	189,008	146,792	29,782	53,270		
Canada							26,016	61,644	31,512	51,624		
Qatar									84,916	47,106		
Saudi Arabia									29,321	37,131		
Switzerland							15,950	13,509	12,739	9,620		
Netherlands	127,000	106,000	300,000	251,000	176,000	129,000	95,894	94,956	13,623	9,460		
Korea South									7,830	4,050		
Indonesia							2,749	16,569	3,528	1,372		

Common Issues.

Common Issues.

Common Issues.

Common Issues.

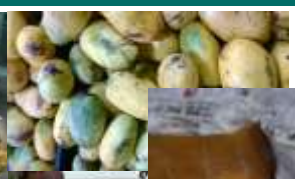


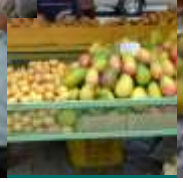
Common Issues.

Point of Difference

Rank	Country	Average Wage (USD)
15	Australia	2,610
51	Brazil	778
57	China	656
58	Mexico	609
61	Egypt	548
62	Thailand	489
67	Syrian Arab Republic	364
69	India	295
70	Philippines	279
71	Pakistan	255

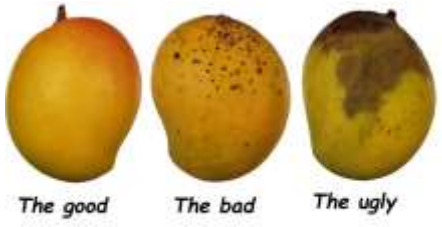
This is not the Targeted Markets for Australian mangoes





This is Targeted Markets for Australian mangoes

First Challenge – Disease.



First Challenge – Disease.

The traditional approach.

- Pre-harvest fungicide treatments
- Post harvest fungicide dip

First Challenge – Disease.

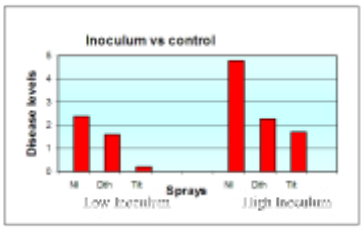
First Challenge – Disease.

First Challenge – Disease.

Concerns.

- Only focused on the disease post flowering.
- Increased pressure on the fungicide.
- Fungicide resistance
- Fungicide residues in fruit.
- Some fungicides do not meet CODEX standards.
- Consumers.

First Challenge – Disease. Progress



Demonstrate the role of inoculum reduction in disease management

Integrate inoculum reduction.

Strategies with fungicide sprays in an integrated system.

Improve the efficiency of current postharvest fungicide dips by a reduction on orchard fruit infection

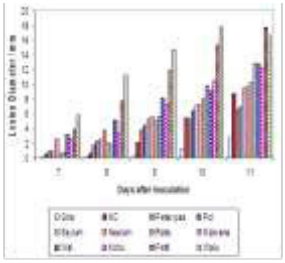
First Challenge – Disease. Progress

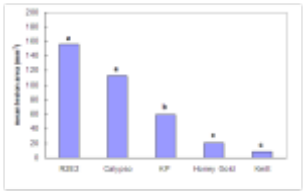
First Challenge – Disease. Progress

Inoculum Reduction Strategies.

- Pruning
- Alternative treatments in the vegetative stage

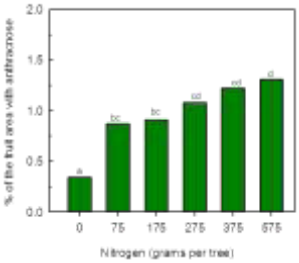
First Challenge – Disease. Progress



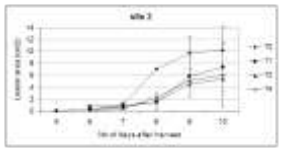


Pathologist and Breeders working together

First Challenge – Disease. Progress

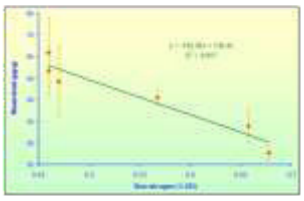


Natural stalk-end rot developments during ripening, in fruits harvested from plants grown under different soil K levels



Pathologist and Agronomists working together

First Challenge – Disease. Progress



Focus on how the plant is functioning.

- Understand the aetiology of the pathogen at all stage of the plants phenology.
- Target fertiliser programs that impact on the plants defence mechanisms when the pathogen is weakest.
- Utilise plant activators to compensate for the impact of fertilise on defence mechanisms.

Pathologist and Plant Physiologists working together

First Challenge – Disease. Progress

Thinking about the SYSTEM and not the issue.

Fruit quality can not be improved after it has been harvested.

All “ologists” need to understand

- how the plant is reacting to interventions to active maximum performance.
- What the consumer is looking for.

Challenge Two: Improve on Farm Productivity.

- Low Productivity
- Biennial Bearing
- Uniformity of;
  - Flowering,
  - Fruit set
  - Fruit Retentions
- Efficiency in Harvest
  - One past harvest v's 3 passes
  - Mechanisation of harvest

Challenge Two: Improve on Farm Productivity.

- Orchards design
  - Higher density
  - Wider production window on individual farms
  - Netted farms
  - Alternative harvesting and packaging systems
- Wider geographic production region

NT RD&E Strategies

Expanded production window:

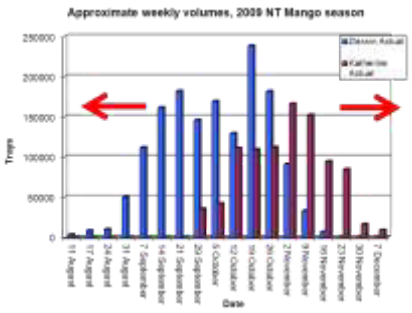
Areas Of Influence	Funding Input x Organisation				Timing						
	DPIF	ACIAR	HAL	Other	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
A. Genetics											
Scion	√√	√			xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
Rootstocks	√√	√		√	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
B. Weather											
MJO	√√		√√	√√	xxxxxxx	xxxxxxx					
C. Environment											
Prodn Regions	√√	√			xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
D Plant Phenology											
crop modelling	√√	√	√√	√	xxx	xxxxxxx	xxxxxxx				
Vegetative Stimulation											
Nutrition	√	√	√	√	Other projects qdaff (ACIAR Pakistan)					xxx	
Pruning	√	√	√	√	xxx	xxx	xxx	xxx	xxx	xxx	xxx
Vegetative inhibition											
Paclobutrazol	√√	√	√√	√		xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxx	xxx
Ethephon	√√	√	√√			xxxxxxx	xxxxxxx				
Others	√√	√	√√	√			xxxxxxx	xxxxxxx	xxxxxxx	xxx	xxx
Floral Induction											
Nitrates	√√	√	√√	√		xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxx	xxx
Others	√√	√	√√	√			xxxxxxx	xxxxxxx	xxxxxxx		
E. Molecular Tools	√√	√√	√	√		xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxx	xxx
F. Integrated Prodn Systems	√√	√√	√√					xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx

Challenge Two: Improve on Farm Productivity.

- New varieties - NMBP plus others
  - Potentially an additional 100,000 trees.
    - Greater yields, higher pack out

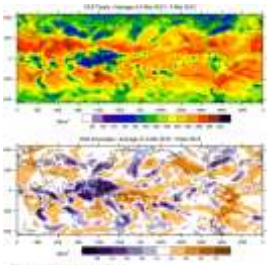
- New Rootstocks.
  - Stocks impacted on yield, growth rates, canopy & profit
  - Opportunity with selected stocks to enhance new scion varieties and orchard systems
  - Link key production & market parameters' with selected stock attributes - as for other mature fruit industries!

Challenge 2: Alternative On Farm Production Options.



NT RD&E Strategies

1. Expanded production window:
   - Climate.



The Madden-Julian Oscillation (MJO) is the major fluctuation in tropical weather on weekly to monthly timescales. The MJO can be characterized as an eastward moving "pulse" of cloud and rainfall near the equator that typically recurs every 30 to 60 days

NT RD&E Strategies

1. Expanded production window:
   - Agronomic practices
     - Investigate the role of N in flower induction
   - Crop Modeling.
     - Develop of a growth model for mango to predict plant responses to various interventions to manipulate flushing, flowering and fruit maturity.
   - Vegetation Inhibitors.
     - Evaluate and understand the modes of action of the various synthetic promoters and critical factors influencing performance of vegetative initiation and inhabitation.

