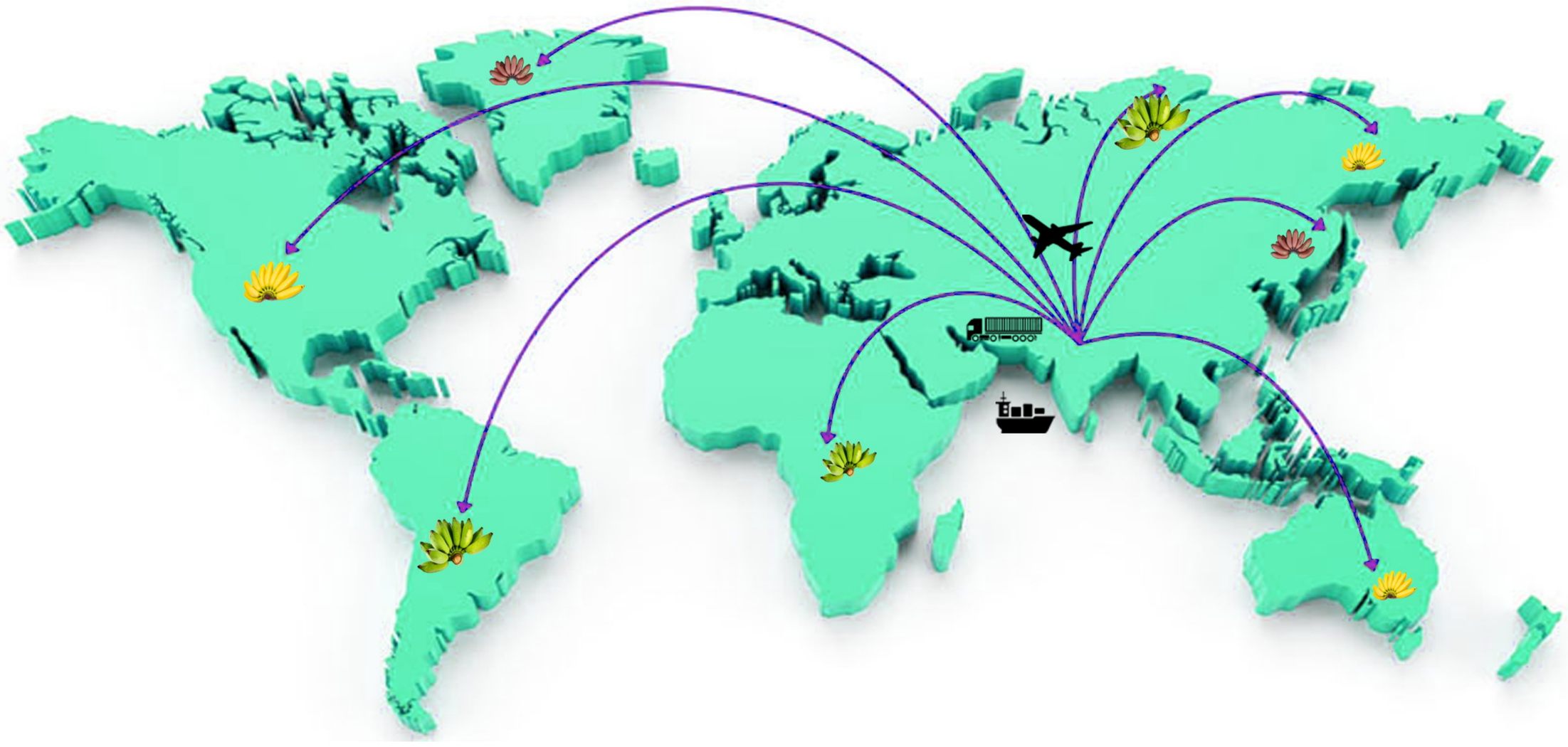
Export of GI and Traditional Bananas

Present Scenario,
Trade Opportunities and way Forward



Editors

P. Suresh Kumar, K. N. Shiva, M. S. Saraswathi, S. Uma and R. Selvarajan

ICAR - NATIONAL RESEARCH CENTRE FOR BANANA

Sardar Patel Outstanding ICAR Institute - 2020

(ISO 9001:2015 Certified Institute)

Thayanur Post, Thogamalai Road, Tiruchirappalli - 620 102, Tamil Nadu, India.

Export of GI and Traditional Bananas -

Present Scenario, Trade Opportunities and way Forward

Editors

P. Suresh Kumar
K. N. Shiva
M. S. Saraswathi
S. Uma
R. Selvarajan

ICAR - National Research Centre for Banana

Sardar Patel Outstanding ICAR Institute - 2020

(ISO 9001:2015 Certified Institute)

Thayanur Post, Thogamalai Road, Tiruchirappalli - 620 102, Tamil Nadu, India.

Title

Export of GI and Traditional Bananas: Present Scenario, Trade Opportunities and Way Forward

Editors

P. Suresh Kumar
K. N. Shiva
M.S. Saraswathi
S. Uma
R. Selvarajan

Published by

Director
ICAR-National Research Centre for Banana
Thogamalai Road, Thayanur Post
Tiruchirappalli- 620102
Tamil Nadu, India

Address

ICAR - National Research Centre for Banana
Thogamalai Road, Thayanur Post
Tiruchirappalli - 620102
Tamil Nadu, India

December 2022

Technical assistance

C. Sivananth, R. Arthee, T. Shuprajhaa, V. K. Vidyarthi, Shobana Kumar

ISBN No. 978- 93- 5768- 469- 9

Layout and Cover design

S. Ajith Kumar, H. Nelson Nicholas

Correct citation

Suresh Kumar P, Shiva K N, Saraswathi M S, Uma S, and Selvarajan R (2022) Export of GI and Traditional Bananas: Present Scenario, Trade Opportunities and Way Forward, ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu.

© 2022 All Right Reserved

No part of this publication should be copied or reproduced without written permission from the authors/institute

Printed at LaxMaster prints, 54, W. B. Road, Tiruchirappalli - 620008

Preface

With the highest productivity among the fruit crops, world is producing more than 150 million tons of banana from mere 6 million hectares. It is a staple food for many in the developing world and the cheapest energy source for any age group. India, in spite of topping the map with the largest production of more than 30 million tons, failed to find a place in export chart due to poor quality and postharvest handling practices keeping aside the domestic consumption. Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu, Karnataka, Kerala and Uttar Pradesh, leads in banana production followed by West Bengal, Odisha, Bihar and Assam. North eastern region offers versatility with its unique varieties.

Presently, India shares 0.3% of total export of banana, 21st biggest exporter, with a value of around INR 6.59 billion (US$ 90 million) and the export volume of 1.81 lakh tonnes. Poor post-harvest handling, unscrupulous practices in cultivation, lacklustre supply chain in domestic market and dismal compliance for certification procedures are some of the reasons for poor show in the export markets. GI and traditional bananas from India could be the right choice to be competitive in the market. They not only create better opportunities and niche in the market but avoid dominance Grand Nain banana and provide diversity to the consumer.

This workshop and the conclave will provide opportunity for various stakeholders of banana chain to come together, debate and provide possible solutions to boost the banana trade. We have invited chapters from doyens of industries, their perspectives and vision to bring changes in the banana trade. Besides, chapters from academia will provide much needed information on banana cultivation, handling and value addition. The chapters on organic cultivation, GAP, export requirements from quarantine, FIEO, DGFT procedures, Port Authority, Airport officials, logistic requirements will provide glimpse of information to the budding exporters and start-ups.

The outcome of the workshop will pave way for innovation in production and supply chain including logistics. This will change the future trade and will empower the farmers with the congregation of clusters, adoption of AI/ IoTs and having more voice in the government policies. Ultimately, branding and boosting the entrepreneurship through providing incubation platforms, market intelligence and handholding for technical backup are requisite in the coming days to sustain the banana production and to create robust supply chain management with better profit and sustainability.

We believe the information provided in the compendium book is comprehensive and propels banana export from India. We acknowledge and thank APEDA, PPVFRA, NABARD and NHB for financial support. ICAR support through ITMU, ABI for various activities is also acknowledged. We thank all the contributors for sharing their experience for the betterment of the industry.

Authors

सत्यमेव जयते
डॉ. हिमांशु पाठक
सचिव, एवं महानिदेशक
Dr HIMANSHU PATHAK
SECRETARY (DARE) & DIRECTOR GENERAL (ICAR)

भारत सरकार
कृषि अनुसंधान और शिक्षा विभाग एवं
भारतीय कृषि अनुसंधान परिषद
कृषि एवं किसान कल्याण मंत्रालय, कृषि भवन, नई दिल्ली 110 001
GOVERNMENT OF INDIA
DEPARTMENT OF AGRICULTURAL RESEARCH & EDUCATION (DARE)
AND
INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR)
MINISTRY OF AGRICULTURE AND FARMERS WELFARE
KRISHI BHAVAN, NEW DELHI 110 001
Tel.: 23382629; 23386711 Fax: 91-11-23384773
E-mail: dg.icar@nic.in

MESSAGE

I am pleased to learn that ICAR-NRC on Banana in association with APEDA are organizing a "Consultative Workshop on Export of GI and Traditional Bananas-Present Scenario, Trade Opportunities and Way Forward" on 21-22 December, 2022 at Tiruchirappalli, Tamilnadu, India.

India is the world's second largest producer of horticultural crops with array of fruits which ensures a wide platform for domestic market and export. The horticultural production touched a record high of 331.05 million tons in 2020-21 including over 100 million tons of fruits. Globally, India is the lead producer of mango, banana and papaya and exported fruits worth Rs. 4,971.22 during 2020-21, predominantly grapes, pomegranates, mangoes, bananas and oranges. About 33% of the total fruits production in India is comprised of Banana alone. ICAR accords special importance to this fruit with a dedicated institute, ICAR-NRC on Banana functioning since August 1993 at Tiruchirappalli, Tamilnadu. This institute has been pivotal in the development of hi-tech banana farming like production of quality planting materials, embryogenic cell lines of banana varieties, rejuvenation of unique land races and obtaining GI, site driven, mat and bunch management methods, etc. The sea shipment protocol developed by institute enabled the export of traditional banana varieties to the Middle-East and European countries and helped improvement in export of 1.91 lakh tonnes of bananas worth Rs. 700 crores. The eco-friendly management of leaf spot and *Fusarium* wilt diseases, and *in-situ* virus detection kits and markers for the genetic fidelity, certification of more than 400 million virus free tissue culture planting materials are also remarkable contributions.

The new age *"Digital India"* requires technology infusion in all sectors of horticulture for its inclusive development. The technologies, machineries, processes and protocols with more digital interventions and precisions are required for producers, produce-owners, supply chain and value chain actors, etc. As access to new destinations in horticultural trade and exports are aimed at, the consumer preference, quality standards and assurances, GAPs and development of functional linkages with international organizations are the frontier areas of R&D in horticulture.

I hope the Consultative Workshop will derive more scope for inter-agency linkages and help strengthening knowledge base in banana for its better farming and better trade.

I wish the Workshop a great success.

(Himanshu Pathak)

12th December 2022
New Delhi

डा. आनन्द कुमार सिंह
उपमहानिदेशक (बागवानी विज्ञान)

Dr. Anand Kumar Singh
Deputy Director General (Hort. Sci.)

भारतीय कृषि अनुसंधान परिषद
कृषि अनुसंधान भवन–II,
पूसा, नई दिल्ली–110 012

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
KRISHI ANUSANDHAN BHAVAN-II,
PUSA, NEW DELHI-110 012 (INDIA)

MESSAGE

Banana has acquired the status of one of the food crops and its significance is quite evident from its cultivation in 118 countries of the world. India remains as the largest producer of banana in the world for the last few decades owing to the adoption of advanced production technologies coupled with area expansion in non-traditional areas. The foresaid factors have also led to increase in production and productivity. Therefore, there is no doubt that India will achieve the targeted production of 50 million tonnes by the end of this decade. But its contribution to the export trade is very meagre (0.3%) mainly because of the domestic consumption. To compete in the international trade, country needs to focus on the export of traditional varieties and GI tagged banana for which the present monoclonal system of cultivation with Grande Naine has to be modified to polyclonal system with traditional banana varieties whose potential remains untapped among the present generation consumers denying a fair price for the produce.

Till date, the consumption of traditional banana varieties like Ney Poovan, Rasthali, Malbhog, Thella Chakkarakeli, Karpuravalli, Red Banana, Nendran, Sabri, Amrit Sagar has been restricted to the ethnic locals of the respective locations despite their quality fruits and risk resilience. But it is high time that we promote such varieties both in the domestic and international markets. This will not only boost their cultivation preventing them from getting extinct but also fetch a better price for our produce in the national and international markets.

This export workshop cum festival on GI & Traditional banana is likely to open up new avenues for the export of GI tagged and traditional Indian banana, besides Grande Naine which dominates the international banana trade. Banana stakeholders like growers, exporters, importers, quarantine officials will be greatly benefitted as the workshop is likely to deliberate upon the vast diversity, varied uses of fruits and other plant parts in processing and pharmaceutical industries, GAP and CODEX standards. This will pave a platform to discuss the issues and deliberate on way forward towards the export of traditional varieties.

My best wishes to the Director, ICAR- NRCB, and his team for the successful conduct of the workshop, and also congratulations to the team for having brought out this highly informative compendium.

\

(A.K. Singh)

Phone: (Off.) 91-11-2584 2068, Fax: +91-11-2584 1976; e-mail: ddghort@gmail.com

डॉ. एम अंगमुथु, आई ए एस
अध्यक्ष

Dr. M. Angamuthu, IAS
Chairman

कृषि और प्रसंस्कृत खाद्य उत्पाद
निर्यात विकास प्राधिकरण
(वाणिज्य एवं उद्योग मंत्रालय, भारत सरकार)

Agricultural and Processed Food Products Export Development Authority
(Ministry of Commerce & Industry, Govt. of India)

MESSAGE

Worldwide banana is grown in more than 130 countries with a production of 164 million tons contributing over 18% of fruit production. Banana exports by different countries are pegged at US$13.8 billion with 20.07 million tonnes of trade. Of which, Grand Naine alone contributes more than 90% of the international banana trade. *India is the largest banana producer in the world and accounts for 36% of the world's banana production. As of 2020, world's banana production was estimated at 119 million tonnes and India's production was 31.5 million tonnes.* Despite being the largest producer and consumer of bananas, India plays only a minuscule role in international trade with a contribution of *2.33* lakh tons of bananas worth *Rs. 740.32 crores during 2020-21.*

The adoption of advanced production technologies along with area expansion in non-traditional banana growing regions has increased the production and productivity of the crop manifold *thus leading to sharp increase in the exports.* Therefore, it is possible to reach the mission of producing 50 million tonnes of bananas before the end of this decade. In this context, it is essential to identify new markets and explore market channels to make cultivation and trade sustainable amidst the competition from other commodities.

Also India is a country with wide diverse agro climatic conditions conducive for production of wide variety of agri products. With a broad base of production, there are several agri commodities having Geographical Indications (GI tags) in India. GI tag conveys assured quality and distinctive attributes to the product's origin in that defined geographical locality region or country. The GI Certified banana varieties in the Country are Nanjangud Banana & Kamalapur Red Banana at Karnataka, Virupakshi & Sirumalai Hill Banana at Tamil Nadu, Chengalikadan Nendran Banana at Kerala, Jalgaon Banana at Maharashtr, Myndoli Banana at Goa which have been identified for creating brand image to the Indian origin varieties popular across the globe.

Given the current market signals, *APEDA in its endeavour to create niche market for Indian GI and indigenous* banana varieties like Ney Poovan, Rasthali, Nendran, and the varieties from the eastern part of India like Sabri, Chinia, Amrit Sagar, etc., *in collaboration with ICAR-NRCB, VFPCK, and other government agencies have initiated* on the development of sea protocols for the export of *these* varieties to West Asia and European countries. *The initiatives* have already started yielding more dividends. Growing interest and enthusiasm among the exporters for ethnic Indian bananas coupled with the rising demand from Indian expatriates for traditional varieties is testimony to raising demand.

I strongly believe that this workshop cum festival on GI & Traditional will pave the way for opening of trade avenues for India as a major exporter with the right mix of *GI and traditional bananas thereby establishing India as a brand, known for its legacy, quality, delicacies and varieties internationally.*

I wish ICAR- NRCB and all the banana stakeholders, for the successful conduct of the workshop and for bringing out the compendium which is a treasure trove of information.

Dr. M. Angamuthu, IAS
Chairman, APEDA

चौथी मंजिल, एन.सी.यू.आई. बिल्डिंग, 3, सीरी इंस्टीट्यूशनल एरिया, अगस्त क्रांति मार्ग, नई दिल्ली – 110016
दूरभाष: +91–11–41486020 (निजी), 41486013, फैक्स: +91–11–26526187 / ईमेल: chairman@apeda.gov.in, वेबसाइट: www.apeda.gov.in

4th Floor, NCUI Building, 3, Siri Institutional Area, August Kranti Marg, New Delhi - 110 016
Tel : +91-11-41486020 (D), 41486013, Fax : +91-11-26526187, E-mail : chairman@apeda.gov.in, Website : www.apeda.gov.in

ICAR-राष्ट्रीय केला अनुसंधान केंद्र,
कृषि एवं किसान कल्याण मंत्रालय,
तोगमलै रोड, तायनूर पोस्ट,
तिरुच्चिरापल्लि - 620102
तमिल नाडु, भारत

ICAR – National Research Centre for Banana,
Ministry of Agriculture & Farmers' Welfare, GoI,
Thogamalai Road, Thayanur Post,
Thiruchirappalli – 620 102.
Tamil Nadu. India.

ISO 9001 : 2015 Certified Institution

Message

India is the land of traditional banana and these varieties plays a pivotal role in the banana trade and livelihood of farmers. Each state grows unique varieties which makes the huge diversity in banana growing regions. Indian diaspora has settlements all over the world. These traditional varieties have a greater scope to get exported to West Asia, China, Central America and Europe. This has brought back considerable area expansion under indigenous bananas and prevented them from vanishing away in the Indian markets. Other than Grand Naine, it is essential to promote branding of traditional banana wealth of India to capture the overseas markets rather than our dependence on a single variety in the banana trade.

The banana cultivation once considered to be profitable and enhanced farmers income manifold became victim of monsoon failure, depleting natural resources, poor adaptation of sustainable agricultural technologies and emergence of new insect pests like scarring beetle, and the threatening diseases like Fusarium wilt with new Tropical Race 4 which affects all the clones of banana including Cavendish group.

Low volume export of banana is due to improper pre and post-harvest practices like, non-adoption of GAP which includes right choice of plant, planting methods, bunch covering, growth regulator sprays, non-ideal post-harvest practices, transport procedures, lack of proper storage facilities, outdated banana handling practices etc. Due to mishandling of produce about 25-40% is being wasted. This leads to price imbalance and large price variations both spatial and temporal, which disheartens farmers. Controlled atmosphere, controlled humidity, remote access monitoring, enhanced air flow, better insulation materials and techniques and internal monitoring controls are essential for successfully enhancing the shelf life of banana to more than 30 days.

After COVID-19 pandemic, it is for sure that the world is switching to new normal in the way the export and food businesses are done around the world. Traditional methods of production and supply chain including logistics will change and the future trade will empower the farmers with the congregation of clusters, adoption of AI/ IoTs and having more voice in the government policies.

We believe this workshop and banana exhibition will create an awareness among the banana producers and exporters about the basic infrastructure needs of cold chain management, cross-border data harmonization and use of international standards/norms country wise, online export documentation processing: traceability details and certified material for exports, support of financial sectors and insurance companies for the fresh agro export, knowledge on numerous documentation during registration process. This also opens up new vista of opportunities in processing and value addition using banana as raw material. The workshop will create a window of opportunity for GI & traditional banana varieties both in domestic and export markets.

R. Selvarajan

Director

Phone : +91 0431-2618125
Website : www.nrcb.res.in
Email : director.nrcb@icar.gov.in
directornrcb@gmail.com

Content

S.No	Title	Page. No
	I. Banana export: Issues and opportunities	
1.	**Leveraging Banana export from India: Scope, Issues and Strategies** Selvarajan R, Suresh Kumar P, Shiva K N, Thangavelu R, Kumar V and Uma S	1
2.	**GI and traditional Banana varieties of India** Saraswathi M S, Durai, P, Backiyarani S, Uma S and Selvarajan R	19
3.	**Role of PPV&FRA on conservation and popularization of GI & Traditional varieties of Banana** Pilania D.S, Arun Kumar, Rajganesh D.S, Sengar R.S, Dubey U.K, Chowdhury D.R, Ravi Prakash, Dinesh K. Agarwal and Prabhu K.V	32
4	**Indigenous ornamental bananas: Scope and new business opportunities** Ramajayam D, Saraswathi M.S and Anuradha C	42
5.	**Ensuring export quality banana bunches through certification of tissue culture - raised plants by virus indexing and genetic fidelity** Selvarajan R, Balasubramanian, V and Saraswathi M S	51
6.	**Post-harvest management of fresh banana and codex standards for export** Shiva K.N, Suresh Kumar P, Kamaraju, K and Uma, S	59
7.	**Artificial Intelligence (AI) and Sensors: Tools for next generation horticulture** Shuprajhaa T and Suresh Kumar P	68
8.	**Phytosanitary measures to be followed in export of Banana** Thangavelu R, Loganathan M and Selvarajan, R	73
9.	**Quarantine and phytosanitary measures in export of banana** Mohanasundaram M and Giribabu P	79
10.	**Indian Banana - A mission to achieve a billion dollar market share by 2025** Azhar Pathan	90
	II. Opportunities in banana processing and allied products	
1.	**Functional food products from banana: Wealth from export rejects** Suresh Kumar P, Amelia Keran D, Sivananth C, Shiva K N and Kamaraju K	95

2.	**Trends in Indian start-up ecosystem with special emphasis on banana food processing sector** Arthee R, Suresh Kumar P and Saraswathi M S	107
3.	**Banana fibre: A natural fibre with multiple utilities** Suresh Kumar P, Ravindra Naik, Shiva K N, Kamaraju K and Uma S	115
4.	**The scope and merits of Banana fibres and its current trends in textile and non - textile applications- Challenges in blending and spinning with silk & other fibers** Mathiazhagan P, Atharvan Deshpande, Radhalakshmi Y.C, Suresh Kumar P, Nilesh Waghmare, Rupesh Khare, Chinnarj S, Seenivasan R, Yerraiah D, Anandi Balagurunathan, Anand Kumar and Priyadharshini A.	124
5.	**Product development studies carried out by SITRA using banana / cotton fiber yarn and fabric blends** Rakash Vasudevan P, Panneerselvam G, Nagarajan N K and Vittobaa M.K	129
6.	**Profitable entrepreneurship from banana fibre: A case study of SS natural fibre unit, Mohanur, Namakkal Tami Nadu** Suganthi P	135
	III. Government's role in boosting banana trade	
1.	**Marketing strategies and support for boosting banana trade - Standards for fresh GI and traditional banana, placing Indian banana in offshore markets** Madhur P Verma and Ravindra Chavan	138
2.	**Role of quarantine and phytosanitary measures on boosting export in Banana** Sivarama Krishnan S, Govindaraj R and Elangovan C	149
3.	**Marketing strategies and support from government in banana business** Saravanan G	158
4.	**Strategy for enhancing export of bananas** Unnikrishnan K	161
5.	**Hurdles and solutions in banana trade: Customs affair in export logistics** Pradeep N	167
6.	**Reaching the new milestones: Logistics in banana at air cargo complex** Subramani P	172
7.	**Role of Vegetable and Fruit Promotion Council Keralam (VFPCK) in creation of banana based business platforms** Shanthi Anna Kurian	178

IV. Policies and schemes in Government sector to promote trade		
1.	**Policies and schemes for improved production and post-harvest handling of Banana: The National Horticulture Board (NHB)** Raja B	182
2.	**Role of public sector banks (PSBs) in creation of banana-based business platforms** Senthil T	186
3.	**Role of public sector banks (PSBs) in creation of banana-based business platforms** Rajasekar N	193
4.	**Pradhan Mantri Formalization of Micro Food Processing Enterprises (PMFME) Scheme: Making India "Aatmanirbhar" in food processing** Vibhor Sharma	198
V. Contribution of Industries in banana business		
1.	**Banana for food process revolution - Room for small and big players** Tamilselvan P, Sivananth C and Suresh Kumar P	201
2.	**Including banana in the ambit of crop insurance: Issues and Opportunities** Srinivasan C.A	219
3.	**Supply chain management in banana: Cold chain perspective - A case study** Nagahari Krishna Lokanadham	227
4.	**Supply chain management in banana: Integration of tradition and innovation of world's favorite fruit** Karthik Jayaraman	230
5.	**Reaching the new milestones in Logistics – Hurdles and Solutions - Maersk story** Kuljeet Rajora	234
VI. Impact of FPOs / Entrepreneurs / Start up ecosystem on banana sustainability		
1.	**Banana cultivation for export: Role of FPOs** Ajeethan G	237
2.	**Banana Export - Challenges, scope and solutions - an importer's perspective** FG Zinggl	241
3.	**Building modern integrated fruit value chains in India; reaping the banana potential** Vineet Munjal and Marcel Stallen	244

4.	**Voluntary compliance certificates: GAP certification and others, need and procedures for export of bananas** Kaushik Sengupta	250
5.	**Voluntary compliance certificates: Organic certification, need and procedures** Bhimsen Joshi	264
6.	**Block chain - enabled traceability of banana supply chain to achieve export compliance** Ramaa Rao, Raghava T and Srivatsa S	269
7.	**Rural digital empowerment through free digital marketing: MarketMirchi.com is a boon for farmers** Pragati Gokhale	275
8.	**Horticulture cluster development programme - Role of Grant Thornton** Udit Paliwal and Chirag Jain	280
9.	**Innovative, functional food products of Banana and market innovations to attract new age consumers** Davanam Srikanth, Akalya Shanmugam, Vadakkepulppara Ramachandran Nair Sinija, Loganathan Manickam	285
	Annexure - I - Agencies involved in export of Banana	293
	Annexure – II - Committees	301

I
Banana export : Issues and opportunities

Leveraging Banana export from India: Scope, Issues and Strategies

Selvarajan R*, Suresh Kumar P, Shiva K N**, Thangavelu R**, Kumar V** and Uma S****

*Director, **Principal Scientist
ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India- 620 102
Corresponding author: psureshars@gmail.com

Introduction

In India, banana is grown in the states from the humid tropics to humid subtropics and semi-arid tropics like Andhra Pradesh, Tamil Nadu, Maharashtra, Gujarat, Karnataka, Uttar Pradesh, Kerala, Madhya Pradesh, Bihar, West Bengal, Assam and Odisha. Besides, north-eastern states, contributes heavily on the banana germplasm diversity and is one of the hot spots in the world. The Cavendish clones occupies 52% of the total area under banana cultivation and contributes 64% of the total banana production. The factors like production function, purchasing power, distribution system, end point delivery greatly influences the supply chain of banana trade. In terms of world export trade, banana ranks 5th most important crop after coffee, cereal, sugar and cocoa. With the international banana trade of more than US$45 billion, banana has a huge impact on the economy of many countries (FAO, 2021). The consumption for bananas, worldwide, is estimated to register a CAGR of 1.21% for the forecast period of 2019-2024. Banana as an enterprise is generating around US $9 billion and providing livelihood to millions of farmers of India, contributes 20% world banana production with the production of 33.06 million tons in an area of 9.24 lakh hectares (NHB, 2022). Banana exports by different countries totalled US$13.8 billion with the volume of 20.1 million tonnes. **Presently, India shares 0.3% of total export of banana, 21st biggest exporter, with the value of around INR 6.59 billion (US$ 90 million) and the export volume of 1.81 lakh tonnes (APEDA, 2021).**

Banana Production: An Overview

World scenario

World production of bananas and plantains was 155.2 million tonnes (115.7 million tonnes of bananas (75%) and 39.5 million tonnes of plantains (25%)) in an area of 8.72 million hectares, led by India and China with a combined total of 28% of global production (FAO, 2020). India made a significant jump in the production after 1990s with the integration of intensive area expansion and adoption of scientific cultivation of banana (Fig 1 and 2). Other than India, the leading producers are China, Brazil, Philippines, Ecuador, Indonesia, Mexico, Guatemala and Colombia in terms of area and production. Highest productivity was recorded in Indonesia and Guatemala nearing to 50 tons per hectare.

Interestingly, in the region wise contribution, Caribbean and Latin American region, contributes lesser in terms of area whereas the African countries contribution is lower in terms of production. Highest area, production and productivity were recorded with the Asian region with the presence of strong players like India, Indonesia, China and Philippines, these countries contribute more than 60% of banana production.

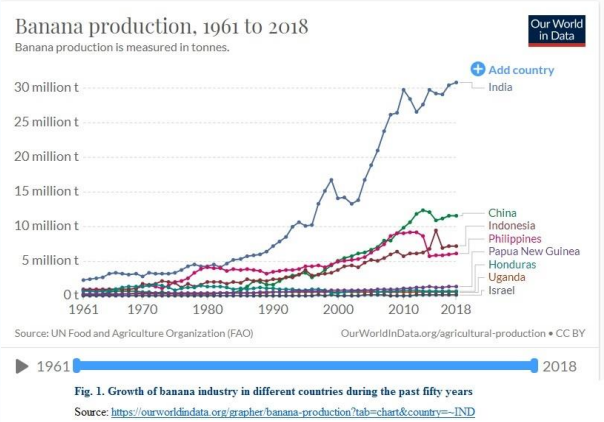
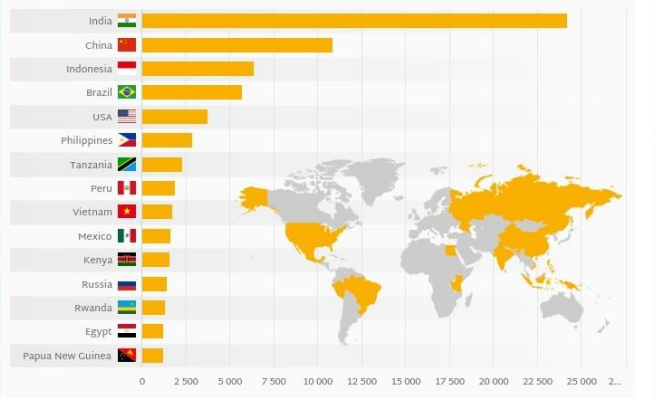


Fig. 1. Growth of banana industry in different countries during the past fifty years

Source: https://ourworldindata.org/grapher/banana-production?tab=chart&country=~IND

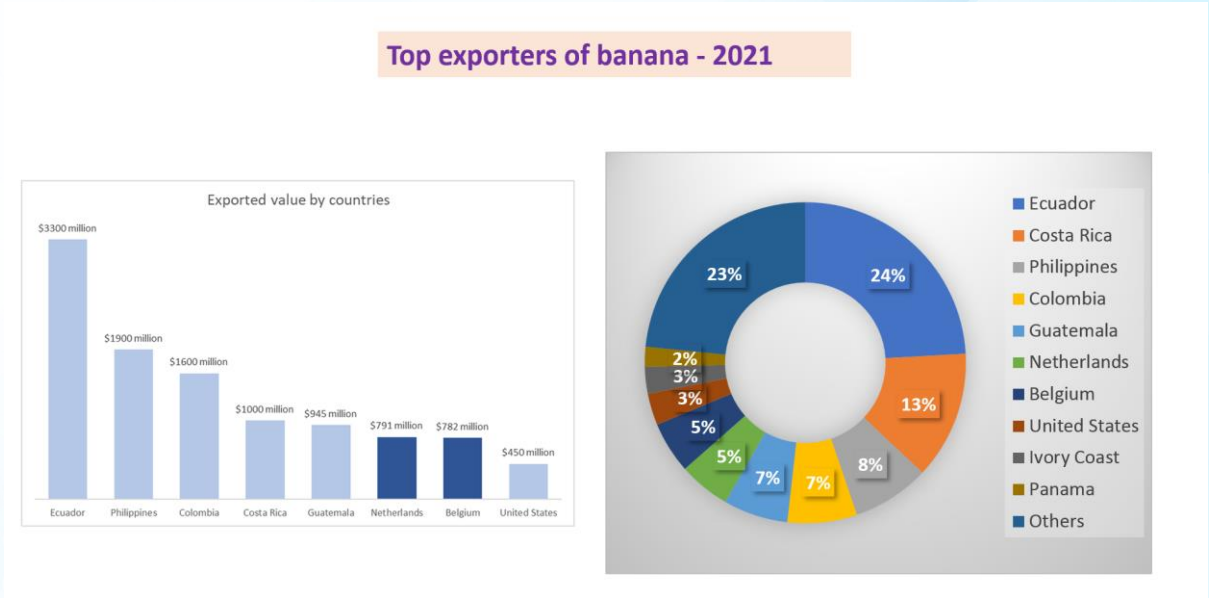


Banana status among the top producers in the world

Very low productivity (10 tons/ ha) was recorded in African countries due to the adoption of polyclonal cultivation and perennial cultivation of banana. As the Latin American banana trade is controlled by the multinational companies, the highest productivity is recorded by these regions.