NT RD&E Strategies

1. Expanded production window:
   - Floral Induction.
     - Evaluate and understand the modes of action of the various synthetic promoters and critical factors influencing performance of floral induction.
   - Development of molecular tools
     - to detect FT expression and confirm the role of this gene in mango. This work will be conducted at Berrimah Research Farm, in collaboration with research teams in China.

Vegetative Inhibitors

Ethephon for hardening off vegetative growth.

Floral Induction

Potassium Nitrate for floral induction

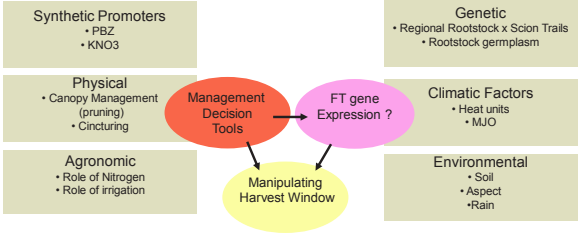
NT RD&E Strategies

1. Expanded production window:

   Development of molecular tools

Wigge, P. A. 2011. FT A mobile developmental signal in plants. Current Biology 21.

Potential Influences on Fruit Maturity



Mango Phenological Cycle

Challenge 3 Improve Market Access

Country	Fruit Fly Treatments			Notes
	VHT	Irradiation	No Protocol	
New Zealand		√		
Japan	√			
Korea	√			
China	√			Property Freedom for MSW
USA		√		No other insects
Hong Kong			√	
Singapore			√	
UAE			√	
Vietnam				Post-harvest dip with dimethoate for FF

Commercial harvest of mangoes in Australia

Mature Firm Green
- Dry matter >14% <16.5%
- Flesh colour as per industry standard

Defects
NO defects

Class 1
Export grade

Steps in the logistics of Mango

Process	Time Interval
Harvest, hold and cool fruit	Day 1
Package fruit	Day 2
Cool fruit to 14º C	Day 3
Transport fruit to Disinfestation Facility	Day 8
Disinfestation process	Day 10
Sea freight to China at 14º C	Day 31
Ripening on arrival	Day 35
Distribution to supermarket	Day 36.

Steps in the logistics of Mango

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Ripening on arrival	Day 35
Distribution to supermarket	Day 36.

Fruit Fly Market Access

Summary of export requirements from Australia

Vapour Heat Treatment (VHT) for fruit fly is mandatory for all mangoes being exported to China, Korea and Japan.

Schedule	Innermost fruit pulp temperature (°C)	Treatment period (consecutive minutes)
1	47 °C or above	• 15 minutes
2	46 °C or above	• 20 minutes

New Zealand.
Irradiation dose rates
- ICA 55 recommends
  - 150 Gy for Fruit fly only
  - 300 Gy for Mango Seed Weevil plus fruit fly.
- All mango varieties .

Fruit Fly Market Access

Does this actually happen with mature hard green mangoes?

Current Fruit Fly Market Access Protocol

What research data is this market access protocol based on?

The evidence that mangoes are a host of Fruit Fly!

Fruit Fly Market Access

Fruit Fly Market Access
An Alternative Option

Researchable Questions.

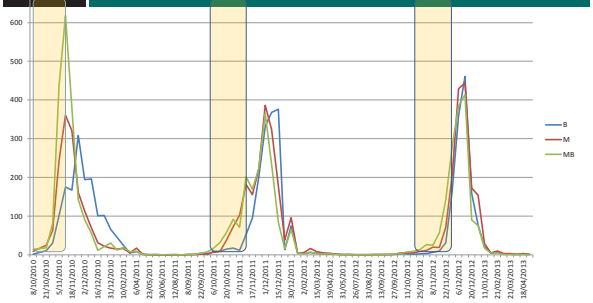
1. Are mature hard green mangoes a host of fruit fly?
2. At what stage of maturity do mangoes become susceptible to fruit fly?
3. What is the correlation between fruit fly pressure and fruit maturity?

Fruit Fly Market Access
An Alternative Option

Testing the accepted

- Two pest species
- Mangoes 4 Varieties
- Four production areas
- Fruit fly trapping program to determine populations pressure.
- Fruit collection at harvest.
- No field treatments to manage fly populations.
- Caged trails

Jarvisi FF numbers – 2010-12
Single KP orchard



Method: fruit assessments

- So far assessed over 110,000 commercially harvested fruit
- Collect untreated fruit at shed
- Measure maturity / fruit quality on sub-sample
- Hold 12-14 days at 22ºC

Method: fruit assessments

Fruit quality assessments for each batch of fruit collected

Method: fruit assessments

Cutting fruit to assess presence/absence of fruit fly larvae

Conclusions

Total fruit assessed over four years. >110,000

The evidence to date;

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.

Commercial harvest of mangoes in Australia

Mature Firm Green
- Dry matter >14% <16.5%
- Flesh colour as per industry standard

Defects
NO defects

Class 1
Export grade

Fruit Fly Market Access An Alternative Option

What have we learned?

Market access principles need to be based on commercial practices.

Key Learnings

Think of the production system and not the issue.

All participants in the research team need to understand the production systems and how the plant is functioning.

Systems Research

Thanks to the research teams in

- **Pakistan, Sri Lanka, Philippines, Indonesia, Cambodia and Australia.**
- **Australian Centre for International Agricultural Research (ACIAR).**

Thank you

Come across

Paper 4: The Development of the Tropical and Subtropical Fruit Sector in Kingdom of Saudi Arabia

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

TECHNICAL COOPERATION PROGRAMME
BETWEEN THE MINISTRY OF AGRICULTURE
AND THE FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS

THE DEVELOPMENT OF THE TROPICAL AND SUBTROPICAL FRUIT SECTOR IN KINGDOM OF SAUDI ARABIA (1981-2016)

Hassan M. Ali-Dinar
FAO-UN, Kingdom of Saudi Arabia
Saleh A. Alghtani
Jazan Agriculture Research Centre, Ministry of Agriculture, Kingdom of Saudi Arabia
Ali A. Aljaleel
Najran Horticulture Research Centre, Ministry of Agriculture, Kingdom of Saudi Arabia

Development of the Horticulture Sector in Kingdom of Saudi Arabia

- Started and progressed through the Technical Cooperation Programme
- The Technical Cooperation between FAO and the Ministry of Agriculture began as early as 1950
- The major thrust of development started with the Unilateral Trust Fund Agreements (UTFA) since 1981
- The UTFA is continuously renewed every 5 years up to the current one (2011-2016) (includes 16 development projects, USD 67 million)
- The Horticulture and Technology Transfer Project (USD USD 4,514,508)

Success Stories Through the Technical Cooperation Programme (1981-2016)

Within the Horticulture Sector, properly functional research and specialized centres have been developed:

- Najran Horticulture Research Center (citrus)
- Jazan Agriculture Research Center (tropical fruits)
- The National Date Palm Research Center
- The Olive Research Unit at Al Jouf
- Ulaa Citrus Propagation Centre
- Integrated Farm Systems and Extension Centres (Eastern Region, Central Region, Northern Region, Southern Region)…(date palm, citrus, grapes, mango, pitaya, pineapple, figs, olive)
- Pilot Extension Farms (Ulaa, Baha) (citrus, grapes, pomegranate)

Involved GCC Countries

Production, Areas and Tree Population

	Area (Ha)	Production (MT)	Tree Population (No.)
Mango			
SAUDI ARABIA	5,130	125,000	600,000
OMAN	1,072	10,199	-
UAE	972	4,200	120,000
Papaya			
SAUDI ARABIA	-	6,314	210,470
OMAN	104	1,760	-
Banana			
Oman	4,374	56,794	

Trade and Food Commodities

- In GCC countries domestic production of fruits generally accounts for only 25.5% of total domestic demands
- Saudi Arabia currently meets 35%- 46.8% of its overall domestic demand for fruits.