Indian Scenario

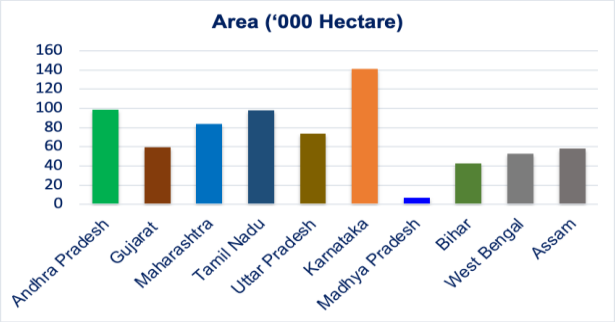
India contributes 19.37.% world banana production with the production of 33.06 million tons in an area of 9.24 lakh hectares (NHB, 2020). For the last one decade, India has remained as the largest producer of bananas in the world. Increase in production is partly due to enhanced area under cultivation, but mainly due to increased productivity per unit area made possible due to the

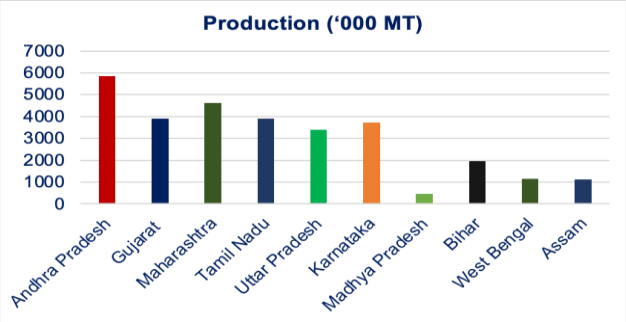


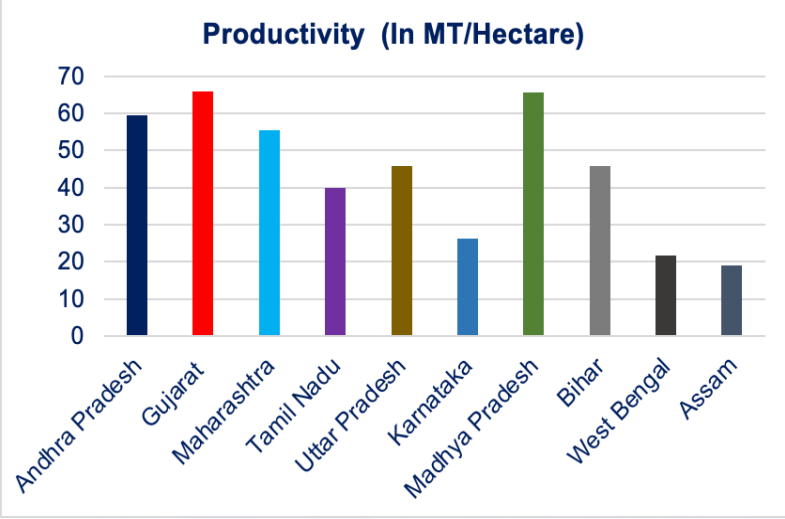
use of tissue culture plants of high yielding superior varieties like, Grand Naine, Robusta and other Cavendish clones for cultivation, integrated nutrient and water management, high density planting and ratooning. Due to its wide adaptability, banana cultivation has been extended from humid tropics to subtropics, arid subtropics, and from sea level up to an elevation of 1500 m above MSL. Availability of wide genetic variability, varying production systems, positive response to Good Agricultural Practices (GAP) have contributed to wider adoption of banana in the country. As a

result of high productivity, good demand and net returns, many farmers have shifted to banana cultivation. Thus, banana has transformed itself from a backyard crop to a high value crop.

In India, Banana ranks first in production and third in area among the fruit crops. India made enormous achievements in banana production with both horizontal and vertical expansion. In 1990s, the crop was cultivated in less than 5 lakh ha concentrated mostly in southern and eastern part of India with the lesser productivity. But in the last decade, the crop has been introduced to new areas like Madhya Pradesh, Uttar Pradesh resulting in enhanced production and productivity. In Tamil Nadu and Kerala, more than 15 different varieties of banana are grown commercially whereas in states like Gujarat and Maharashtra only monoclonal cultivation of Grand Naine is being done. Andhra Pradesh (17.64%), Maharashtra (12.77%), Gujarat (11.81%), Tamil Nadu (11.78%) and Uttar Pradesh (10.24%), leads in production. The other major banana producing states are Karnataka, Kerala, West Bengal and Assam (NHB, 2022). Within India, Gujarat and Madhya Pradesh recorded the highest productivity of 65.70 metric tonnes/ha as against the national average of 36.89 tonnes/ha. The comparatively lower productivity (39.90 t/ha) in Tamil Nadu is due to the adoption of polyclonal system of banana cultivation.







Banana Production Scenario in India - 2020 - 21

Varietal diversity in Indian states

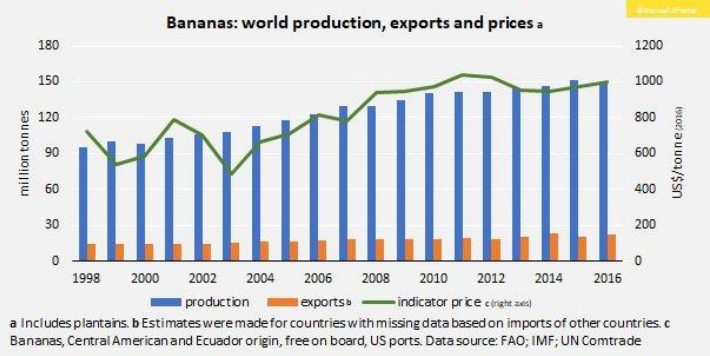
State	Growing belts	Varieties
Andhra Pradesh	East Godavari, West Godavari, Kurnool, Cuddapah	Grand Naine, Dwarf Cavendish, Robusta, Rasthali, Amritpant, Thellachakrakeli, Karpooravalli, Poovan, Chakrakeli, Monthan and YenaguBontha
Assam	Goalpara, Nagaon, Sonitpur, foothills of Garo hills	Jahaji (Dwarf Cavendish), Chini Champa, Malbhog, Borjahaji (Robusta), Honda, Manjahaji, Chinia (Manohar), Kanchkol, Bhimkol, Jatikol, Digjowa, Kulpait, Bharat Moni
Bihar	Purnia, Bagalpur, Katiyar, Muzzafarpur, Vaishali, Samasthipur, Darbanga	Grand Naine, Alpon, Chinia , Chini Champa, Malbhog, Muthia, Kothia , Gauria, FHIA-17
Gujarat	Surat, Vadodara, Anand, Kheda, Junagadh, Narmada, Bharuch	Grand Naine, Lacatan, Harichal (Lokhandi), Gandevi Selection, Basrai, Robusta, Harichal, Shrimati
Jharkhand	Ranchi, Sahebganj	Basrai, Singapuri
Karnataka	Bangalore, Chitradurga, Shioroga, Hassan, Chikka Mangloor	Dwarf Cavendish, Robusta, Rasthali, Poovan, Monthan, Elakkibale, Grand Naine
Kerala	Thiruvananthapuram, Kollam, Pathanamthitta, Alappuzha, Kottayam, Idukki, Ernakulam, Thrissur, Palakkad, Malappuram, Kozhikode, Wynadu, Kannur, Kasargod	Nendran (Plantain), Palayankodan (Poovan), Rasthali, Monthan, Red Banana, Robusta
Madhya Pradesh	Khandwa, Badwani, Khargaon, Dhar	Basrai, Grand Naine
Maharashtra	Jalgaon, Ahmednagar, Buldhana, Pune, Wardha, Dhule, Nanded, Parbani, Nandurbar, Satara, Sangli, Osmanabad, Buldhana, Akola, Yeothmal, Amravati, Thane, Kulara, Alibag	Grand Naine,, Basrai, Robusta, Lal Velchi, Safed Velchi, Shreemanti
Orissa	Ganjam, Puri, Khurda, Gajpati, Cuttack, Dhenkanal, Angul, Sundargarh, Sambalpur, Bargarh, Deogarh, Koraput, Keonjhar,	Dwarf Cavendish, Robusta, Champa, Patkapura (Rasthali)

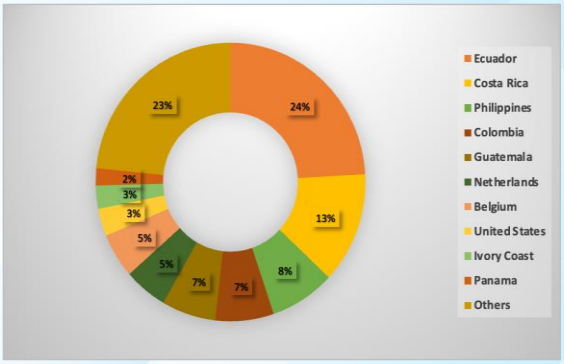
	Raygada, Mayurbhanj	
Tamil Nadu	Thoothukudi, Tiruchirapalli, Coimbatore, Tirunelveli, Karur, Erode, Kanniyakumari	Grand Naine, Virupakshi, Robusta, Red Banana, Poovan, Rasthali, Nendran, Monthan, Karpuravalli, Sakkai, Peyan, Matti
West Bengal	Hooghly, Nadia, North 24 Parganas	Champa, Mortman , Dwarf Cavendish, Giant Governor, Kanthali, Singapuri

Adopted and revised: http://nhb.gov.in/report_files/banana/BANANA.htm

Export scenario of world and India

With the presence of bigger domestic population, the banana produced are predominantly consumed within the country itself by the major banana producers like India, China and Brazil. Besides, the banana exports are governed by multinational fruit companies with the organized business environment whereas in India, the business is totally unorganized and is handled by multiple authorities in bits and pieces.





World trend in production, export and prices
http://www.fao.org/economic/est/est-commodities/bananas/en/

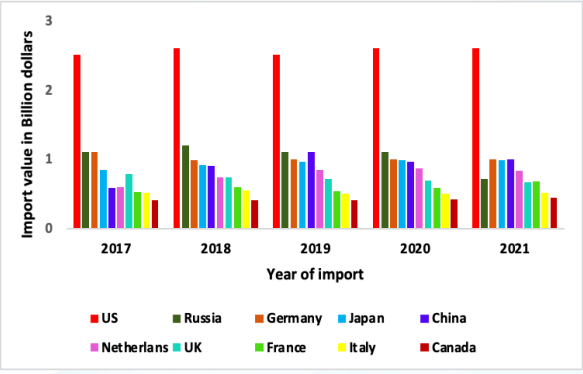
Export scenario of banana from major countries

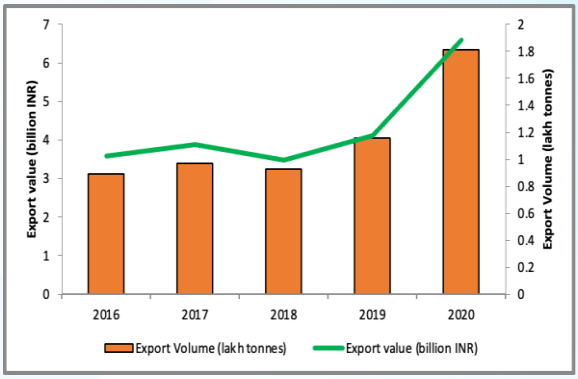
Rank	Country	Production (Million Tonnes)	Export Qty. (MT)	Export value (US$ Billion)	Share to world production (%)	Proportion of total export (%)
1	Ecuador	6.5	5.2	2.7	6.0	30.7
2	Guatemala	3.7	2.4	1.2	2.6	10.5
3	Costa Rica	2.4	2.3	0.99	2.5	8.5
4	Belgium	2.4	2.0	0.94	2.1	8.0
5	Colombia	2.0	1.7	0.91	1.9	7.8
6	Philippines	5.8	1.2	0.62	1.8	5.3
NA	**India**	**29.1**	**0.01**	**0.033**	**26.7**	**0.3**
	Total		18.2	11.8		

Source: http://www.worldstopexports.com/bananas-exports-country/

Export summery report from different states (HS Code: 0803)			
State	**Value (US $)**	**State**	**Value (US $)**
Maharashtra	100908660	Rajasthan	850573
Kerala	22400289	Telangana	693997
Andhra Pradesh	7110249	Bihar	678266
Uttar Pradesh	6460403	Madhya Pradesh	166766
Gujarat	5354333	Chattisgarh	25695
Tamil Nadu	4062692	Himachal Pradesh	22355
Haryana	3032837	Tripura	14988
Karnataka	2098724	Uttarakhand	13687
Delhi	1597170	Puducherry	7470
Punjab	1592972	Jharkhand	7094
Unspecified	1463193	Assam	5482
West Bengal	1029887	Rajasthan	850573
Jammu & Kashmir	922993	Telangana	693997
		Total	**160520775**

Banana exports from Tamil Nadu (HS code: 0803)			
Country	**Value (US $)**	**Country**	**Value (US $)**
Iran	1313240	Switzerland	1678
UAE	1184119	France	1387
Maldives	946573	Austria	1298
Qatar	173384	Germany	515
Uzbekistan	142160	Canada	511
Saudi Arab	91184	Malaysia	477
Singapore	90786	U S A	459
Kuwait	57549	Mali	320
Iraq	27204	Australia	224
Bahrain IS	12655	Netherland	217
Nepal	7402	Japan	204
Oman	4496	Korea RP	112
U K	4468	Belgium	70
		Total	**4062692**





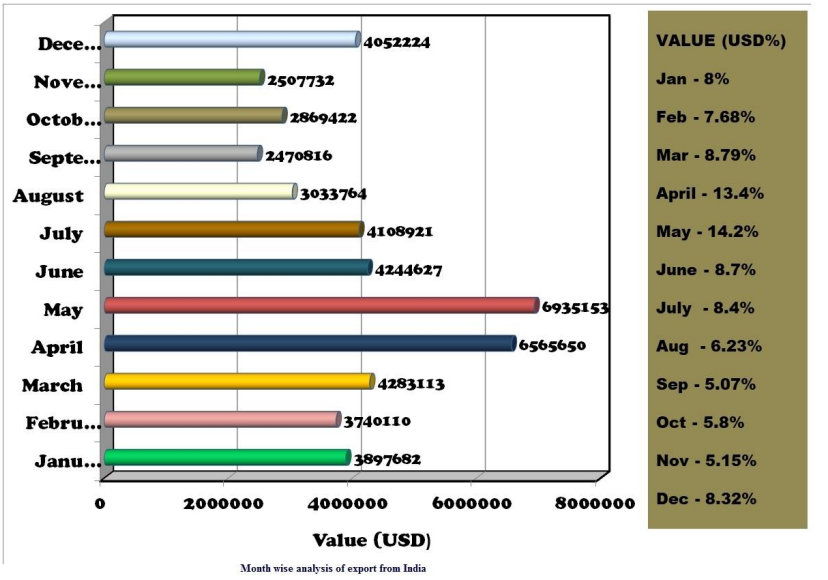
Export volume & value of Banana in India (2016-2020)

Five multinational fruit companies alone controlled 44% of the international banana trade. The market share of the above players decreased from 70% in 2002 to about 44% currently. In the past, multinational companies owned a large number of plantations in Central and South America and other banana-producing regions. Since the 1980s they have divested a large share of their own production, replacing it with greater purchases from independent producers. For example, Chiquita has decreased the number of its plantations in Central America. Fyffes used to own plantations in Jamaica, Belize and the Windward Islands, but withdrew from production and switched to purchasing its bananas through contracts with producers. The disengagement from production was partly caused by legal and economic problems at the plantation level, but also reflects the change in market power along the banana value chain. Along the global banana supply chain major supermarket chains in the US and EU have gained market power over the big producers in the 21st century as they dominate the retail market and increasingly purchase from smaller wholesalers or directly from growers

Major market players in the banana trade

Even though, nearly 20 per cent of total world output is produced in India, the export is negligible. Nonetheless, India, in recent times, increased its export volume by 47 percent due to further expansion in the harvested area for traded varieties. While banana production in India primarily targets the domestic market, a growing share of production is exported to the Gulf countries, Malaysia and Nepal. Supply shortages in the Philippines, the main competing exporter, meant that shipments from India could benefit from the high demand in Gulf countries and Southeast Asia. Another supporting factor was the low price of Indian bananas, which reportedly sold at a 50 percent discount compared to bananas from Ecuador and the Philippines at the Dubai auction centre.

Company	Country	Market share [%]
Chiquita	U.S.	13
Fyffes	Ireland	6
Dole Food Company	U.S.	11
Fresh Del Monte Produce	U.S.	12
Noboa	Ecuador	2



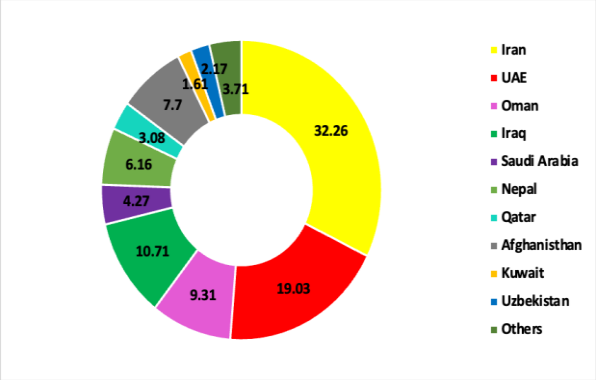
Month wise analysis of export from India

India is the 20th biggest exporter of bananas globally due to the fact that the country also consumes bananas in greater quantity. India exports US$ 90 million worth bananas which is roughly 630 crores during the year 2020. Maharashtra almost monopolized the banana export with the handling volume of 96.91% in value and the other top

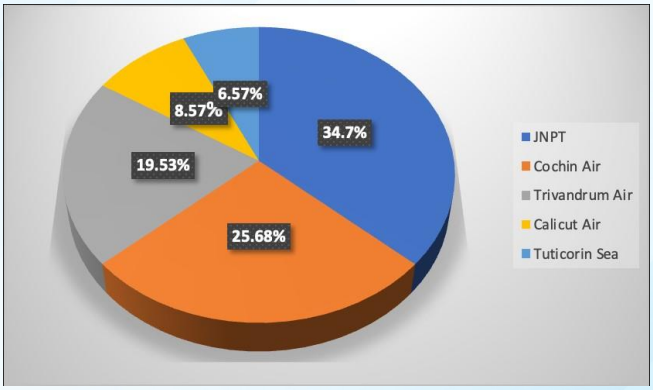
banana producing states are catching up significantly for the past three years. The month wise segregation of data revealed that the peak export was happened during April to May (27.6%) whereas in other months, the export is almost stagnant to 6-8%.

Month wise analysis of export from India

India export maximum bananas to middle east countries with the lion share to United Arab Emirates (41%), followed by Saudi Arabia, Iran, Kuwait and Oman.



Country-wise export of Banana from India



Major places of Banana export in India

Jawaharlal Nehru Port, Mumbai handles the maximum value of US$16 million (34.7%) followed by Cochin (25.7%), Trivandrum (19.5%), Calicut (8.6%) through air and Tuticorin sea (6.6%). In India main five banana exporters are Fair Exports Pvt Ltd. (9.31%), INI Farms private Ltd (7.99%), Desai Fruits and vegetables (5.3%), Mayi Industries (5.56%), Ambadi Food (3.59%) and White Globe (3.08%). These players contribute to 35 % of total banana export. There are numerous small, independent exporters who contribute to the growth of the industry.

ICAR- NRCB success stories to boost banana trade

Considering the business potential and the presence of Indian population, three project initiatives were undertaken for developing sea protocol for traditional Banana like Nendran to West Asia and Europe and to establish the harvesting and postharvest handling procedures for Grand Naine for its sea transport to farthest markets like Europe which requires more than 25 days of travel.

- APEDA, New Delhi and Fair Exports (India) Pvt. Ltd., Kochi under the Public Private Partnership (PPP) for Nendran to West Asia;
- TNAU, Coimbatore & University of Udinae, Port of Trieste, Italy for Grand Naine to Italy
- VFPCK, Kerala for exporting Nendran to United Kingdom

The projects culminated with significant outcomes. Fair exports Pvt Ltd., Kochin, Kerala, started sailing 40 tons of Nendran bananas through sea every week to Dubai with the volume of 2000 tons per year. **With the saving of Rs. 40000 to 50000 per ton compared to airlifted bananas, the company realizing the savings of Rs. 4-5 crores per year.** A cable way conveyor-

based harvesting and then export protocol resulted successful export of Grand naine to Italy with more than 86 % recorded the sound fingers. In the recent attempt during March 2021, for sending Nendran to London through sea yielded the cluster of fingers with more than 95% of fruits being sold with premium rate. This opens up new vista of opportunity to place Indian bananas in the farthest markets. **ICAR initiatives will enhance the export volume (50%), reduce the freight charges (saving more than 80%) significantly. Made the Indian ethnic banana available at cheaper cost in the off shore market, given the better price realization for the farmers at the farm gate. Made the jump in export trade from the sea route contribution of more than 90% handling in Rs. 1000 crores export value.** There is a possibility to enhance nearly 1,90,000 containers in the coming years with the handling volume of minimum of 10 million tons which in value term is around INR 22000 crores equivalent to US$ 3.5 billion.

Flagging off ceremony at Fair Exports - Angamally, Kerala for var. Nendran to Dubai

Flagging off ceremony at TNAU - Coimbatore for var. Grand Naine to Italy

Sea exports of Nendran banana from Cochin, Kerala to London- ICAR-NRCB scientists with VFPCK officials and exporters

Opportunities

There is great scope for increasing the trade as only 15% of bananas and plantains are traded on the world market, the rest are used for domestic consumption. Banana industry in India has seen a significant growth over the past two decades with the widespread availability of tissue cultured planting material and other technological advances, coupled with the fillip provided by state governments in the global banana trade.

India to be the major destination for export with its proximity

India's social and economic development potential is closely linked to its ability to bring in new investments, technologies and know-how to its huge agricultural sector. Given the declining share of traditional agricultural commodities in production, consumption and trade, horticulture and other non-traditional high-value agriculture represent an important area of potential income growth in rural areas. Investopedia defines net exports as the value of a country's total exports minus the value of its total imports. They predicted India with US$ 60.9 million recorded 158.4% increase in growth and has the highest strong competitive advantage among the nations. Around 20-30% of banana produced in India estimated to go waste due to the ineffective cold chain. Unlike the rest of the world's major banana growing areas, which are dominated by large-scale commercial farms, the Indian banana industry is based on large numbers of small, independent farmers, typically cultivating less than three acres.

Bananas grown for export are only a fraction of the US$ 45 billion in annual banana and plantain production - in fact, bananas are the fourth-most valuable global crop after rice, wheat, and milk. Nearly nine-tenths of the world's bananas are eaten in poor countries, where at least 400 million people rely on them for 15-27% of their daily calories. The industry is responding to the market signals and gradually shifting production-mix to meet the growing demand for high value commodities. This is reflected in the changing share of high value crops in total value of output from agriculture.

There was a decline in export during the past two years in majority of the exporting regions like Philippines and Ecuador due to drought, flood and the spread of diseases like Fusarium wilt TR4 which negatively affected the yields and resulted in shortages. It shows the greater opportunity for India to target not only the Middle East markets but also a quality conscious, premium markets like USA and EU. Less than 0.1% of current Indian banana production is exported, which represents less than 0.3% of the international banana trade.

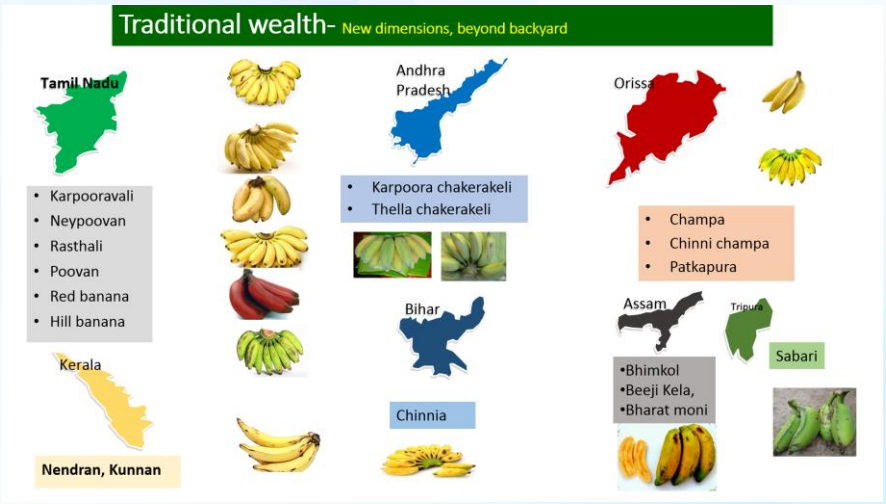
India's affinity to Middle Eastern markets, where there is growing demand for bananas, offers significant potential for boosting its exports. India also offers an alternative to the region's current supply from more remote sources. Presently nearly 3000 numbers of containers is being exported from India to market in Middle East. But there is possibility to enhance this number to roughly 2 lakh containers in the coming years with the handling volume of minimum of 10 million tons which in value term is around INR 22000 crores equivalent to US$ 3.5 billion.

The issue of changing tariffs is an also and an opportunity for banana sea trade by opening new exporting markets. Another supporting factor is the low price of Indian bananas, which reportedly sold at 50% lesser compared to bananas from Ecuador and Philippines. Recent reforms

introduced by the central government in the areas of contract farming expected to have a positive impact on the value chain.

GI & Traditional Banana: way for sustainability and profitability

India is the land of traditional varieties and these varieties plays a pivotal role in the banana trade and livelihood of farmers. Each state grows unique varieties which makes the huge diversity in banana growing across regions. Indian diaspora has settlements all over the world. These traditional varieties have a greater scope to get exported to West Asia, China, Central America and Europe. This has brought back considerable area expansion under indigenous bananas and prevented them from vanishing away in the Indian markets. Other than Grand Naine, it is essential to promote branding of traditional banana wealth of India to capture the overseas markets rather than our dependence on a single variety in the banana trade.

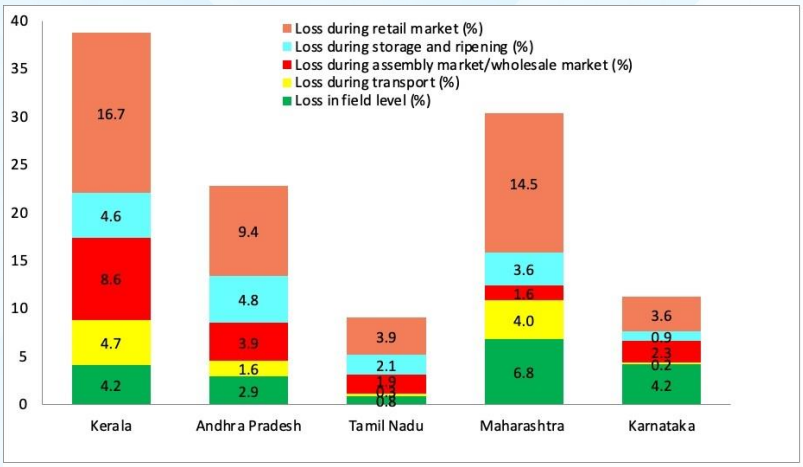


Challenges

The banana cultivation once considered to be the profitable and the tools to enhance the farmers income manifold become victim of monsoon failure, depleting natural resources, poor adaptation of sustainable agricultural technologies and emergence of new insect pests like scarring beetle, skipper butterfly and the threatening diseases like Fusarium wilt with new Tropical Race 4 which affects all the clones of banana including Cavendish group. Besides potentially affecting trade supplies, TR4 may also significantly hamper the export earnings potential of producing countries if importing countries react with import restrictions, tightened sanitary and phytosanitary measures or additional controls. Such effects are already at play in the Philippines and in Mozambique, which face disease-related import bans in Australia and the United Republic of Tanzania respectively.

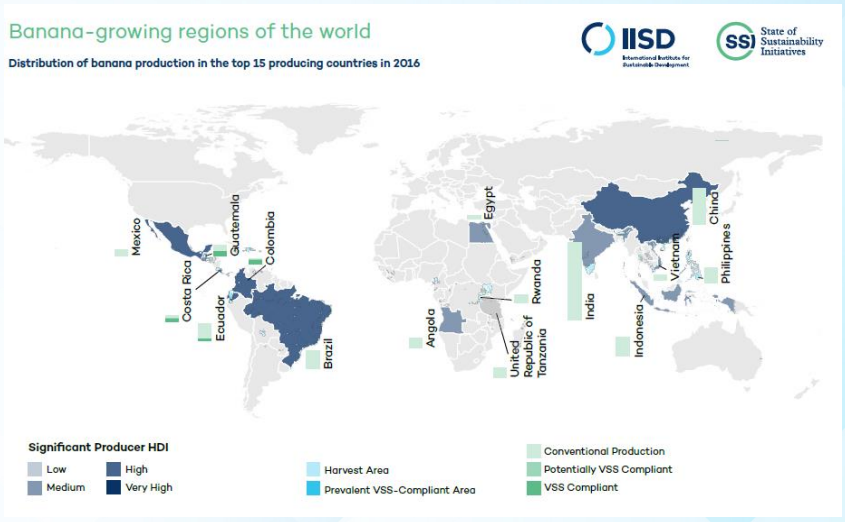
Farm gate prices, which is the price paid to the farmer at the farm and does not consider transport cost to the point of export, have remained mostly unchanged over the past decades, while the prices for raw material inputs have fluctuated, putting significant pressure on farmer revenues. The need for vertical integration in the banana trading companies is due to the specific characteristics of the way the banana trade being carried out.

Bananas are highly perishable goods, so a lack of coordination between producers, transporters, and distributors could result in big losses. Under the all India coordinate research project trial, it was identified that the loss percentage during the handling of banana vary in different segments. The average postharvest loss was more in retail level (approx. 16%) followed by the wholesale market (8.6%). This reflects the need for making sea change in the way the produce being handled.



Postharvest loss at different level in different states, Kerala (Nendran), AP (KCKeli), TN (Poovan), MH (GN) and KN (Ney poovan)

Low volume export of banana is due to improper pre- and post-harvest practices like, not following GAP which includes right choice of plant, planting methods, bunch covering, growth regulator sprays, non-ideal post-harvest practices, transport procedures, lack of proper storage facilities, outdated banana handling practices etc. Due to mishandling of produce about 25-40% is being wasted. This leads to price imbalance and large price variations both spatial and temporal, which disheartens farmers.



Another big challenge for banana cultivation with warmer temperatures is the spread of pests and diseases. Farmers who grow banana, may abandon banana when climate change makes the cultivation less viable. A threat to production derives from the potential return of the El Niño weather phenomenon, which affected production heavily in several regions. With the increasing temperature, the demand for water is projected to increase by 12-15%.

The increased uptake of voluntary sustainability standards (VSSs) in the banana sector is another important development to watch, especially given the pace of this uptake in recent years. In 2016, 7% of banana production was VSS-compliant—a notable development given that these standards were almost non-existent in the sector about a decade ago. That same year, 1% of production was potentially VSS compliant, while conventional banana production accounted for 92% of the market. VSS-compliant banana production, which at first primarily came from smallholders, expanded significantly at the turn of the century, as large plantations owned by Dole,

Fyffe, and Chiquita became certified. Worldwide banana that complies with voluntary sustainability standards (VSSs) accounted only seven percent of total production. Among the standards Rainforest alliance handles the maximum area followed by organic and fairtrade international. VSSs continue to play an important role in helping to address the sector's sustainability challenges, since the criteria embedded in each standard, which certified plantations and producers need to comply with, encourage the improvement of agricultural practices. These criteria include soil conservation measures that can enhance crop yields and the resilience of banana plantations to climate change, the definition of minimum and living wages for workers, and the application of integrated pest management measures.

The mode of transport is the factor that continues to change the industry, 74% of perishable reefer cargo will be carried by containerships in the years to come – that will provide up to 95% of overall reefer capacity. Worldwide trade in perishable products continued to increase in 2010, with seaborne trade following suit, so demand for reefer capacity is still inherently strong. Traditionally, most of the refrigerated "reefer" seaborne trade was transported in specialized "reefer vessels", i.e. ships where the entire lot is cooled, and cargo is loaded for example on pallets. Today, refrigerated cargo is increasingly containerized, making use of "reefer containers". In banana, the containerization rate was only 33 per cent. Refrigerating entire holds is considerably cheaper than refrigerating cargo in individual containers, each with its own integral power unit.

Controlled atmosphere, controlled humidity, remote access monitoring, enhanced air flow, better insulation materials and techniques and internal monitoring controls are essential for successfully enhancing the shelf life of banana to more than 30 days.