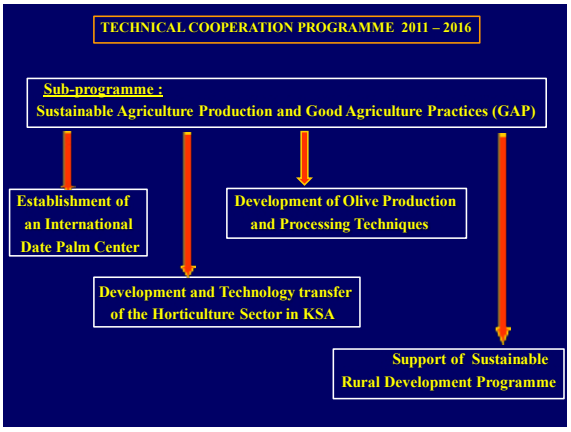
Fruit Imports

Saudi Arabia (2011-2012):

- Mango (3.9%) of sharing global imports
- Mango (62,279 MT) (Yemen: 59.29%, Pakistan: 20.28%, India: 9.61%, Egypt: 4.21%, and Kenya: 3.94%)
- Banana (306,173 MT)

UAE (2011-2012):

- Mango (5.2%) of sharing global imports



Najran Horticulture Research Centre

Propagation Nurseries

More than 1,823,250 disease free grafted citrus trees were distributed to farmers since 2007

A new nursery with a capacity of 250, 000 grafted citrus trees per year

Citrus Gene banks

125 citrus cultivars were introduced and considered one of the largest in the middle east and the largest in the Gulf States

Research and Production Technologies

Organic manure application

Capacity Building

- Study tours to train Saudi Nationals were conducted to more than 15 countries world wide, located in Europe, USA, South East Asia, Middle East and North Africa.
- More than 3000 researchers, agricultural engineers and farmers were trained since 2007.

- JARC established 1972 (Field crops)
- JARC tropical fruits…. 1982
- Emphasis…..on mango

Mango Gene Bank

It includes 50 mango cultivars introduced worldwide

Mango introductions over the past years		
Year	Number	Cultivars
1982	11	Tommi Atkin, Palmer, Julie, Zell, Kent, Haden, Keitt, Sabrie, Apple, Borebo, Kitshener
1983	5	Glenn, Van Dyke, Najwa, Otto, Sensation
1984	12	Hindi Khass, Parie, Bulk Heart, Zibda, Vajr Klein, Hindi Bosennara, Golluk, Awaise, Yemenia, Karabau, Neilum, Taymour
1989	4	Kingston, Onno, Florigen, Nam Dog My
2007	8	13-1, Turpentine, Kaisar, Benshan, Royal Special, Malika, Valencia Bright, Langra
2010	7	Kubania, Goose Neck, Dibsha, Mabruka, Aromanis, Sukarie, Naoumi
2011	3	Vazlie, Kazalla, Imperial

Other tropical fruits

- Pineapple (Perola, Jupi, Hawaii, Red Spanish)
- Guava (FAO, Jazan)
- Figs (Brown Turkey, Local, Mailly)
- Cashew
- Carambola
- Sapote
- Annona
- Papaya (Solo, Somali, Jordanian)

Capacity Building

Research and Production Technologies

Research on production aspects particularly flowering and fruit set and adaptability of rootstocks to environmental stresses are major in addition to harvest and post harvest.

Major Constraints/ Challenges

- Restricted water resources
- Increasing soil salinity
- Lack of proper rootstocks to reduce salinity hazards
- Limited knowledge of appropriate harvest and post-harvest techniques
- Pests and diseases (Fruit fly and mango die back)
- Limited research on good agricultural practices
- Lack of sufficient qualified national staff

The Way Forward

- Regional cooperation to address jointly the major common problems and share experience
- Promote South-South cooperation and develop joint projects that address the common major problems
- Liaise with regional and international organizations for potential support to address common problems
- Explore potential fruit crops that tolerate the existing environmental conditions and of added value to fruit growers
- Exchange of relevantgenetic resources

Paper 5: Banana Fusarium disease: the return of a catastrophic plant disease
by Altus Viljoen, Department of Plant Pathology, Stellenbosch University, South Africa

Banana Fusarium wilt

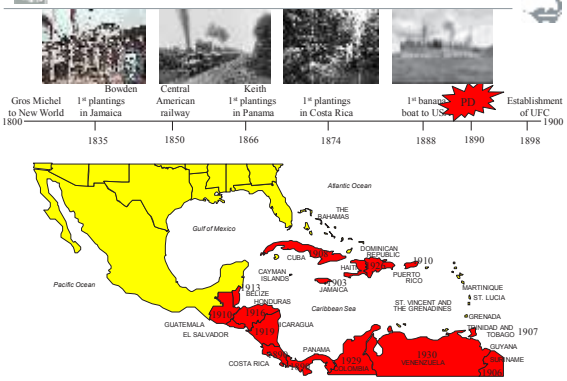
Return of a catastrophic plant disease

Altus Viljoen
Department of Plant Pathology, Stellenbosch University, South Africa

Department of Plant Pathology
Faculty of Agriculture and Forestry Sciences

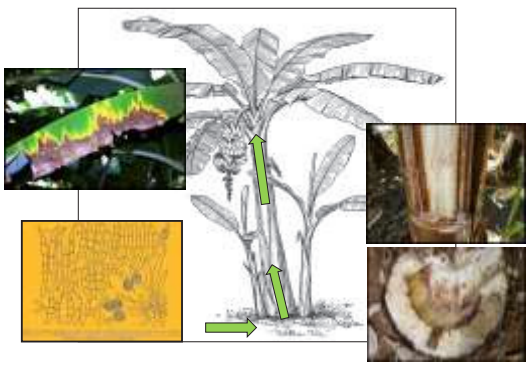
The Gros Michel era: 1866-1962

Panama disease in Central America



What is killing our bananas?

Infection biology and symptomology



Sustainable Gros Michel production?

Plantation management:
- Plant nutrition
- Irrigation
- pH adjustment of soil
- New tillage practices

The battle continues …

1947: Costa Rica ran out of new land

1950: UFC intensifies research:

- Chemical control revisited
- Cover crops
- Deep cultivation
- Flood fallowing

Gros Michel converts to Cavendish

Slide: R.C. Ploetz

Fusarium wilt of Cavendish bananas

Fusarium wilt: Races in Foc

Race 1 ⇒ 'Gros Michel' (AAA), 'Silk' (AAB), 'Pome' (AAB), 'Pisang Awak' (ABB)

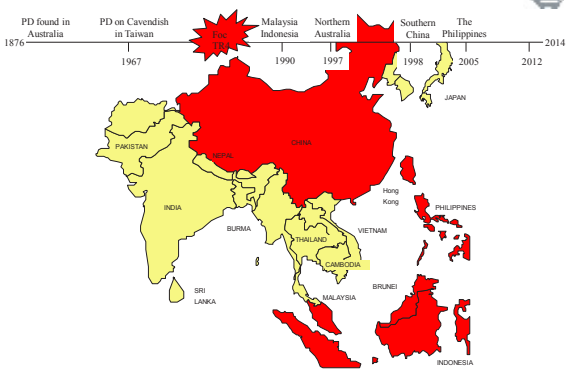
Race 2 ⇒ 'Bluggoe' (ABB)

Race 3 ⇒ *Heliconia* species

Race 4 ⇒ Cavendish (AAA), 'Pisang Mas' (AA), cvs susceptible to Foc races 1 and 2

- "tropical"
- "sub-tropical"

Foc TR4 (VCG 01213/16) in Asia

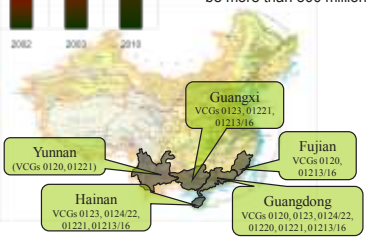


Banana Fusarium wilt in The Philippines

- The Philippines is the second largest exporter of bananas
- Cavendish cultivars accounting for about 51% of national banana production, Saba 29%, Lakatan 10% and Latundan about 11%.
- More than 80% of the bananas (and 99% of the Cavendish cultivars) are produced in Mindanao.
- 2001: Cavendish bananas in the highlands severely affected by Fusarium wilt
- 2003: Sporadic cases observed in lowlands
- 2005: Significant increase in lowlands
- 2013: Small-scale growers severely affected

Occurrence of Fusarium wilt in China

- Fusarium wilt was first discovered in Fanyu of Guangzhou in 1998
- The disease now occurs in all of the main production areas
- Cost of Fusarium wilt estimated to be more than 500 million Yuan/year



Banana Fusarium wilt in Oman

2009: Fusarium isolated from banana in Saham; Foc not confirmed
May 2011: Foc confirmed from banana in Sohar
July 2011: Foc confirmed from Cavendish bananas in Al-Batinah

Reasons for Fusarium wilt epidemics

1. Large scale monoculture of bananas
2. Expansion of the international trade
3. Domination of trade with Cavendish bananas
4. Disregard of quarantine regulations
5. Movement of plants, people and equipment

Next stop - Africa

"But it is Africa where the cause is most urgent. While Europe attempts to promote the interest of small growers, big banana companies are moving operations to countries that Europeans can buy bananas from. Cavendish plantations are now expanding across the African continent."