Some of the major obstacles faced by the banana exporters are;

- Insufficient coordination among border agencies, multiple border controls
- Long waiting times loading/unloading port reducing the quality, thus final price of perishables
- Non-availability of online export documentation processing
- Lack of cross-border data harmonization and use of international standards/norms country wise
- Non availability of traceable and certified material for exports
- Basic infrastructure and cold chain management
- Lack of aggressive working by the banking and insurance companies in the fresh agro-export sector and farming sector, largely affecting funding given by government banking/pvt sector. This leads to pushing the farmers for borrowing finance at higher interest, lowering risk taking ability for export
- Export requires numerous documentations during registration process as well traceability charts are required by importers which are time consuming and tedious making Indian farmers hesitant as majority have low literacy. eg: Sedex / ISO / Global gap. Understanding the minimum residue level standards required in international market by implementing international certifications is required.

- As there is no presence of single window, there are many documentations which are replicated losing time value which is most important in perishable exports. This requires advanced managerial competencies in very different domains—such as trade policies, business process analysis, change management, electronic business and information technology management and standards, legal issues and single window architectures.

Strategies for boosting banana export in India

Considering the price volatility in the international market, following measures could provide the road map for keeping Indian banana off-shore in newer markets besides the traditional markets.

Identifying push and pull factors

Forward and backward improvements in banana is essential for getting higher quality banana and improvement in trade. There is a need to promote the adoption of quality planting material production (Tissue culture plants, identification of good mother block, selecting disease free orchards for the suckers, uniform suckers) for all the varieties for cultivation. **Productivity map for the zones may be done to provide specific production strategies for different regions**.

Enabling IoT/ AI based data driven ecosystems

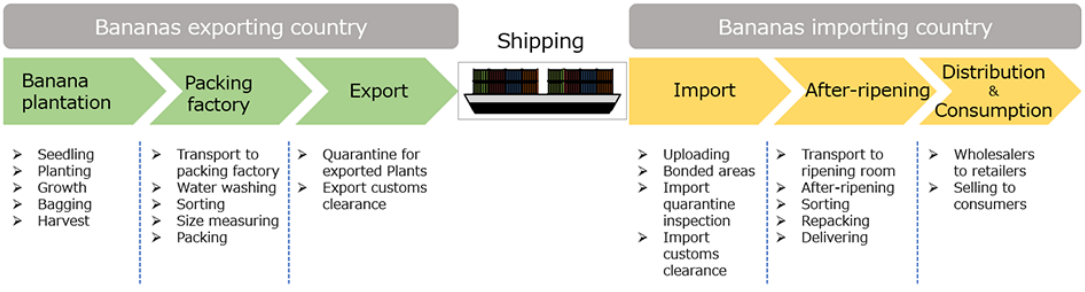
Developing methodologies based on input-output models which provide information about the cluster wise production of banana and could identify the major catchments for supplying the fresh produces. This will allow in calculating the impact of any change in the supply chain. Enabling start-ups, skill development, identifying innovations through value chain approach and developing IoT/ AI based ecosystems, sensor-based production linked with the demand of present and future markets.

Change in banana production and market driven high throughput cultivation

Production technology of modern lines needs to be demonstrated to the growers on a massive scale. The production processes depend on less external inputs - manures, plant protection measures which would lead to better net incomes by reducing the input cost. **Cluster formation or co-operative farming for procurement** of all the inputs on collective basis, better implementation of the technologies, credit approval, better price realization are needs to be strengthened and encouraged. **Traceability of the farm** should be given importance with the stricter adherence to good agricultural and handling practices and complying to certification procedures. Farmers need to be educated about export requirements and international quality standards. Unlike other countries where the banana is grown in larger area and monitored by big firms, Indian banana industry is highly fragmented. Time has ripened that the farmers have to work together and should "**widen the circle of banana growing regions**" by coming together. This will reduce the input cost and enhance uniform maintenance of plantations and thus able to get uniform quality, exportable bunches and also reduce the cost for acquiring GAP certification for the orchards.

Development of robust supply chain infrastructure and logistics system

The supply chain in banana has to be shortened to reduce the travel cost, starting from production site to port. The days taken and the cost incurred for inland transport cost make the banana export less competitive. Efforts should be made to waive off the inland transit cost across



the states. **The concept of creation of linking farms with the collection centres and then to the primary processing centres needs to be promoted**. Farmer's producer organizations could be equipped with the better farming infrastructure including cable way conveyor system and the creation of APEDA certified pack houses to ease the export of banana from different regions. Banana specific export zones could be created with the provision of tax holidays to the entrepreneurs to sustain the banana industry. Development of exclusive railway transport system connecting different banana growing regions may also be mooted.

Branding, stop in plug-in and plug-out of banana trade

Indian bananas are generally sold with 30% lesser cost than Philippines and Ecuador. This is mainly due to irregular bunches, finger size, and poor postharvest handling practices. Quality control, packing and marketing are other problems faced by the exporters. Identification of banana growing clusters specifically for the export of banana and creation of clusters of cottage or small scale industries under a central unit need to be promoted for processing the fruit under standard specified conditions and practices. Packing, branding and marketing has to be done by the central unit. Efforts have also to be made for developing cost effective suitable packing material for banana export and to standardize the packaging techniques to have consistent quality for traditional varieties.

Regulation of market and ease of doing business

Government may take steps to reduce the GST cost for packages. It will be advisable to have some working arrangements for ripening of banana arrival in importing countries on a regular basis. New markets have to be tapped other than vertical penetration in the traditional market. Government agencies must come out with the **strategy for demand forecasting** and accessing more data points to provide real time movement of commodities through APP based services and tapping IoT/ AI platforms.

Inclusion of banana as the commodity in bilateral agreements and providing tax holidays

Banana could also be suggested as the tradable commodity when the bilateral agreements being signed between the countries and to reduce the customs duty upon arrival. The entrepreneurs have to be encouraged with the tax holidays, reduction in GST, providing special Green channel at

port, reduction in handling time from 8-10 hrs to within two hrs. Fast clearance in port by single point inspection for phytosanitary, quarantine and customs procedures.

Traceability and block chain

When dealing with international regulators and buyers, showcasing product adherence to quality and safety factors are critical factors in gaining the credibility and trust of the buyer. 67% of India's exporters are one-time exporters. A high percentage of exporters today cannot export on a regular basis as they are unable to meet or showcase the compliance standards required. Most Western country's buyers today are increasingly seeking traceability and transparency metrics to approve any produce. Showcasing traceability and transparency is a necessity. Traceability on farm and crop management for quality yield of crops, adherence to quality standards and certifications and end to end traceability are essential for building confidence among the buyers and consumers.

Development of processing unit for downstream processes

Export units pushes to generate enormous rejects, it has to be absorbed with sophisticated, robust internal market or through development of processing clusters. Unlike developed countries, the food processing sector in India is dominated by the unorganized sector, contributing more than 80% share. Building infrastructure especially for converting banana into healthy powder, puree which has greater nutritional potential and could be used in functional food markets with its pre-biotic characters. Using the banana wastes for the production of innovative / novel products like nutraceuticals, bio colourant, through encapsulation methods and developing synbiotic foods are needed to be promoted.

Specific government policy measures to enhance competitiveness for exports

The global agricultural exports are approximately $1.57 trillion as per the WTO International Trade Statistics (2015). India's share in global export is about 2.2% and India ranks at 9th position in the world. Infrastructural bottlenecks have prevented wide adoption of e-NAM. Even mandi regulations have prevented effective functioning of this platform and helped in fair price discovery for farmers. Over the years, Indian government took many steps to boost the banana trade in the oversees market and thereby double the farmers income and roping in new farm laws. The new policy aimed to increase India's agricultural export to US$ 60 billion by 2022 and US$ 100 billion in the next few years with a stable trade policy regime. Government took initiatives for pre-harvest linkages, strengthening market access, provides new regulatory mechanism like contract farming without affecting farmers interest, e-government initiatives, impetus for organic farming and bridging the gaps in infrastructure development. Disaggregated production creates problems for processors. The Government is proactively addressing it through National Bank for Agriculture and Rural Development (NABARD) and Small Farmers' Agribusiness Consortium (SFAC), which are developing Self Help Groups (SHG) and Farmer Producer Companies (FPO). Additionally, Small Industries Development Bank of India (SIDBI) is available to address the all-important micro, small

and medium enterprises, to improve credit penetration to Small and Medium Enterprise (SME) processors.

Focus is given to develop export-oriented infrastructure in the identified cluster areas where integrated post-harvest, processing facilities, laboratories etc. Financing facility of Rs. 1,00,000 crore is provided during 2019-20 for funding Agriculture Infrastructure Projects at farm-gate & aggregation points (Primary Agricultural Cooperative Societies, Farmers Producer Organisations, Agriculture entrepreneurs, Start-ups, etc). The organizations like MIDH, MoFPI, APEDA, NHB and NHM are supporting the entrepreneurs through various subsidy and grant schemes through public private partnership mode. The infrastructure gaps identified has been taken up with State Govt. for generating proposal for funding support under TIES/KISAN SAMPADA Yojana/MIDH. NABARD announces many venture capital fund for equity investment in agriculture and rural-focused start-ups for enhancing the quality of the production. Initiatives are taken to improve the logistics, APEDA liaising with airport/sea port authorities e.g. Air India, Airport Authority of India, Port Trust authorities and CONCOR for early redressal of logistic issues. Government mooted to triple the capacity of food processing sector in India from the current 10 per cent of agriculture produce and has also committed Rs 6,000 crore (US$ 936.38 billion) as investments for mega food parks in the country, as a part of the Scheme for Agro-Marine Processing and Development of Agro-Processing Clusters (SAMPADA). Government of India during the past decade focused its energy to develop and promote more and more start-ups who can develop better ecosystem and develop a sustainable business model. A recent initiative of one district one product (ODOP) and cluster based processing are right approaches to boost the food processing which is less than 5% for the past three decades in spite of being the sunrise sector. Countries like Philippines, Ecuador and Costa Rica are better organized and have large sized banana plantations owned by international companies. Therefore to enhance competitiveness following measures need to be taken for making available quality banana of international standard.

- Production technology of modern lines needs to be demonstrated to the growers on a massive scale. Traceability of the farm should be given importance with the stricter adherence to good agricultural and handling practices.
- Farmers need to be educated about export requirements and intentional quality standards.
- Protocol for postharvest handling of traditional banana varieties like Nendran, Ney Poovan and Red banana need to be perfected for shipping by sea. Specification and grade standards should be made available for each banana varieties.
- Banana holding in the India are very small and it is not possible to install cable ways for transporting bunches from field to packhouses to avoid bruises. Under these circumstances, group of farmers need to be encouraged to have system of make shift pack houses, to cut hands from bunches in the field itself and send these hands to central packhouse for further processing and packing.
- Most modern packhouse facilities need to be created. The concept of creating of linking farms with collection centres and then to the primary processing centres to be promoted. Farmer's producer organizations could be equipped with the better farming infrastructure

including cable way conveyor system and the creation of APEDA certified pack houses to ease the export of banana from different regions. Banana specific export zones could be created with the provision of tax holidays to the entrepreneurs for sustain the banana industry.

- It will be advisable to have some working arrangements for ripening of banana arrival in importing countries on a regular basis. It is suggested that training to packhouse workers about postharvest handling technology and also international quality standards must be imparted.
- It is suggested that training to pack house workers about post-harvest handling technology and also about international quality standards must be imparted.
- Banana could also be suggested as the tradable commodity when the bilateral agreements being signed with the countries and to reduce the customs duty upon arrival. India should get the Most favoured Nations (MFN) when trading banana with other countries with zero or reduced tariff to be competitive in the market.

Conclusion

It is for sure that the world is switching to new normal in the way the export and food businesses are done around the world after COVID-19 pandemic. Traditional methods of production and supply chain including logistics will change and the future trade will empower the farmers with the congregation of clusters, adoption of AI/ IoTs and having more voice in the government policies. Through the combination of farmer's cooperation, technological upgradation, establishment of processing industries and favourable policies, the banana trade from India could make more impact and foot print in the world trade including the domestic trade across states. Ultimately, branding and boosting the entrepreneurship through providing incubation platforms, providing marketing intelligence and handholding for technological backup are requisite in the coming days to sustain the banana production and to create robust supply chain management with better profit and sustainability.

GI and traditional Banana varieties of India

Saraswathi M S*, Durai, P, Backiyarani S* Uma S* and Selvarajan R*****

*Principal Scientist, **Technical Officer, ***Director
ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India - 620 102
Corresponding author:saraswathimse@gmail.com

Introduction

Bananas are said to have originated some 10,000 years ago and believed to be the world's first fruit domesticated by man. This is popularly called as 'Poorman's apple' owing to its nutritional richness equivalent to that of apple but at an affordable cost. They contain good amount of fiber, several antioxidants with very little protein and almost no fat. They have low calorific value and major proportion of water and carbohydrates which makes it a filling fruit and also aids in weight loss. India being one of the major centres of origin, it harbours a wide range of banana cultivars belonging to different ploidies, genomic groups and subgroups besides 34 wild taxa belonging to two genera of the Musaceae family viz. *Ensete* and *Musa*. Only 50% of the varieties are commercially cultivated and the rest are still confined only to certain pockets. Among the commercial varieties, cv. Grande Naine dominates the banana industry contributing to 63% of the total production. Monoclonal system in place of polyclonal system of cultivation, has inadvertently led to slow decline in the area under cultivation of traditional and GI tagged banana varieties. Therefore, its high time that we popularize the traditional and GI tagged varieties among the consumers.

Traditional varieties are those local varieties of banana which are selected and grown traditionally by farmers over generations in a particular place or locality. They are usually well adapted to local environmental conditions, therefore they are highly risk-resilient giving a stable yield. They have an outstanding taste, quality and uniqueness meeting the consumer preferences. They are well knitted with the local culture and customs. Many such traditional varieties exist all over the world including India. But unfortunately they are either forgotten or underutilized leading to the reduction in area under traditional varieties and diminished the diversity. Further it is difficult to get a good price for traditional varieties because the present day consumers are not aware of such varieties.

The potential of such banana varieties should be explored and brought back into cultivation so that they do not become extinct. Conservation of such traditional varieties not only enhances the biodiversity of farm land but also ensures food and nutritional security.

1. Matti (AA)

Its distribution is restricted to southern tips of Tamil Nadu particularly Kanyakumari of Tamil Nadu and Kerala. Fruits are being used as weaning food for babies. Immune to Fusarium wilt diseases.

Morpho-agronomic characteristics

Plants are medium sized whose height ranged from 2 to 2.2m. Pseudostem is yellowish green with the petiolar base having dark purple blotches on their sides. Leaves are erect and greenish yellow in colour. Petiolar canals are open with spreading margins whose edges are pink coloured. Petiole base is free and has dry wings. Peduncle is very short with 20-25cm length and pubescent in nature. Bunch is slightly angular or sometimes horizontal in position. There are 8-10 hands of fruits in a bunch and are very compactly packed. Bunch weight ranges from 7-15kgs. Male bud is purple in colour and the bracts are slightly imbricate in nature, lanceolate in shape. Male flowers are whitish and the stigma is yellow in colour. Fruits are slender and has lengthily bottle necked tip. Green in colour and turns very attractive golden yellow upon ripening. Base of the style is persistent. Fruit pedicel is very short measuring 4-6mm. Pulp is juicy, deep creamy in colour, sweet taste and good aroma. Fruits do not easily drop off from the pedicel. Duration of the crop is 14-15 months.

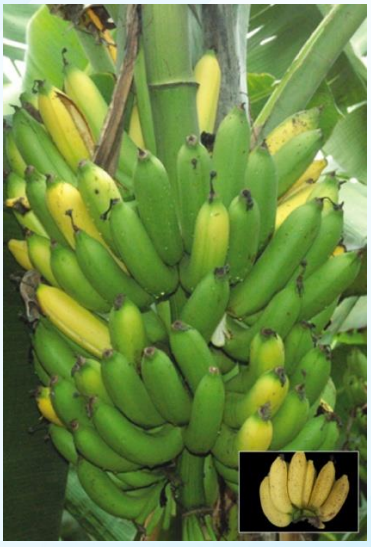
2. Semmatti (AA)

This has restricted distribution in southern parts of Tamil Nadu. Semmatti is also called as Sanna Chenkadali, which indicates their slenderness of the fruits with red skin. Immune to Fusarium wilt diseases and hence being used as both male and female parent in banana improvement programmes. Fruits are considered to have therapeutic values and rich in carotenoids. Used in breeding programme to impart tolerance to leaf spot diseases (*Mycosphaerella eumusae*).