Dan Koeppel – Banana: The fate of the fruit

Fusarium wilt in Africa

Introduction of Foc TR4 into Africa

Introduction of Foc TR4 into Africa

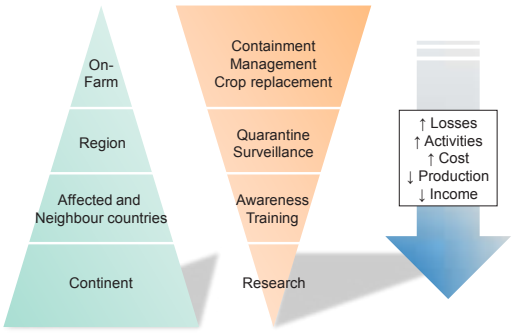
- Farm developed in 2009 near Namialo, a dry region in northern Mozambique
- No other banana farm in a radius of 100 km, with only pockets of volunteer bananas (cooking type)
- Water deficit was experienced in 2012, with Farm 2 being particularly affected
- Symptoms first observed in Feb 2013
- Water from Monapo River feeds into two ponds for sprinkler irrigation
- Considerable pedestrian movement of people from local communities through
- Farm personnel were rotated between fields
- International staff is replaced fairly regularly

Metocheria farm, Mozambique

On-farm movement of Foc TR4

Foc TR4 in Mozambique: Feb 2015

Impact of Foc TR4 in Africa



Regional strategy meetings on Foc TR4

Action plan for Foc TR4 in Africa

Goal:
To control the current disease outbreak of banana Fusarium wilt (Foc TR4) in Mozambique and to prepare other African countries that rely on banana for food security and income generation, against similar incursions.

Objectives:
1. Arrest and contain the spread of Foc TR4 in Mozambique and surrounding countries
2. Strengthen the capacity of NARS to sustainably manage the disease in Africa
3. Institute mechanisms to coordinate and communicate AC4TR4 activities in Africa.
4. Carry out research to generate new information and technologies for sustainable management of Foc TR4

Managing Fusarium wilt: Metocheria






Somaclone resistance to Foc TR4

Farm name	Planting date	Variety	# seedlings	PD incidence (%)	
				Aug 2013	Feb 2014
Phil Fresh Fruits	Oct 2012	GCTCV 219	3800	0.1	1.39
		G Naine	200	79.5	100
Bancud Farm	Oct 2012	GCTCV 219	500	0	2
		G Naine	100	46	97
Lapiz Farm	Oct 2012	GCTCV 219	1800	0	0
		G Naine	200	2.5	76


Awareness raising

BARNESA meeting

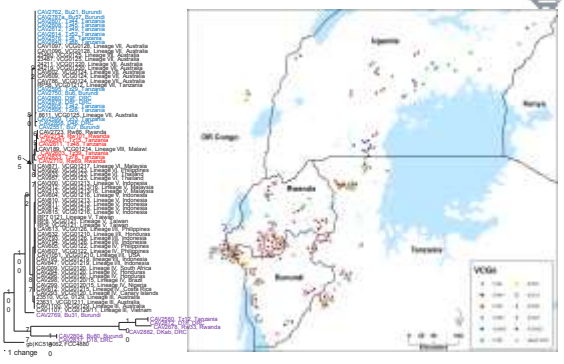
BARNESA STEERING COMMITTEE MEETING ON Foc TR4
Golf View Hotel, Entebbe, Uganda
26th to 28rd October 2014

Awareness and training





Distribution of Foc VCGs in Africa



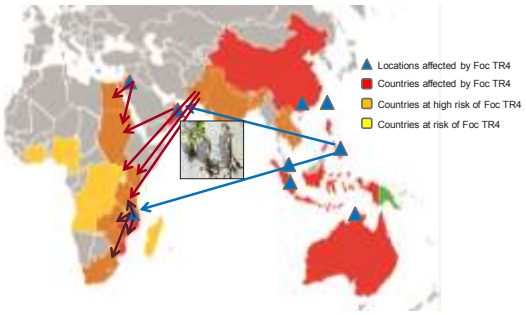
Evaluation of African bananas in Asia

- Natural infection by *Fusarium oxysporum* f. sp. *cubense* TR4

Results: Mindanao, Philippines

BANANA CULTIVARS	ITC CODE		NAME	VARIETY	# PLANTS	As of week 2, 2013			Mortality
						% PD	% Moko	% BBT	
African Varieties	1	ITC0081	Igitsiri (Intuntu)	EAHB - AAA	100	3			12
	2	ITC0084	Mbwazirumi	EAHB- AAA	100	3	2	7	18
	4	ITC0166	Ingagara	EAHB- AAA	100	5		2	11
	5	ITC0179	Inkira	EAHB- AAA	100	4			18
	8	ITC0217	Akpakpak	Plantain – AAB	100	1			4
	9	ITC0519	Obubit Ntanga	Plantain – AAB	100	0	2		13
	13	ITC1354	Enzirabahima	EAHB- AAA	100	3	1	1	12
	14	ITC1355	Kazirakwe	EAHB- AAA	100	1		6	7
	15	ITC1465	Ibwi	EAHB- AAA	100	32		11	3
	10	ITC0570	Williams	EAHB- AAA	100	46		3	1

Movement of Foc TR4 – illegal plants!



Cavendish banana production in Sudan

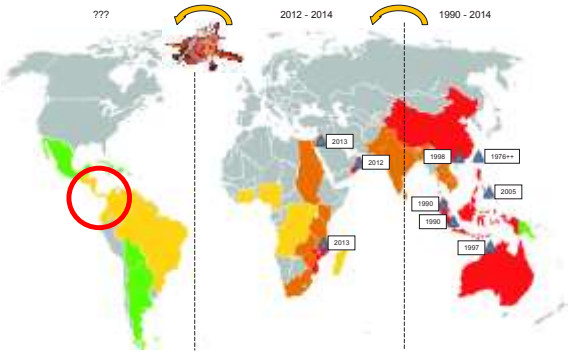
Source of map: Perry-Castañeda Library Map Collection

Photo by Gerardo Gutiérrez

Prevention of banana Fusarium wilt

- Can be achieved by means of enhanced awareness, legislation, regulation, quarantine and avoidance
- These actions take place before Foc enters countries and farms, or once it has been introduced into countries
- The activity chosen to deal with Fusarium wilt depends on the availability, affordability, geographical area and production systems under threat
- Successful prevention depends on a proper knowledge of the disease and its management
- Protecting bananas against Foc TR4 is the responsibility of a number of stakeholders, including national and regional authorities, research scientists, extension officers and producers

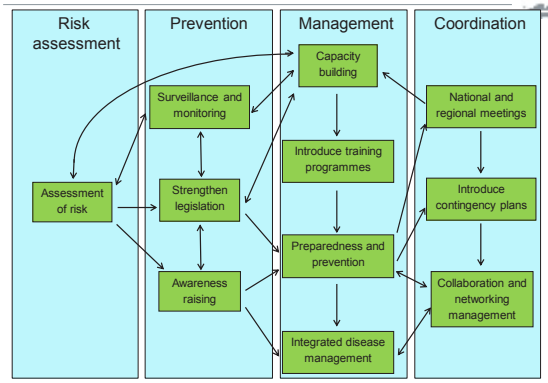
Global distribution of Foc TR4



FAO Global Foc TR4 programme

FAO Global Foc TR4 programme

FAO global programme on Foc TR4



sun.ac.za/banana-fusarium-wilt-africa

Pre-border activities

- Assess national biosecurity legislation and regulations
- Assess a country's ability to prevent and respond to incursions of Foc
- Obtain sufficient knowledge on Foc and means to deal with it
- Raise awareness about Foc TR4 among policy makers, government and quarantine officials, the public, researchers, producers and other stakeholders
- Develop standardised training manuals, identification and surveillance protocols, and methods to deal with Foc incursions nationally and regionally
- Develop national capacity and infrastructure to deal with incursions
- Train plant health officials, scientists, extension officers, border control and quarantine people, and producers on Foc identification and management
- Distribute posters, brochures and information materials on Foc TR4 and other races
- Prepare technical materials on the prevention, detection, contention and eradication of Foc-affected plants.
- Introduce an emergency fund to rapidly respond to incursions
- Develpe an entrance risk analysis and identify high-risk entry points

On-border activities

- Evaluate quarantine measures and strengthen border control
- Include Foc TR4 as quarantine pest on national lists
- Develop legislation and phytosanitory regulation for bananas and/or parts of bananas introduced from Foc TR4-affected countries or countries at risk
- Strictly control the importation of banana and plantain plants and plant parts from countries affected or at risk of Foc TR4 through national quarantine stations
- Request *in vitro* plants to be accompanied by certificates for disease indexing
- Identify and strengthen high risk entry points for banana plants infected with Foc
- Train scientists in the use of reliable diagnostics for Foc TR4 identification

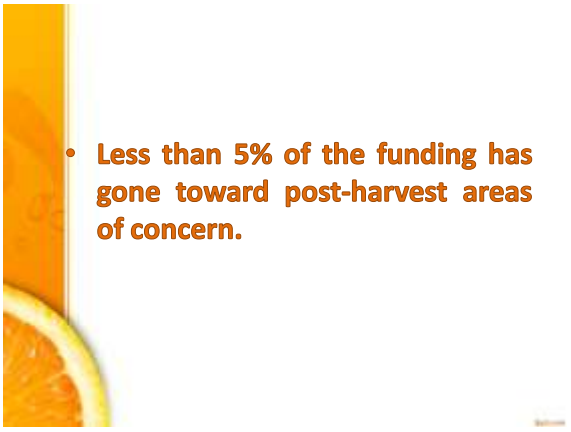
Post-border, off-farm activities

- Map the distribution of Foc TR4 and other Foc races in banana-growing countries
- Gather epidemiological data to establish means of introduction and spread
- Assess, train and introduce surveillance systems and teams in-country
- Introduce legislation to regulate the movement of banana planting materials and other risky materials within country borders
- Set up quarantine zones to prevent the movement of infected planting materials and other possible risky materials in-country
- Collaborate nationally and regionally to prevent the introduction of Foc TR4 in the region
- Organise training workshops and expert consultations with *Fusarium* specialists

Farm-border activities

- Obtain clean planting and propagation material from reputable sources, preferentially tissue culture bananas
- Put up highly visible and clearly understandable signs at farm entrances to notify visitors about farm biosecurity
- Clean all vehicles by hosing-off clay and plant parts and disinfection before entering or leaving farm gates
- Manage visitors and vehicles entering farm borders:
  - Allow visitors only by appointment and upon signing in
  - Disinfect shoes and vehicles of visitors
  - Use only on-farm vehicles and provide boots to visitors
- Enquire about the employment history, nationality and movement of all farm workers
- Avoid sharing farm machinery, equipment and field tools
- Strictly control access of contractors and service providers

Paper 6: Postharvest Management Practices in Tropical Fruits for Market Access
by Dr. Kahil S. Yousif, Alzaiem Alazhari University



Respiration

Refrigeration

High water content

- Humidification
- Curing
- Packaging

Susceptability to pathogens

- Protective spraying
- Field cleaning
- Systemic fungicide

Easily bruised mechanical damage

- Good harvest practices
- Transport
- Packaging
- Good packing house operations

- To employ new technologies, the scale of operation of business and cost is essential.

- Proposed points of intervention that are less costly, effective and within reach of small scale farmers.

Deterioration

Proposed Technology

Respiration

- Evaporative cooling

Zero Energy Cool Chambers (ZECC) Prof. Roy model.

- Solar – driven cold store (FRC) Ammonia water absorption system.

High water content

- Shading
- Early or late day harvesting
- Curing.

Susceptible to pathogens

- Hot air, water treatment Sanitation.

Mechanical damage

- Stackable plastic – containers
- Improved harvesting
- Training of harvesters
- Field packing

Thanks

Paper 7: Fruit fly management practices on tropical fruit in Africa
by Dr. Talal S. El-Abbassi, Plant Protection Research Institute, Egypt

INTRODUCTION

Fruit flies belonging to Family Tephritidae are considered the most important insect pests that cause enormous damage for a wide host range of horticultures allover the world. . More than 950 species are of economic significance in Africa . Some of these species are accidentally introduced from other regions, in particular from Asia. So far, four Asian species belonging to the genus Bactrocera invaded Africa, two of these were introduced in recent years and the risk for other introductions is great.

Fruit fly management practices on tropical fruit in Africa

Prepared by

Prof. Dr. Talal S. El-Abbassi

Plant Protection Research Institute
Cairo,EGYPT •

- *Dacus (Dacus) bivittatus* — Pumpkin fruit fly
- *Dacus (Dacus) punctatifrons*
- *Dacus (Didacus) ciliates* — Lesser pumpkin fruit fly
- *Dacus (Didacus) vertebratus* — Jointed pumpkin fly
- *Dacus (Dedacus)frontalis*
- *Dacus (Dedacus) lounsburyii*
- *Trithithrum nigerrimum*
- *Trithithrum coffeae* — Coffee fly
- *Bactrocera (Daculus) oleae* — Olive fruit fly

Invasive Species

- *Bactrocera (Zeugodacus) cucurbitae* — Melon fly
- *Bactrocera (Bactrocera) invadens*
- *Bactrocera (Bactrocera) latifrons* — *Malaysian* fruit fly
- *Bactrocera (Bactrocera) zonata* — Peach fruit fly

Fruit flies of major importance in Africa

Indigenous Species

- *Ceratitis (Capitata) capitata* — Mediterranean fruit fly
- *Ceratitis (Pardalaspis)ditissima*
- *Ceratitis (Prdalaspis) punctata* — Cocoa fruit fly
- *Ceratitis (Pardalaspis) bremi*
- *Ceratitis (Pardalaspis) rosa* — Natal fruit fly
- *Ceratitis (Pardalaspis) fasciventris*
- *Ceratitis (Pardalaspis) colae*
- *Ceratitis (Ceratolaspis) cosyra* — Marula fruit fly
- *Ceratitis (Ceratolaspis) quinaria* — Five spotted fruit fly
- *Ceratitis (Ceratoplaspis) silvestrii*

Distribution of *B.cucurbitae* (Melon Fly)

West Africa
Benin
Burkina Faso
Cameroon
Gambia
Guinea
Ivory Coast
Mali
Niger
Nigeria
Senegal
Togo

East Africa
Sudan
Kenya
Tanzania
Uganda
Congo
Mauritius
Réunion
Seychelles

The Geographical distribution and presence of these four invasive Bactrocera species in Africa have been studied and illustrated in the following figs.

Distribution of B.latifrons (Malaysian Fruit Fly)

Kenya

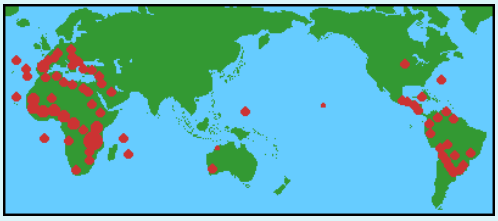
Tanzania

Distribution of *B.invadens*

Senegal
Mali
Guinea
Liberia
Cote D'Ivoire
Ghana
Togo
Benin
Burkina Faso
Niger
Nigeria
Cameroon
Rep.Of Congo
Chad
Dem.Rep.Congo

Sudan
Kenya
Tanzania
Loanda
Burundi
Ethiopia
Comoro
Islands
Mozambique
Zambia
Namibia

C.Capitata Distribution Map



Distribution of *B.zonata* (Peach Fruit Fly)

Libya

Egypt
SaudiArabia
Oman
UAE
Yemen
Mauritius
Réunion

Many fruit fly species are serious pests of agriculture throughout Africa and represent a threat to the agriculture and ecology of many countries.