Morpho-agronomic characteristics

Plant is slender in stature. Pseudostem is 2.0-2.10 m height with 60-65 cm circumference at its base and light reddish in colour with dark blotches both below and on the upper sides of the petiolar base. The leaves are narrow and erect with the adaxial side purplish in colour. Petiole is also light purple in colour and the petiolar canal is narrow and open type. Peduncle is hairy, 20-25cm long. There are few hands of neutral flowers which are persistent just below the bunch and the remaining are deciduous in nature. Bunch is slightly angular in position. There are 7-8 hands of fruits are in a bunch and are compactly placed and completely turned towards the stalk. Male bud is deep purple in colour and convolute in nature. Bract scars are predominant. The basal portion of the compound tepals are slightly pink tinged on the outer sides. Style is white and the stigma is yellow. Fruits are thin, reddish skin and ended with lengthily pointed tip. Fruit tip bears dried persistent stylar base. Pulp is juicy, soft, acidic taste and has an aromatic flavor. Ripened fruits are reddish in colour. Fruits turn green when grown under stress. Crop duration is 12 months. This is actually being conserved in the home gardens and not under commercial cultivation.

3. Amritsagar (AAA)

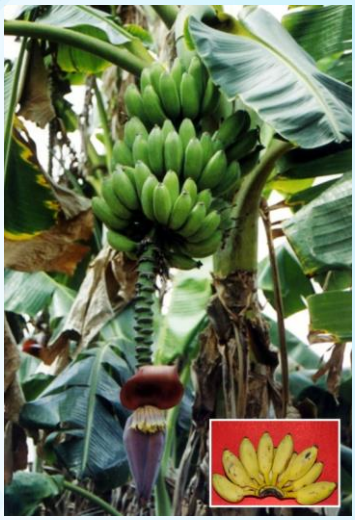


Amritsagar is an unique member of the Cavendish sub-group with good aromatic fruit pulp. This has high carotenoid content (Pro Vitamin - A) compared to other members. Owing to the fragrance and excellent fruit quality, it has been elevated from a backyard to commercial variety in North eastern states of India like Tripura, Mizoram and Nagaland by the name Mizo Cavendish. This performs well in sandy loamy soils. This is susceptible to Sigatoka leaf spot diseases and scarring beetle.

Morpho-agronomic characteristics

Plant is medium statured, with 2.0 to 2.5 m height. Pseudostem is green, with brown black blotches particularly on the sides of the petiolar bases. Petiolar bases are free and have very attractive pink colored margins. Petiolar margins are curling outward. Peduncle is green and hairy in nature. There are 5-6 hands of fruits in a bunch and are loosely packed. Bunch has no definite shape. Bunch weight ranges from 10 -12 kgs. Fruits are completely turned towards the peduncle. Fruits are green in colour and turns golden yellow upon ripening. Pulp is orange yellow in colour, juicy and has good aroma. Male axis is slightly angular in position with a conspicuous bend at the middle. Crop duration is 11-12 months**.**

4. Bhatmanohar (ABBB)



Bhatmanohar is a natural tetraploid (ABBB) reported for the first time in India. It has been collected from the Namsai forest range of Arunachal Pradesh. This has been classified as a member of Pisang Awak subgroup. Fruits are very sugary and tasty like other Pisang Awak members. It is resistant to leaf spot diseases, female fertile, used in banana improvement programme. Flower bud is used as vegetable and used in the preparation of pickles, figs and wine etc. It performs well in the Pisang Awak grown areas.

Morpho-agronomic characteristics

Plant is medium statured with 2.5 – 3m height. Pseudostem is green with pink shades like any other Pisang Awak group members. Leaves are green, not shiny and droopy in nature. Petioles are tightly clasped on the pseudostem and slightly wax coated. Petiolar canal is narrow with erect margins. Petioles are slightly droopy in nature and the laminar bases are asymmetrically rounded. Bunch is pendulous in position and cylindrical in shape. There are 8-10 hands of fruits in a bunch. Fruits are short or stout with blunt tip. Pulp is very sweet in taste with 29-31^{o}Brix. Male bud is purple brown colour and male flowers are pink shaded. Crop duration is 15-16 months.

5. Borchampa (AAB)

Borchampa belongs to Mysore subgroup. It is the shortest variety of all the members of Mysore subgroup with 1.8 to 2.2 m height. Fruits are very bold Like Maio Popoulu, 9 to 10 cm long with 16 to 18 cm circumference at the middle. Fruit weight ranged from 120 – 130g. It is the most fragrant type among the members of Mysore sub-group. This has a very short duration of 9-10 months when compared to other Mysore group members. .

Morpho - agronomic characteristics

Pseudostem is green with black brown blotches and slightly ash-coated. Leaves are dull coloured and droopy in nature. Matured leaves have green coloured midrib while younger leaves have pink coloured midrib. Petiole is green, 30-40 cm long and has wide petiole canal with erect margins. Pink line runs along the edges of the margins. Petiolar base clasp the pseudostem with its margins. Bunch is smaller in size and has only 3-4 hands of fruits. Male axis is falling vertically downwards and has bold bract scars with maximum interspaces and barren appearance.

Male bud is small, top shaped and dark purple in color. Male bracts are dark purple on outer and crimson red on inner surface. There are medium grooves on outer surface with moderate wax coating. Tip is gradually pointed without yellow tinges. Bract falls after the flowers, before falling, they both reflex and revolute. Male flowers are cream in color. Stigma is pure white, straight, bears five unequal orange colored lobed stigma. Fruits are dark green, short 9-10 cm long and very stout with 16-18 cm circumference at the middle, with a blunt tip like Mottapoovan. Each fruit weighs 120 – 130 gram. Pedicel is more than 1 cm long and fruits do not easily drop off from the pedicel. Fruits turn yellow color upon ripening. Pulp is cream colored, juicy and sweet with aromatic flavor.

6. Borkal Baista (ABB)

Borkal Baista which grows in the forest ranges are also nurtured by the tribal communities of Assam, Manipur and Tripura in their backyards. This is more or less parthenocarpic in nature with occasional seed setting. Fruit pulp is very sweet with 30 – 32 ^{0} Brix. Borkal Baista is also resistant to major pest and diseases. It is valued for its therapeutic uses by North Eastern Indian tribes as coolant. Central core and male flower bud is used as vegetable. Tribal people prepare pickles from the male bract and flowers. Although it exhibits more of *M. balbisiana* traits, ploidy analysis using flow cytometry revealed its triploid nature.

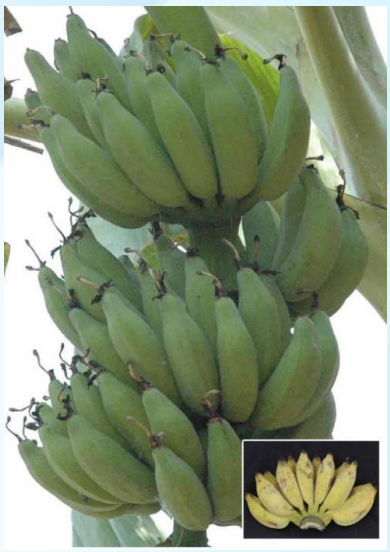
Morpho-agronomic characteristics

It is tall and robust plant with minimum 18 ft height. Pseudostem is dark green, shiny and has pink coloured blotches. Leaves are dark green and drooping. Petiole bases are very tightly clasped on the pseudo stem. Brown blotches are appears on the sides of the petiole bases. Peduncle is green, glabrous and short with 30-40 cm length. Bunch weight is 20-25 kg. There are 10-15 hands of fruits in a bunch and are loosely packed. Fruits are ash coated. Fruit have very long pedicel 2.5 to 3cm measuring. Fruit tip is blunt. Rachis is more than 1.5m in long. Male bud is purple brown in colour, huge and almost round in shape. It is resistant to Sigatoka leaf spot diseases and tolerant to extreme cold weather conditions. It is highly female fertile. Pulp is very sweet (30-32^{o}Brix).

7. Kechuleppa (ABB)

Kechuleppa is one of the unique ABB accessions found in the homestead gardens of Assam and Tripura of North Eastern India. It has the potential to yield upto 25 kgs. Fruit pulp is very tasty with TSS of 32^{o} Brix. Fruits do not easily drop off from the pedicel. This set seeds when crossed with suitable male parents. Fruit peel is very thick. Keeping quality is appreciable. Suitable for making value added products like banana wine, juice and figs. Droopy leaves, propping is not required, resistant to shattering even at full ripeness.

Morpho-agronomic characteristics



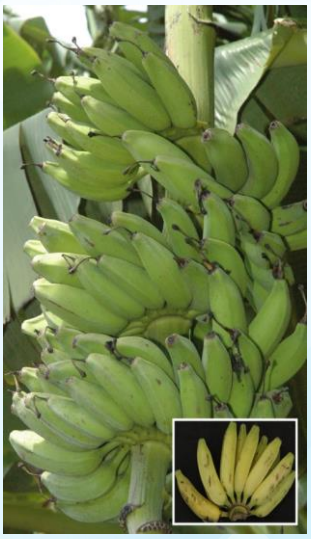
It is characterized by tall and robust stature. Pseudostem is very tall with 3-3.5m height and 75 – 80 cm circumference at the base; colour of the pseudostem is green with pink streaks. Leaves are dark green and drooping in nature. Shiny on the upper while lower side shows dull with maximum wax coating, midrib is green on upper surface but it is watery green on lower surface. Laminar bases are asymmetrically auriculate round. Petioles are long and bigger, more than 50 cm in length and has narrow canal with erect margins. Green colour petiole is completely wax coated. Brown black blotches appear on the sides of the petiolar base and they tightly clasp the pseudostem It yields 20-25 kg bunches. Crop duration is about 15 months. Bunch is bigger with cylindrical shape. There are 8-10 hands per bunch and 12-14 fingers per hand. Male axis is 70-75 cm in length, has medium bract scars, few hands of neutral flowers are persistent just below the bunch and few bracts and flowers are persistent above the male bud. Male bud is ovoid in shape, purple brown in colour and fully wax coated. Male flowers are pink tinged. Fruits are tapers towards the distal end and have persistent style at the tip. Fruit tip is lengthily pointed. Pulp is very sweet, with 30-32^{o}Brix.

8. Krishnavazhai (AAB)

Krishnavazhai belongs to Pome subgroup. Pseudostem is completely covered by the black pigments which extend upto the underside of the midrib. Pseudostem looks black hence the name Krishna Vazhai. Pulp cream in colour, sweet in taste with good aroma and is used in the preparation

of Panchamirtham (a delicacy). Crop duration is 14-15 months. It is more suitable for cultivation in higher altitudes under perennial system of cultivation with wider spacing. It is susceptible to Fusarium wilt (race 1), pseudostem borer and rhizome weevil.

Morpho-agronomic characteristics



Stature is medium tall with 2.5 2.75 m height. Pseudostem is completely black pigmented, which extends on the ventral side of leaf midrib. Leaves are more towards erect and the petiole is 30-40 cm in length and has wider canal with erect green coloured margins. In young leaves, the margins are pinkish in colour. Peduncle is slightly hairy and horizontal in position. 6 – 7 hands of fruits in each bunch and are loosely packed with maximum space. Male axis is hanging vertically downwards, barren, rachis bears medium bract scars. Just above the bud, pink pigment appears as blotches on the rachis. Male axis is whiplash in shape with stalk diameter reducing very sharply. Male bud is top shaped and maroon in colour. Male sterile and anthers get aborted before bunch maturation. Bunch is cylindrical in shape. Fruits are easily detachable from the pedicel when it is over ripen. Pulp is cream in colour and very sweet in taste.

9. Nutepong (ABB)

Nutepong is one of the lesser exploited landraces of India. It is being grown by the tribal community of North Eastern India in their backyards. It is a high yielding landrace, yields upto 30 – 35 kgs bunches. This is more suitable for marginal cultivation and tolerant to cold and snowstorm. Matured and unripe fruits are more preferable for making banana snacks like bhajji (a special snack in south India). Fruits are meant for mainly for cooking and sometimes as a dessert when no other banana varieties are available in the market. No incidence of Fusarium wilt is recorded under field conditions. This valuable accession should be exploited for their better yield and quality through commercial cultivation.

Morpho-agronomic characteristics

It belongs to Bontha subgroup. This is robust statured with 2.75– 3 m height. Pseudostem is pale green in colour and slightly shiny. Leaves are normal and dark green in color and glabrous. Laminar bases are symmetrically rounded. Petiole is yellowish green in colour, 45-50 cm in length. Petiolar base is tightly clasping the pseudostem and light brown black blotches appears on the sides of petiole bases. Petiolar canal is narow and the petiole margins are green in colour and have dry wings. Peduncle is long measuring 75cm and pendulous in position. Bunch is pendulous in position and cylindrical in shape. Yields about 30- 35 kgs bunches. There are 7-9 hands of fruits in a bunch, which are moderately packed. Male axis is 70 to 80 cm long, barren, hanging downwards. Male bud is purplish red in colour, intermediate in shape and the male flowers are pink.

Fruits are bold, green, 18-20cm long with gradual tip. Starchy fruits are more suitable for making banana bajji and other snacks of south India. Crop duration is 12 - 13 months.

10. Pagar Banana (ABB)

Pagar Banana is yet another lesser exploited landrace of India. It is being grown by the tribal community of North Eastern India in their backyards. It is high yielding landrace producing 10-15kgs bunches. This is more suitable for marginal cultivation. It is a dual purpose variety used as dessert when no other varieties are available in the market. It is tolerant to cold. This should be exploited for their better yield and quality through commercial cultivation.

Morpho-agronomic characteristics

It is an unique type with brown colour male bud and orange yellow flowers in ABB genome. Tall and robust plant with 4-5 m height. Pseudostem is green in colour. Leaves are normal, green and dull in appearance. Peduncle is glabrous, green and slightly angular in position. Bunch is slightly angular in position. 7-8 hands of fruits per bunch and are loosely placed. Fruits are angular, flattened, green in colour, blunt tip and starchy type. Fruits turn golden yellow upon ripening. Crop duration is 15-16 months.

11. Thiruvananthapuram (AAB)

The distribution is restricted to Kerala, Andaman and Nicobar Islands. Immune to leaf spot diseases. Excellent fruit retention even at full ripeness. Used in Siddha medicine. Nutritional banana with good carotenoid content.

Morpho-agronomic characteristics

Unique type with medium stature. Leaves are drooping. Pseudostem is watery green, petiole base is free. Peduncle is hairy. Bunch is angular in position. Male bud is huge and male flowers are orange yellow in color. Pollen sacs are magenta pink in color Pulp is orange in color with good aroma. Yields 8-10 kg bunches. Crop duration is 12 months.

12. Pacha Bontha Batheesa (ABB)

Pacha Bontha Batheesa is one of the lesser exploited landrace of India. It is being grown by the people of Bihar and West Bengal in their backyards. It is high yielding landrace, yields up to 30 – 35 kgs bunches. Matured and unripe fruits are more suitable for making vegetable. Bunch is very long with more than 25 hands of fruits, towards the terminal ends the fruit size is drastically decreasing in size.

Morpho-agronomic characteristics

It belongs to Monthan subgroup. It is robust statured plant with 2.75-3 m height. Pseudostem is pale green in colour and slightly shiny. Leaves are normal and dark green in color and glabrous. Laminar bases are symmetrically rounded. Petiole is yellowish green in colour, 45-50 cm in length. Petiole base is tightly clasped on the pseudostem and light brown black blotches are appears on the sides of petiole bases. Petiolar canal is narrow and the petiole margins are green in colour and have dry wings. Peduncle is long with about 75cm and pendulous in position. Bunch is pendulous in position and cylindrical in shape. Produce 30- 35 kgs bunches. There 22 to 25 hands of fruits in a bunch, which are very closely packed. Normally no male axis, (extended female phase) rarely male flower bud is present, Male bud is purplish red in colour, intermediate in shape and the male flowers are pink. Fruits are bold, green, 18 -20cm long with gradual tip. Starchy fruits are more suitable for making curry. Crop duration is 12 - 13 months.

13. Manoranjitham (AAA)

It is an unique AAA type endemic to Kolli hills of Tamil Nadu. Grown by Malyali tribes in their backyards and offered to Kongaiyye Amman. This is nearing extinction due to the rampant spread of fusarium wilt. It is a fragrant banana smelling like Manoranjitham flowers (*Atrabotrys odaratissimus*). Immune to leaf spot disease.

Morpho-agronomic characteristics

Pseudostem is green with black blotches. Leaves are normal, petiolar base is free. Peduncle is green and hairy. Bunch is compact. Fruits are dark in green. Male bud is maroon in colour. Male flowers are orange yellow in colour. Pulp is sweet with good aroma. Immune to leaf spot disease. Dark green fruits turn yellow upon ripening. Highly susceptible to Fusarium wilt. Crop duration is 13-14 months.