Because of the threats the pests would constitute to the agricultural systems of foreign countries, certain countries would restrict or prohibit the entry of host produce from the African countries, thereby eliminating many current (and potential future) African export markets.

In Africa horticulture is recognized to become a major source of income for smallholders and various national development . However, the expansion of fruit production and export is greatly increasing the risk of transferring African fruit flies both within Africa and to other regions of the world; heavy fruit fly infestation seriously reduces the quantity of marketable fruit and increases production costs

A proposal of an international program (a broad strategy) among African countries should be prepared to respond to the threat of these invasive pest species.

Such program must include a range of alternatives (exclusion, detection and prevention, and control

In the absence of government efforts to control exotic fruit fly pests, losses and damage to private and commercial crops would provoke independent control efforts. Lacking the resources or capability to use sophisticated program techniques, such as detection trapping, sterile insect technique, and regulatory controls, the growers or homeowners could be expected to rely predominantly on chemical pesticides. Those efforts could result in continually increasing, uncoordinated, and less controlled use of pesticides.

Chemical pesticides have been extensively used for controlling these insect pests for a long time which caused many environmental problems like (high pesticide residues in edible fruits – developing resistant strains of pests against pesticides – disturbing the natural balance and the environmental pollution) .

Bactrocera invadens and *Ceratitis cosyra* are of the major constraints that in general limit tropical fruit production in Africa and mango fruits in particular. They cause up to 40–80% direct damage to mango fruits and also restrict export to large lucrative markets in Europe, the Middle East, Japan and USA .

To achieve these goals

Understanding and extensive studies on the biology and ecology of any insect pest is considered the corner stone to establish effective control measures that might enable us to win the battle against such pest.

Developing and implementing an integrated pest management (IPM) programmes is highly requested to minimize the use of chemical pesticides to overcome these abovementioned problems and produce fruit fly-free and residue-free fruits to facilitate compliance with standards required for export markets.

B- Ecological Studies include the following points:

1) Geographical distribution of economic fruit flies allover the country through :
   - Finding the relationship between weather factors represented in (Maximum and minimum day temp. and daily relative humidity .
   - Survey for all favorite ,wild and alternative hosts.

2) Diagnosing symptoms of infestation by fruit flies at various plant hosts.

A- The biological studies include the following points

- Knowledge of population cycles
- Studies on various developmental stages of subjected insect species
- The length of time required for the Tephritidae fruit flies to complete their life cycles in relation to weather conditions
- Distinguishing between the different fruit fly species in larval stage

B- Ecological Studies include the following points:

1) Geographical distribution of economic fruit flies allover the country through :
   - Finding the relationship between weather factors represented in (Maximum and minimum day temp. and daily relative humidity .
   - Survey for all favorite ,wild and alternative hosts.

2) Diagnosing symptoms of infestation by fruit flies at various plant hosts.

B- Ecological Studies include the following points: (continued)

C) Detecting and monitoring system:-

1-Trap catch for fruit flies:
   - Selecting appropriate and effective trap for catching flies
   - Using effective attractants (sex attractants, food attractants ,lures and dispensers).

2-Collecting infested fruits from various locations and hosts to be incubated under laboratory conditions

B- Ecological Studies include the following points: (continued)

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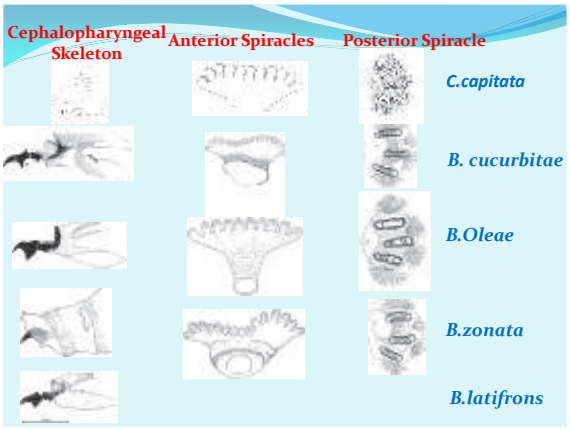


B- Ecological Studies include the following points: (continued)

3- Identification of captured flies into traps or flies emerging from infested fruits.

N.B. identification of various fruit fly species by Inspecting larvae in infested fruit needs well trained and experienced staff.

D) Determination of hot spots ,seasonal peaks and No. of generations per year.

The program should focuses on effects of both chemical and nonchemical control methods on the physical environment, human health and safety ,socioeconomics, cultural and visual resources, and biological resources.

An integrated program would offer the greatest .flexibility for responding to fruit fly pest outbreaks

Developmental Goal

To increase the level of production and quality of fresh fruit and fleshy vegetables, leading to enhanced availability for local consumption, increased exports and higher farmer's incomes .

To upgrade the technical knowledge and understanding of the impact of fruit flies on production and export of fresh fruits and fleshy vegetables by plant protection, quarantine, extension services staff and the private sector.

IPM STRATEGY

The strategy of IPM programme is based on usage of all means of control procedures in a complementary way (legislative control, physical control , cultural control, biological control , Biotechnological Control sterile insect technique , wise use of pesticides and postharvest treatments)

It would be characterized by cooperative integrated efforts to control (suppress, eradicate, or otherwise manage) invasive exotic fruit fly pests. It would utilize principles of integrated pest management (IPM)

The integrated program appears to offer the best combination of short-term risk and long-term benefit to agricultural resources and the environment, when compared to no action or a nonchemical program

1- Legislative control (continued)

- Prohibit total coverage spray using chemical pesticides
- Prohibit usage of pesticides not recommended by Ministry of Agriculture.
- Growers are committed to participate in conducting collective control at the level of a province or a district in case of pest outbreak .

1- Legislative control

-Apply restricted quarantine laws at all country borders to avoid entrance of fruits infested with fruit flies into territories.

- Avoid transfer of infested fruits from area to another within the country (internal quarantine procedures) especially free areas.
- Issuance of pronouncements to growers to apply proper sanitary procedures which safe the environment and protect fruit hosts from insect infestation like getting rid of infested, cracked and fallen fruits

Fruits can be easily protected against fruit flies by bagging them in paper bags. The bag provides a physical protection to the fruit by preventing adult female flies from laying eggs .

This technique has been successfully practiced in Malaysia for exporting Carambola and also widely practiced to protect mangoes in Thailand and Philippines

Bagging is inexpensive and easy to apply and guarantees nearly complete protection from fruit flies. It is ideal for small scale growers who do not use pesticides

2. Physical Control

Physical control involves physical actions taken to eliminate fruit fly hosts or host produce. Fruit stripping and host elimination are two principal physical control methods. Fruit stripping is employed when fruit fly larvae are found. The physical elimination of fruit fly hosts, when possible and appropriate, may be especially helpful in the elimination of small, isolated infestations

Except in very limited circumstances,host elimination is unacceptable because of environmental considerations, time and resource constraints

Getting rid of infested, cracked and fallen fruits

3. Cultural Control

Cultural control reduces pest populations through manipulation of agricultural practices. In general, agricultural practices are modified to make the crop environment as unfavorable as possible for the insect pest.

Cultural control methods frequently include: clean culture, special timing, trap cropping, use of resistant varieties, crop rotation, varying plant locations, and manipulation of alternate hosts.

Collecting and burying host fruit left after harvest, destroying damaged fruit, and removing unwanted or wild alternate hosts in and around fields are often recommended for suppressing fruit fly infestations.

Harvesting the fruit before it reaches a stage of ripeness highly susceptible to fruit fly attack.

Although this technique theoretically could reduce fruit fly populations, it is not likely to do so for a variety of reasons.

First, some fruits lose flavor when harvested too early, as they will not ripen fully .

Second, the development of most fruit flies generally coincides with the development (growth) of their host crops.

Third, it is doubtful that enough control could be exercised over commercial agricultural practices to make the technique effective or worthwhile

- Over flooding soil after harvesting may kill larvae and pupae by suffocation and prevent invasion of newly emerged flies to successive fruit hosts
- Avoiding cultivating many fruit fly hosts in the same field (mixed host orchards are severely infested).
- Good and balanced nourishing regimes result in strong trees more tolerable to infestation

Reduce populations :

If fruit flies are present in your field prior to crop ripening, you can try to reduce their population by attracting the adults to a poisoned bait.

This can be done by spraying a protein-bait–insecticide mixture onto nearby non-crop plants, windbreaks, or a border of corn plants.

Finally, the presence of multiple hosts in many areas that are susceptible to fruit fly infestations limits the applicability of this method.

Trap cropping involves the planting of a crop that is favored by the pest in order to attract and concentrate the pest in a limited area where the pest can be destroyed by chemical or cultural methods.

It is unlikely that this method could be applicable to most fruit fly programs because of the perennial nature of many host species, the availability of multiple host species in the program areas, and the lack of data on effectiveness of trap crops in attracting fruit flies from distant areas.

5. Biotechnological Control

Biotechnological control would involve the use of genetic engineering techniques to control fruit fly pests. Currently, there are four primary areas of genetic engineering that show promise for control of insect pests:

(1) bio-engineering of crop plants (insertion of specific genes into the plants to improve plant characteristics such as pest resistance),
(2) improvement of insect-infecting viruses,
(3) production of genetic mutations of the pest (thereby affecting its reproductive capabilities) by radiation or other means, and
(4) gene probe techniques to screen for insecticidal properties in microorganisms.

4. Biological Control

Biological control (or biocontrol) is a pest control strategy making use of living natural enemies, antagonists or competitors, and other self replicating biotic entities.

In spite of its advantages, biological control has major limitations which influence its suitability for control programs, including: lack of immediate results; potential lack of effectiveness; logistical difficulties; and incomplete or unavailable information about rearing techniques.

6. Sterile Insect Technique

Sterile insect technique (SIT) involves the release of sterilized fruit flies into infested areas where they mate with the feral fruit flies, producing only infertile eggs. SIT has been used successfully and/or developed as a control method for the Medfly, Mexican fruit fly, Caribbean fruit fly (Carib fly), and the melon fly. SIT may be used as a component of an overall detection and prevention strategy, or it may be used as a component of suppression or eradication programs

Biotechnology is being developed for use against fruit flies, but has not been used extensively because of a number of constraints:

(1) the technology is still relatively undeveloped;

(2) some control mechanisms have not been developed.

(3) Insectinfecting viruses have not been proven effective, nor are they available commercially for fruit fly control;

(4) screening done for new strains of bacteria against fruit flies is only the first step in basic research and development of insect-infecting microorganisms; and

(5) the information relative to the environmental impacts of bioengineered organisms is incomplete and unavailable..

2- Fiber blocks (5 × 5 × 0.5 cm) are saturated with a mixture of the male sex attractant (Methyl eugenol) and a technical insecticide (fenetrothion) at a rate of 4:1 . Each block is loaded with 10 ml of this mixture.

3- Blocks are distributed at a rate of 1 block per acre(i.e. the distance between each two successive blocks is Ca. 65 meters.

7. Chemical Control Methods

A- Male Annihilation Technique (MAT)

This technique is being used successfully for suppressing population of the peach fruit fly in Egypt (National area wide program for extermination of peach fruit fly in Egypt)

1- This technique is used to reduce the No. of males to the least level .

Fiber blocks Saturation room

Fiber blocks

Fiber blocks Saturation room

- Several materials with insecticidal properties inconjunction with an improved bait attractant have been tested against several species of economic tephritid
fruit flies.

- Phloxine B is a photoactive dye which is toxic to certain insect species added to an attractant bait evoked a high degree of mortality in Medfly and other fruit fly species

B-Bait spray Application Technique (BAT)

1-This technique is currently used for controlling most species of fruit flies

b- In this technique, a food attractant material is mixed with an insecticide . Concentration of the attractant material depends on the type of this material . For instance , in case of Buminal (a protein hydrolysate) the efficient concentration is 10% .

Partial Bait Spray

- Recently new safer insecticides (Spinosad) has been developed for area-wide control of fruit flies .

-These latter treatments offer environmentally friendly alternatives to present organophosphate formulations for eradication or suppression of fruit flies without adverse effect on non-target organisms (honey bees ,predators and parasites).

C. Soil Treatments

- Soil treatment with certain chemical insecticides (such as Diazinon, Chlorpyrifos and Fenthion) directly to the soil within the drip line of host plants immediately after fruit fly larval detection induces significant control against fruit flies .

- Because of the nature of the chemicals and /or the method of delivery, there is no potential for drift, runoff, or leaching.

- Generally, no more than three applications are made

Trees are sprayed with a quantity 100-150 ml of bait mixture. Only trunks near from trees canopy are sprayed .Be sure that the spray solution will not contact fruits . Tree are treated by spraying a tree row and leaving a row without treatment , or spraying a row and leaving two rows without treatment depending on level of infestation .

Comparison between Medfly and Peach Fruit Fly

Serial No.	Item Of Comparison	Medfly	Peach Fruit Fly
1	Mean Larval duration	6-8 Days	9-10 Days
2	Flight Range	Up to five Mile	Up to 20 Miles
3	Pre- Oviposition period	4-7 days	16-23 days
4	Range of required temperatures	15-30 C	25-35 C
5	Mean Adult longevity	55.2 days (Males) 61.8 days (Females)	41.0 days (Males) 48.0 days (Females)

D- Mass trapping

Ceratitis spp. can not be controlled using MAT due to many technical and scientific concerns . Therefore Mass trapping is being used in some areas .This technique depends on distributing traps loaded with female attractant lure mounted in sachets in fruit orchards at a rate of 21 traps per acre .These traps are supposed to be effective for a period of approximately 4 months

8. postharvest treatments

Export of fresh fruits and vegetables to various countries require conducting certain post harvest treatment to ensure that the consignments are free from infestation. More attention has been paid to apply natural control techniques for controlling insect pests and diseases in fruits and vegetable as safe alternatives to chemical treatments . Type of applicable natural method technique and time of application is dependant on host and pest . These natural techniques could be summarized as follows:-

No.	Item	*B.cucurbitae*	*B.Invadens*	*B.latifrons*	*B.zonata*
1	Name	Melon fly	----------	Malaysian f.fly	Peach fruit fly
2	Distrib.	West Africa Some East Africa (19 countries)	Most west ,East &few south (27 countries)	Kenya & Tanzania 2 countries	Egypt,Libya, Reunion & Mauritius 4 countries
3	Hosts	>100 hosts	46 hosts	15 Hosts 12 solanacae 3 cucurbits	>50 hosts
4	Life cycle: Duration	14-27 days	31 days	46 days	34-56 days
	Larval duration	6-11 days	11.1 days	8.5 days	9-10 days
	Pupal duration	6-9 days	12.4 days	10.2 days	9-10 days
	Pre-ovp.period	10-16 days	----------	10-11 Days	16-23 days
5	Flight Range	2 Km	Not studied	200 meters	Up to 30 Km
6	Sex Attractant	Cuelure	Methyl Eugenol	Alpha-ionol + cad oil	Methyl eugenol

Warm water Immersion



A- Immersion of fruits in warm water path at a temperature 46-48 ˚C for an hour. This technique is recommended for mango fruits and sufficient to kill all immature stage of *Bactrocera zonata* inside fruits of present.

B- Expose fruits to hot water vapor until temperature of fruit pulp reaches 46.2˚C , then keeping temperature at this level for 30 minutes. This method is recommended for treating mango and guava fruits against . *Bactrocera zonata* .

Hot water vapour control room

Hot water vapor chamber



Water boiler

Cold treatment Champer


C- Cold treatment : This technique is recommended for treating citrus and pomegranate fruits . Fruits should be kept at constant temperature at 1.7˚C for continuously 14 days. This technique is sufficient to kill all immature stage of *Bactrocera zonata* inside treated fruits.