14. Peyan (ABB)

The distribution is restricted to Tamil Nadu, Kerala, Andhra Pradesh and Karnataka. Fruits are very tasty fruit with Sapota flavor. Immune to leaf spot disease and Fusarium wilt (races 1 and 2), fruits remain persistent even at full ripeness. Suitable for perennial cultivation.

Morpho-agronomic Characteristics

Tall and robust statured. Leaves are very long measuring 2-2.5 m. Pseudostem is greenish with ash coating. Dark blotches appears on the petiolar base. Peduncle is glabrous and slightly angular in position. 8-10

hands of fruits, which are loosely packed. Fruits are silvery green, flattened, angular, tapers towards the apex. Male bud is lanceolate, purple in colour, ash coated and imbricate. Fruit skin is very thick. Pulp is orange in colour, juicy, sweet with aromatic flavor.

15. Dudhsagar (AAB)

Restricted distribution in North eastern part of India, Karnataka and Kerala. Fruits are dessert, aromatic, and flavored fruit. Immune to both Fusarium wilt (race 1) and Sigatoka leaf spot diseases. Maintained in backyard for its quality fruits and freeness from major biotic and abiotic stresses.

Morpho-agronomic characteristics

Medium statured and pseudostem is bluish green in colour. Leaves are dark green with dull appearance, Petiole base is free. Peduncle is short and pubescent in nature. Bunch is pendulous in position. 5-6 hands of fruits, and are loosely packed. Fruits are short, stout, and dark green in colour. Tip is gradual. Male bud is maroon in colour, ashy coated, lanceolate in shape and slightly imbricate. Dark green fruits turn yellow upon ripening. Pulp is sweet, juicy with good aroma and flavour. It has excellent fruit quality. Crop duration is 14-15 months.

16. Kunnan (AB)

Distributed in Southern Tamil Nadu and Kerala. Used for the preparation of infant foods. Field tolerant to Sigatoka leaf spot disease. Pulp is starchy when unripe but turns very sweet after ripening. Tolerance to leaf spot diseases and suitability for marginal cultivation, has made it popular in homestead gardens.

Morpho-agronomic characteristics

Plant is medium in size. Pseudostem is yellowish green with dark blotches. Leaves are erect, dark green leathery, wax coated on the lower surface. Petiole length ranges from 60-65cm and the petiolar canal is closed type. Petiole base is tightly clasped on the pseudostem. Peduncle is dark green, glabrous, 20-25cm long, slightly angular in position. Bunch is truncated cone in shape and the hands are compactly packed. Length of the fruits ranges from 12-14 cm, tapers towards the apex. Fruits are strongly attached with pedicel. Pulp is firm, starchy with moderate sweet taste. Immune to leaf spot disease. Crop duration is 14-15 months.

17. Poovillachundan (AB)

Distributed in Southern Tamil Nadu and Kerala. Very long fruits, Dessert. Used for the preparation of infant food. Field tolerant to sigatoka leaf spot disease. Usually male flower bud is absent. When the plant grows under stress the male flower bud appears.

Morpho-agronomic characteristics

Plant is 2.25m – 2.50m height. Leaves are erect, leaner, oblong, 210-225cm length, with 60-65 cm width. Petiole is yellowish green, tightly clasped on the pseudostem. Peduncle is glabrous, 20-30 cm long. Bunch is slightly angular in position. Generally male phase is absent 8-10 hands of fruits per bunch, they are loosely packed. Fruits tapers towards apex, lengthily pointed tip. comparatively smaller fruits ended with pointed tip. Ripened fruits easily drop off from the pedicel. Pulp is white, very soft and tasty. Immune to leaf spot disease. Crop duration is 14-15 months. Distributed in Southern Tamil Nadu and Kerala

18. Kadali (AB) Distributed in Southern Tamil Nadu and Kerala. Revered as sacred fruit, this variety is mainly nurtured in sacred grooves and village temples. Offered to Lord Ayyappan and used in the preparation of Pancharmirtham. This has so many synonyms viz., Neyvediya Kadali, Ney Kadali, Devan Kadali and Pooja Kadali etc.

Morpho-agronomic characteristics

It is a small statured plant. Pseudostem is yellowish green. Leaves are narrow, oblong, medium and slightly wax coated on its lower side. Petiole base is free, and margins are dark red, petiolar canal is wide and open type. Peduncle is velvetty in nature. Bunch is smaller in size, slightly angular in position. Bract scars are pre-dominant and male bud is small, maroon in color, slightly imbricate. Fruits are tapering towards the apex. Pulp is sweet, juicy, and has pleasant aroma. Crop duration is 11-12 months.

19. Padali Moongil

Distributed in Southern Tamil Nadu and Kerala. Very long fruits used as dessert and for the preparation of infant food. Each fruit weighs 130-140 g. Field tolerant to Sigatoka leaf spot disease. Usually male flower bud does not appear but if the plant grows under stress, the male flower bud appears.

Morpho-agronomic characteristics

The plant is 2.25m – 2.50m tall. Leaves are erect, narrow, oblong, 200-215cm long, with 60-65 cm width. Petiole is yellowish green, tightly clasped on the pseudostem. Peduncle is glabrous, 20-30 cm long. Bunch is horizontal in position. Generally male phase is absent. 3-4 hands of fruits per bunch. Fruits tapers towards apex, lengthily pointed tip. Ripened

fruits easily drop off from the pedicel. Pulp is white, very soft and tasty. Immune to leaf spot disease. Crop duration is 14-15 months.

20. Chinali

Distributed in Tamil Nadu, Karnataka and Kerala. Carotenoid rich pulp. Pulp is juicy, orange yellow, very sweet in taste with good aroma. Rarely seen under cultivation.

Morpho-agronomic characteristics

Normal statured. Pseudostem is greenish yellow with pink tinges. Leaves are green. Petiole margin is deep red. Petiolar canal is wider with spreading margins. Peduncle is hairy in nature. Bunch is pendulous in position. Below the bunch, the male axis is barren but remaining portion of male axis completely covered by male bracts and flowers. There are 5-7 hands fruits per bunch and they are loosely packed. Dark green fruits change into golden yellow upon ripening. Fruit skin is thick and do not easily peel off. Fruits also do not easily drop off from the pedicel. Pulp is orange in colour, sweet and juicy.

GI tagged banana varieties

Geographical Indication is a name or sign used on certain products that corresponds to a specific geographical location or origin, such as a town, region or country. GI registration is governed by the Geographical Indications of goods (Registration and Protection) Act, 1999. **It indicates a community's intellectual property attached to that particular product and prevents the unauthorised use by others. It helps the community to get a premium price for the product ultimately enabling the consumers to get quality products of desired traits.** The tag creates a distinct identity and creates an international market for it. The products are recognized for their nutritional or scientific importance at the national as well as global level. It also plays a significant role in the conservation of biodiversity which is unique to a particular location. Till date, GI tags have been provided for nearly in India including 107 agricultural crops of which seven are banana varieties.

1. Chengalikodan (GI tag No. 479-2014)

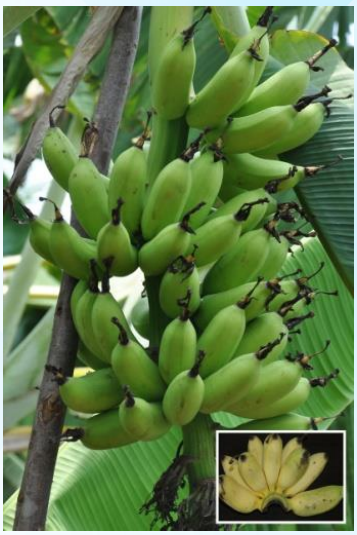
Chengalikodan is a banana variety that originated in Chengazhikodu village of Thrissur district in Kerala, India. But now being cultivated in Chowannur, Desamangalam, Erumapetty, Kaiparambu, Mundoor, Ollukkara, Pazhayannur, Puzhakkal, Thayyur and Wadakkancherry of Thrissur District. GI tag for the variety was obtained by the Chengalikodan Banana Growers' Association, Erumapetty in the year 2014. Chengalikodan banana is known for its unique shape, size, colour and taste. The average bunch bears 20 to 25 fruits per hand. It has a sugar content of 26 to 30 percent, acidity of 0.31 to 0.60 percent with a shelf life of seven to nine days. During Onam, it is offered as 'Kazhchakula' to the deity in temples all around the state, including the famous

Guruvayur Sree Krishna Temple. Due to these holy ties, the demand for this variety goes high during the festival season and the bunches are sold at a cost of Rs.1, 500 to 5,000. Susceptible to Cercospora leaf spot and pseudostem weevil.

2. Kamalapur Red Banana (GI tag No. 133-209)

Kamalapur Red Banana is a banana variety grown in Kamalapur and surrounding areas like Rajnal, Okali and Nadvinhalli villages of Kalaburagi district, Karnataka, India in a total area of about 100 hectares. It is grown only on hill slopes in the valley surrounded by hills on three sides which protects the crop from damage due to storms as the plants are very tall and hence not suitable for plains. This is grown as a rainfed crop in areas with hot and humid weather. The plant is 6.7 to 7.6 tall and robust with 0.91 to 0.98 m circumference. The leaves are greenish yellow and oblong in shape. The crop duration is 18 months producing 15 to 20 kg bunches, and is generally free from pests. The skin or the rind of the fruit is moderate red in colour with pulp being cream in colour. TSS ranges from 20-22^{o}Brix. Planting is done during August/September, and before planting, the suckers are dipped in cow dung water overnight to prevent any diseases to the plant. Fruits are rich in calcium, iron, potassium and fibre and vitamins C and B6. Calorific value is also high which could be attributed to the large amount of organic fertilizers used for their cultivation. GI tag for the variety was obtained during 2009 by the Kamalapur farming community. Advised for the treatment of typhoid patients particularly children.

3. Nanjangud rasabale (GI tag No. 35-2005)

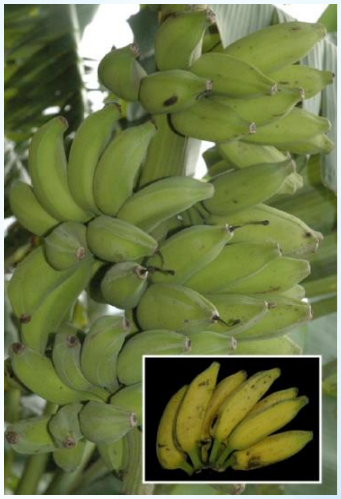


Nanjangud rasabale is a banana variety which is grown in and around the areas of Mysore and Chamarajanagar district of Karnataka, India where the soil type is black clay alluvial saline that changed the taste and aroma, giving it a particular geographical identity. Their distribution is restricted to the region between 30^{o}N to 30^{o}S latitude. A dry and humid climate is said to be the best condition for its growth. GI tag was granted in the year 2005. The great slump in the area under cultivation began when water from the Kabini dam was used for irrigation instead of rainwater in the village pond and the incidence and spread of fusarium wilt to a greater extent totally wiped out the area and presently it is cultivated in just 10 acres. The fruits are known for its sweetness, flavor and aroma. The fruits are medium sized with longer shelf life of 14 days and develops red freckles upon ripening.

4. Jalgaon banana (GI tag No. 498-2016)

This is a Cavendish type grown in Tandalwadi village of Jalgaon district, Maharashtra, India. Nisargraja Krishi Vigyan Kendra (KVK) Jalgaon acquired the GI tag for Jalgaon bananas in the year 2016. Fibre and mineral rich 'Jalgaon banana' are sent to Delhi and Dubai markets. India has exported 22 tonnes of Geographical Indication (GI)-certified fiber and mineral-rich Jalgaon banana to Dubai. This has boosted the export of bananas both in terms of volume and value.

5. Virupakshi and Sirumalai bananas (GI tag Nos. 124&125-2008)



Both the hill bananas were listed in the endangered category because of the bunchy top virus but was revived and brought back into cultivation by the sustained efforts of TNHBGF under the scientific guidance of ICAR-NRCB, Trichy and Tamil Nadu Agricultural University, Coimbatore. This is grown only in the Palani and Sirumalai hills of Dindigul district, Tamil Nadu respectively. It is grown as a shade tree under perennial system in the coffee plantations. The fruits are yellowish green in colour upon ripening with characteristic black spots. Though the fruits do not look attractive, it is a choice variety among consumers owing to its distinct taste. The famous Panchamirtham is made using these bananas and offered to Lord Muruga at Palani temple. Fruits do not easily drop off from the pedicels and the keeping quality is good. Sirumalai fruits have high medicinal value and aid in easy bowel movement. They are rich in potassium and thereby often suggested as a medicine to treat nervous disorders. So, TNHBGF (Tamil Nadu Hill Banana Growers' Federation) obtained the GI tags in the year 2008. Their efforts were recognized by PPV&FRA, New Delhi and bestowed them with Plant Genome Saviour Community Award during the year 2010 - 2011.

6. Goa Myndoli (Moira) (GI tag No. 680-2021)

This variety is grown in Pernem, Bardez and Bicholim taluks of Northern Goa along the river tributaries of Chapora and Mapusa. It grows in well drained soils rich in organic matter, iron, manganese and copper. Fruits are dark yellow in colour weighing 200g, Medium thick skin, lesser and sinfully sweet (31^{o}Brix). Myndoli Kelya Chi Halwo is the delicacy prepared from Myndoli.

Role of PPV&FRA on conservation and popularization of GI & Traditional varieties of Banana

Pilania D.S, Arun Kumar, Rajganesh, D.S, Sengar, R.S, Dubey, U.K, Chowdhury, D.R, Ravi Prakash, Dinesh K. Agarwal and Prabhu, K.V

Protection of Plant Varieties and Farmers' Rights Authority
Govt. of India, Ministry of Agriculture & Farmers Welfare, Department of Agriculture and Farmers Welfare, NASC Complex, DPS Marg, Opp - Todapur Village, New Delhi - 110 012
Corresponding author: ta-ppvfra@nic.in; +91-11-25843316

Indian Agriculture

The agriculture contributes only 21% of India's GDP, but its importance in the country's economic, social, and political fabric goes well beyond this indicator. The rural areas are still home to some 72 percent of the India's 1.21 billion people, a large number of whom are poor. Most of the rural poor depend on rain-fed agriculture and fragile forests for their livelihoods. Agriculture continues to be an integral component of the national economy and livelihood of millions of people. The farmers have been given due attention in India since ages and are known as Annadata Indian farmer has always been the lifeline of food for all the people of this country. To him we owe our daily bread and livelihood. He has been ordained the title of **'Annadatta'** the food provider or the God of food; so vital to our very existence. Times and ages have been singing glory of him and his wife 'Annapurna' the goddess of food; the land has provided him the output he so lovingly ploughed and nurtured.

Agriculture provides the principal means of livelihood for over 58.4% of India's population. It contributes approximately one-fifth of total gross domestic product (GDP). Agriculture accounts for about 10 per cent of the total export earnings and provides raw material to a large number of industries. Low and volatile growth rates and the recent escalation of agrarian crisis in several parts of the Indian countryside, however, are a threat not only to national food security, but also to the economic well-being of the nation as a whole. Agriculture is the mainstay of the Indian economy.

Farmers Rights and National Seed Policy, 2002

Govt. of India announced National Seeds Policy, 2002 to provide and an appropriate climate for the seed industry to utilize available and prospective opportunities, safe guarding of the interest of Indian farmers and the conservation of agro-biodiversity. While unnecessary regulation needs to be dismantled, it must be ensured that gullible farmers are not exploited by unscrupulous elements. A regulatory system of new genera is therefore, needed, which will encompass quality assurance mechanisms couples with facilitation of a vibrant and responsible seed industry.

National Policy for Farmers, 2007 envisages that there is a need to focus more on the economic well-being of the farmers, rather than just on production. Socio–economic well-being must be a prime consideration of agriculture policy, besides production and growth. The aim of the policy is to stimulate attitudes and actions which should result in assessing agriculture progress in terms of improvement in the income of farm families, not only to meet their consumption requirements but also to enhance their capacity to invest in farm related activities.

Farmers are an important part of the economic, social and political fabric of the society in genetic resource-rich, developing countries. Their role in agro-biodiversity conservation and innovation is acknowledged worldwide. In most developing countries, traditional farming is the foundation of agricultural production and seed supply through informal innovations by local farming communities. Traditionally, farmers across the globe have preserved plant genetic diversity while also enriching this diversity by human selection. As a result, there exist numerous landraces, conserved in-situ that show high adaptability to local conditions and other desirable characteristics such as drought resistance, pest resistance and medicinal properties. Genetic diversity in crop plants especially intra-specific variability is important for farming as it enables adaptation to variable environmental conditions including biotic and abiotic stresses. It also provides the gene sources for mitigating climate change.