THANK YOU

Paper 8: A viable seed system is the basis for the successful banana postharvest value chain in Sudan
by Dr. Salah B. Bakhiet, Agricultural Research Corporation, Sudan

A viable system for planting materials as the basis for the successful banana postharvest value chain in Sudan

By:
Salah B. Bakhiet (PhD)
ARC - SUDAN

Introduction and background

- Banana production in Sudan is practiced for a long time, but the first tangible export began in 2008.
- Production is entirely on the fertile silt loamy soils irrigated from rivers or underground water using surface irrigation.
- The total area under banana production is increasing from 17353 hectare in 2003 to 26260 hectare in 2011
- The main banana cultivar grown in Sudan is Dwarf Cavendish.

- Banana cultivars with high yielding characteristics were introduced and evaluated recently including Grand Nain and Williams and their selections under different names.
- The existing plantings of these improved varieties have shown that these can be grown and adopted by farmers successfully and provide a starting point for expansion.

Table 1: Bunch weight (kg)

Cultivar	MP	FR	SR
Asdia	29.74 d	31.60 e	35.43 c
CHC	34.98 c	38.13 d	39.53 b
Du Roi-52	38.36 b	39.82 c	39.53 a
GN	40.14 a	41.47 b	43.30 ab
GNN	40.54 a	42.73 a	44.99 a
SE±	0.4	0.4	1.2

- Dwarf Cavendish showed to has harvest management problems for the export process. Therefore it requires special bunch handling practices compared to the other higher (taller) varieties. The yield potential of this local variety is not as high as Grand nain, Williams or Chinese Cavendish.
- For to obtain a high yielding cultivars which expected to provide a range of 1.5-1.6 /bunches/production unit per year after establishment, and 28-32 weeks from flowering to flowering, a viable seed system must be carefully applied within other factors to achieve successful post harvest value chain

Table 2: Number of days from planting to flowering, and shoot to shoot between cycles/week

Cultivar	MP	FR	SR	MP-FR /week	FR-SR/week
Asdia	315 ab	454	594	20	20
CHC	322 a	472	614	21	20
DU-52	299 b	444	586	21	20
GN	318 a	443	605	18	23
GNN	323 a	441	597	17	22
SD±	5.8	8.6	9.3		

Planting and field establishment

This is the process that encompasses the selection, extraction, transportation of the planting seed and actual planting in the prepared land.

Seed selection

Successful banana production requires strict hygiene controls and practices. The practices start from recognizing the importance of using pests and diseases free planting materials.

- There are two alternatives to obtain plant material that will be used in the field planting.
- **a) Seedbeds** which are pest and disease free and developed in areas had good vigor and production potential.
- **b) Tissue culture** to propagate meristems developed in close system laboratory and nursery and considered as uniform and pest and disease free planting material.

- The small holding banana growers preferring the first system since the tissue cultured based system requires substantial investment in structures and control management, which the plants need for their development before being taken to the field for planting. Nevertheless, huge plantations are started recently to be established with tissue cultured planting material.

The corm

Tissue cultured plants can be guaranteed free of pests and diseases

Tissue cultured plants Ready for field planting

Seed extraction

This is the process of extracting seed from the seedbed area. The seed must be healthy and has a diameter of at least 6 inch at the base of the corm seed piece. It must be extracted carefully so as to avoid damage when separating from the plant. Green part of the pseudostem should be left so as to avoid dehydration, which reduces the seed's vigor.

Conventional Suckers

for maximum benefit clean planting materials needs to be combined with clean soils

Suckers from obsolete plantation

BBTV

Banana Weevil

Nematodes

Seed transportation

- Regardless of the transportation system used to carry the seedbed or Tissue cultured seedlings – it is important to keep the seed healthy by handle it with care during transport.
- The seed should not be exposed to the sun, and must be located as near as possible to the planting field, and has to be planted as quickly as possible after the time of extraction.

Planting

- Fallowing for 6-24 months without a non-host cover crop can break nematodes and banana weevil borer cycles.
- The planting hole should be deep and wide enough so as to place the seed under at least 5 cm of earth surface.
- If available, a single dose of compost (1 kg) should be added and mixed with the upper layer of extracted soil at the bottom of the hole before planting.
- After placing the seed in the hole, the covered hole has to be tamped down very well in order to eliminate airbags that may accumulate illness factors and thus deteriorate the seed viability.
- One to three days after planting process, irrigation has to be applied to avoid negative drought effect on vigor of the new plants.

Replanting

- Three weeks after planting, the area has to be inspected in order to count how many seeds have failed to emerge and to replace them.
- The idea is to avoid irregular growth in the plantation or areas without plants due to losses during planting (2-3% is a normal loss).
- A good planting process can reduce this average, which reflects a proper control and follow-up when establishing the plantation.

The CFC Banana Funded project experience

- Introduce of a high yielding banana cultivars, suitable for exports and local market has been decided.
- Grandnain, Grandnegra, Asdia of Williams, Chinese Cavendish and Dwarf Cavendish selection cultivars have been received from Du Roi Lab. in RSA. Four additional selected clones of GN namely Marianne, MH13, CV902 and Bambo were also introduced from Vitropic in France .

- A nursery of Horticulture Department was ready to receive more TC plants ordered for field planting. (A documented report has been written under the title: (Handling tissue cultured plants).
- The transplanted seeds have given intensive care for at least 45 days before field planting.
- Evaluation trial for comparing different elite banana cultivars was conducted in Kassala.

New banana plantation with clean tissue cultured plants

Three months old

Five months old

26

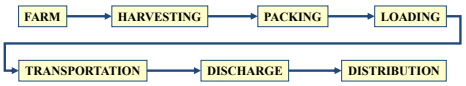
Well established 7 months banana plants

27

Bunch performance of GN

Irrigation technology

- **Quality (value chain) starts in the field and goes through the supply chain**:



- **To guarantee the quality of the final product, understanding and controlling every single process in the supply chain (HACCP) is needed.**

Post harvest practices

Post-harvest and marketing group have studied the current post-harvest practices and infrastructure to identify possible opportunities for improved quality banana. Before this training has to take place, a guideline report has been prepared under the title: Post-harvest trial in Kassala.

Training

- Training materials developed to support export quality for bananas.
- Training has been conducted in the existing fields on bunch selection, hand thinning and tagging for maturity. Also post harvest and packaging demonstrations were undertaken.

Bunch selection

34

Lower hands thinning

35

- Initial plans for export production from the existing fields have been prepared.
- An Export trial as part of post harvest was planned to be undertaken.
- Refrigerated truck, cartons and a team of labours with mobile tools were used in this trial.

Exportable fruits

Quarantine Inspection

39

Loading fruits in returnable crates

40

Harvesting trials and analysis of fruit availability for export

Post harvest trials

- Post harvest trials using organic substances (Citrex – alaun and clorine) against banana crown rot disease were conducted in collaboration with the post harvest division (FRC).
- A scientific paper with applicable findings was prepared (not published).

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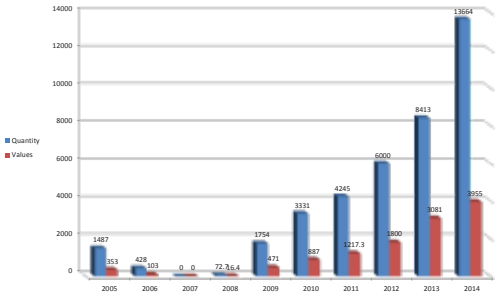
interventions

- Viable seed system together with good agricultural practices were applied.
- Bunch selection and fruit protection in the field were practiced.
- Proper harvest time and harvest process were identified (using caliper).
- Quarantine measures is always done before backing.
- De handing, organic treatments and packing in the filed were practiced.
- Refrigerated trucks were used for transport to export market and local market.

Banana export is taking place

- Ongoing banana export initiated by private sector based on high seasonal production has been supported and followed up.

Sudan banana export and values
(2005-2014)



Export Trial to Europe

Lessons learnt

Using pads

Washing before dehanding

Knives for dehaning and clustering

Fruit preparation and clustring

Sizing up clusters

Using trays

Spraying disinfectant

Piston machine for carton stick up

Packaging of the fruits

Vacuum pump

Deflating air from the bag

Just before palletizing

Final step before loading

Challenges

- Banana sector needs substantial scientific and technical support to become successful sustainable exporter.
- The export infrastructures as proper farming system, packing houses, inputs, cold transport, heat treated pallets, internal control and market identification are not all in place at present.