Farmers Rights

Farmers being the custodians and developers of crop genetic resources, and their rights in this regard are crucial for enabling them to maintain this vital role for local and global food security, for the conservation and sustainable use of these vital resources in-situ as well as on-farm, and as a central means in the fight against poverty. It provides the pool from which plant traits can be found that meet the challenges of crop pests and diseases, of marginal soils, and- not least- of changing climate conditions, which in turn is vital for diluting the risks faced by smallholder farmers.

Farmers' Rights enables farmers to continue their work as stewards and innovators of agricultural biodiversity, and about recognizing and rewarding them for their contribution to the global pool of genetic resources. Such rights are critical to ensuring the conservation and sustainable use of genetic resources for food and agriculture and consequently for food security – today and in the future. Farmers' Rights are a precondition for the maintenance of crop genetic diversity, which is the basis of all food and agriculture production in the world.

Farmers' Rights consist of the customary rights of farmers to save, use, exchange and sell farm-saved seed and propagating material, their rights to be recognized, rewarded and supported for their contribution to the global pool of genetic resources as well as to the development of commercial varieties of plants, and to participate in decision making on issues related to crop genetic resources.

Another main theme of farmers' rights is farmers' free choice of, and access to, genetic resources for food and agriculture, together with the freedom to share and sell harvested produce, and to improve cultivars. These are basic customary rights, and important preconditions for continued conservation and innovation with regard to plant genetic resources among farmers, and thus also for food security. Recent research has shown that such diversity includes not only farmers' varieties but often also improved ones from professional breeders.

Assisting farmers in in-situ conservation and farmer breeding, and providing incentives for such activities are among the central components in farmers' rights. The availability of a rich diversity of seeds and propagating material is the basis of farmers' rights, as well as for sustainable agriculture and food security.

Farmers Rights at International level

Among the most important international agreements are – aside from the International Treaty itself – the Convention on Biological Diversity (CBD), the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO), the Convention of the Union for the Protection of New Varieties of Plants (UPOV) and World Intellectual Property Organization (WIPO) of the United Nations (UN). These international agreements are interlinked and they interact in various ways with regard to Farmers' Rights.

In 1961, five European countries agreed to provide ***sui generis*** IP protection to plant varieties and formed the International Union for the Protection of New Varieties of Plants (UPOV) which provided for the rights of plant breeders, and prohibited two or more types of protection to a particular plant species. The UPOV Acts underwent three amendments in 1972, 1978 and in 1991. The 1978 amendment of UPOV Act made the provision of farmers' privilege unaltered and provided for restricting the plant breeders' right on the ground of public interest to prevent adverse effect of the monopoly. This provision indirectly addressed the right of farmer to the adequate availability of seeds. This aspect is also present in the UPOV Act, 1991. The third amendment of UPOV Act, in 1991, left the farmers' privilege optional to the member countries. A farmer who produces 90M T in his farm is treated as a small farmer in the Netherlands and is eligible for relaxations in the royalty for re-sow his farm produce.

The idea of farmers' rights came up in the early 1980s as a counter move to the increased demand for plant breeders' rights, as voiced in international negotiations. The purpose was to draw attention to the unremunerated innovations of farmers that were seen as the foundation of all modern plant breeding. It was based on the fact that the farmers have been engaged in the informal breeding process besides conserving and preserving biological and genetic resources for time immemorial. Hence, they deserved to be recognized and rewarded like the contribution of breeders in development of the new varieties was recognized and rewarded through plant breeders' right. The first mention of farmers' rights was made in the meeting of the Working Group of the FAO Commission on Plant Genetic Resources, 1986, in the context of the International Undertaking on Plant Genetic Resources (IUPGR). Already in 1987, considerations and practical solutions were suggested that formed a foundation for all further negotiations on farmers' rights, and provided substantial input to the framing of our current understanding of the concept.

The 25th session of the FAO Conference of 1989 was a landmark in the history of recognition of farmers' right. The FAO Conference Resolution 4/89 first introduced the concept of farmers' rights into the IUPGR and also defined farmers' rights in its resolution 5/89. The FAO's Conference endorsed the concept of farmers' right, and defined these as right arising from the past, present and future contributions of farmers in conserving, improving, and making available plant genetic resources, particularly those in the centers of origin/diversity.

By 1995, with the establishment of WTO, the TRIPS Agreement provided that IP in agriculture should be protected either by patents or by an effective *sui generis* protection or both. Countries have adopted the sui generis models as per their needs.

The International Treaty on Plant Genetic Resources for Food and Agriculture recognizes the enormous contributions made by farmers worldwide in conserving and developing crop genetic resources, and it provides for measures to protect and promote these rights. Among the most important international agreements are – aside from the International Treaty itself – the Convention on Biological Diversity (CBD), the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO), the Convention of the Union for the Protection of New Varieties of Plants (UPOV) and World Intellectual Property Organization (WIPO) of the United Nations (UN). These international agreements are interlinked and they interact in various ways with regard to Farmers' Rights.

The Protection of Plant Varieties & Farmers' Rights Act, 2001

With the exclusion of plant varieties from the scope of the patentable subject matter, India was obliged to protect these under a system as per the mandate of Article 27.3(b) of TRIPS. The idea was to establish a farmers' rights regime to recognize and protect the 'rights arising from the past, present and future contributions of farmers in conserving, improving and making available plant genetic resources'. A different form of protection was felt needed in India in addition to or instead of the existing international models as agriculture provided for employment and key means of livelihood to a good percentage of the Indian population. It was in this background that the farmers' right regime was introduced under the Indian **Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act** in 2001. India is one of the first countries in the world with a legislation granting rights to both breeders and farmers simultaneously under one Act. It is the only legislation in this area that grants formal rights to farmers in a way that prevents their self-reliance from being jeopardized while at the same time recognizing the efforts of the plant breeders in developing new plant varieties.

The Government of India established the Protection of Plant Varieties and Farmers' Rights Authority on 11th November, 2005. The PPV&FR Authority is a body corporate under the Ministry of Agriculture with Chairperson as the Chief Executive. Besides the Chairperson, the Authority has 15 members, notified by the Government of India (GOI). The Authority has the four major objectives as under:

- To provide an effective system for protection of Plant varieties and rights of farmers and plant breeders.
- **To recognize and protect the rights of farmers in respect of the contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties.**
- To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development in public / private sector for development of plant variety.
- Facilitate the growth of seed industry which will ensure the availability of high quality seeds and planting material to the farmers.

The Act deals with Plant Variety Protection and Farmers' Rights and follows a holistic approach. The *sui-generis* system adopted by India is unique in the world in the sense that it has taken the farmers' rights concept a step forward and genuinely addresses the concerns of farmers as breeders, innovators, conservers, etc. It has tried to incorporate the features of UPOV and ITPGRFA along with certain distinctive features of its own as per requirement of farmers.

Farmer in PPV&FR Act (Section 2k) has been defined as: 'any person who cultivates crops by cultivating the land himself; or cultivates crops by directly supervising the cultivation or land through any other person; or conserves and preserves, severally or jointly, with any other person any wild species or traditional varieties or adds value to such wild species or traditional varieties through selection and identification of their useful properties.

Provisions of Farmer Rights under the PPVFR Act, 2001

Breeders' Rights

- Breeders will have exclusive rights to produce, sell, market, distribute, import or export the protected variety. Breeder can appoint agent/licensee and civil remedy in case of infringement of rights.

Researchers' Rights

- Researcher can use the variety using such variety for conducting experiment or research, use of the variety as an initial source of variety for the purpose of developing of another variety but repeated use requires prior permission.

Farmers' Rights

- Farmer is entitled to save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a protected variety in the same manner as he was entitled before operation of the PPV&FR Act, provided that he shall not be entitled to sell branded seed of a protected variety.
- Farmers have also been given a right to claim for compensation if the claimed characters under the given conditions are not realized. The Act treats the farmer as plant breeder so far as the farmers' variety is concerned and they can register them under the Act.

Rights of communities

- A farmer, group of farmers or any governmental or non-governmental organization on behalf of any village or local community may file in any notified center of the Authority any claim attributable to the contribution of the people of that village or local community, as the case may be, in evaluation of nay variety for the purpose of staking of claim on behalf of such village or local community.

Compulsory licence (Section 47)

- The PPV&FR Authority can grant compulsory licence after the expiry of three years from the date of issue of a certificate of registration of a variety on the ground of inadequate supply, unreasonable price to the public.

- The criteria of compulsory licence will depend on nature of variety, time elapsed since grant of licence, price of seed and efforts of breeder to meet seed requirement of public and the capacity / ability / technical competence of the applicant to produce and market and period of compulsory licence will be maximum up to period of protection.

Benefit Sharing (Section 26)

- The claims under benefit sharing can be submitted by Citizens of India or Firms/ NGOs formed or established in India. Such claims after due examination and after receiving counter-claims will be disposed by the Authority.
- The amount thus determined shall be deposited by the breeder in the National Gene Fund. Upon grant of Registration certificate, Authority will advertise and invite claims of benefit sharing to the variety and shall determine the quantum of such awards after ascertaining the extent and nature of use of genetic material in the development of the variety, commercial utility and demand in the market.
- The benefit claim will be decided after providing opportunity to be heard to both the claimer and Breeder.

Protection to farmers against innocent infringement

- Farmers are exempted in any suit before the court for infringement of a variety registered under the Act or relating to any right in a variety registered under the Act and no cognizance of any offence under the Act shall be taken for such infringement by any court against a farmer.
- Farmers are also exempted from payment of any fees in any proceedings before the Authority or Registrar or in any Court or for registration of their varieties as 'famers' variety'.

Recognition of farmers from National Gene Fund (Section 45)

The Indian legislation recognizes the important role of farmers in the conservation of genetic diversity that is so closely linked with varietal development interests. The "Gene Fund" created under the Act is to promote, recognize and reward those engaged in such activities in the agro-biodiversity hot-spots. This Gene fund shall be enriched from the money received in the form of Compensation, Annual fee, Benefit sharing and contributions from National & International Organizations. Funds collected under this head shall be utilized for reimbursement of benefit sharing, reimbursement of compensation; support and reward the farming communities, particularly the tribal and rural communities engaged in the conservation, improvement and preservation of genetic resources of economic plants and their wild relatives, particularly in the areas identified as agro-biodiversity hotspots and for capacity building on *ex situ* conservation at the level of the local body, particularly in the regions identified as agro-biodiversity hot spots and for supporting *in situ* conservation.

Award/Rewards to Farmers'/Farming Communities

Section 45(2) of the Act reads with Rules 70 (2) (a) of PPV&FR Rules, 2003 provides for support and reward, to farmers, communities of farmers, particularly the tribal and rural communities engaged in conservation, improvement and preservation of genetic resources of economic plants and their wild relatives, particularly in areas identified as agro-biodiversity hotspots from National Gene Fund. To operationalize these provisions, Plant Genome Savior Community Award was instituted in 2009–10. A maximum of five such awards of Rs. 10.0 lakhs each can be conferred annually. Along with this, ten farmers are conferred the Plant Genome Saviour Farmer Reward and fifteen farmers are conferred Plant Genome Saviour Farmer Recognition certificates. The selection of awardees is made by a committee of experts/ scientists headed by an eminent scientist.

The Authority has instituted the **"Plant Genome Savior Community Award"** as a national activity to encourage and recognize the selfless services of the rural folk in ensuring the continuous availability of biodiversity for plant breeding purposes. Authority has also constituted the 'Plant Genome Savior Community Award' which shall be given annually and there shall be a maximum of five Awards of Rs. 10.0 lakhs each, one memento and certificate.

Plant Genome Saviour Farmer Reward and Recognition (Gene Fund Rules, 2012 - under section 39 (1) (iii)

Who can apply: A farmer who is engaged in conservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation, Shall be entitled to a reward to be called

Reward: Maximum of ten rewards to farmers consisting of citation, memento and cash of Rupees 1, 50, 000 each.

Recognition: Maximum of twenty recognitions to farmers consisting of citation, memento and cash of Rupees 1, 00, 000 each.

Varieties that can be protected under the act

- New Variety
- Extant Variety-Section 2 (j)
- Notified under Seeds Act, 1966
- Farmer's Variety
- Varieties of Common Knowledge Essentially Derived Variety - Section 2 (i)

Farmer's Variety [Section 2 l (i) & (ii)]

- Variety which have been traditionally cultivated and evolved by the farmers in their fields
- Wild relative or land race of a variety about which the farmers possess the common knowledge.
- Farmers variety are protected as extant variety [Section 2 (j), 15(2)]

Farmer's as a Breeder [Section 39(1) (iii)]

A farmer who has bred or developed a new variety shall be entitled for registration in the like manner as a breeder of a variety under the Act.

Testing of farmers varieties

Farmers shall submit half the quantity of seeds in five packets to the National Gene Bank. The farmers' variety along with example variety and any other similar variety shall be evaluated in the paired row test, replicated trial for one season and at two locations. The length of row and plant population shall be specified in the Journal. Off types shall not exceed double the number of off-types specified in the guidelines for new varieties. If the variety meets the uniformity criteria, it shall be deemed to have met the stability criteria.

Registration of farmers' varieties [Section 39(1) (iii)]

- The PPV&FR Act allows for the registration of existing farmers' varieties that fulfill requirements for distinctness, uniformity, stability and denomination, but does not include that of novelty.
- This right provides farmers with an opportunity when a crop species is species is included in the crop portfolio under the PPV&FR Act for registration. Once registered, these varieties are entitled to all PBRs.

Role of PPVFRA in conservation of banana traditional plant varieties

Banana farmer varieties received for registration under the PPVFR Act, 2001

Application of Banana farmer varieties for Plant variety registration has received from different states of India are as under: Assam, Bihar, Chhattisgarh, Delhi, Jharkhand, Maharashtra and Tamil Nadu.

Recognition of farming community for banana traditional varieties conservation

Protection of Plant Varieties and Farmers' Rights Authority, Ministry of Agriculture and Farmers Welfare, Govt. of India is recognizing farmers and farming communities by way of registration of plant varieties and awarding and rewarding.

Plant Genome Saviour Community Award, Reward and Recognition

- In the year 2010-11 **Tamil Nadu Hill Banana Growers' Federation, Pattiveeranpatti, Dindigul district, Tamil Nadu** has been conferred the Plant Genome Saviour Community Award consisting of Rs.10.00 lakh, citation and memento.
- In the year 2013-14 **Chengalikodan Banana Growers Association, Erumapetty, Thrissur, Kerala** received the Plant Genome Saviour Community Award. This community is conserving Chengalikodan Nendran Banana by traditional method.
- **Shri Shivagouda M Patil, Vijaynagar, Belagavi, Karnataka**, recognize Plant Genome Saviour Farmer for the year 2018-19, practicing organic farming with traditional varieties of banana (72 types). Some of the banana varieties are high yielding, moisture and stress tolerant, disease tolerant, thousand finger banana, variegated and different coloured banana

with medicinal properties. He has shared planting materials with Joint Director of Agriculture, KSDA, Belagavi.

- **Shri Reji Joseph, Angadi, Pathanamthitta, Kerala**, an innovative farmer has been conferred Plant Genome Saviour Farmer Recognition during 2019-2020. The farmer is conserving and growing of varieties of Yam, Turmeric, **Banana**, Colocasia, Ginger crops. The work of the farmer was recognized in Limca book award in 2013 for tallest Taro and he is also holding one national record for harvesting 5 kg tuber from Dioscorea esculenta and 18.39 kg turmeric from a single plant. Principal Agricultural Officer, Pathanamthitta, Kerala, has certified that the plant genetic resources conserved by the farmer have been used as donor of genes in varieties registrable under the PPV&FR Act, 2001.
- **Shri Boloram Sarongsa, Silputa, nagarjan, Karbi Anglong, Assam**, is a tribal farmer, recognize as Plant Genome Saviour Farmer Recognition (2019-20) conserving seven land races of chilli and also cultivates bitter gourd, indian bean, broad bean, colocasia, **banana**, jackfruit, lemon, red vine spinach etc. Most of these varieties are moderately tolerant to drought situation, moderately resistant to major diseases and tolerant to insect and pests and suitable for upland cultivation in Assam.
- **Shri K.V. Kannan, Snehalayam, Kandoth, Payyanur, Kannur, Kerala** is engaged in the conservation of Plant biodiversity. He was recognized Plant Genome Saviour Farmer Reward for the year 2013. He is doing a commendable work for conservation of coconut, rice, jackfruit, **banana**, guava and Mango important local dessert; type popular in North Malabar region and spreading awareness among farmers about conservation of fruit/medicinal plants, land races and farmer varieties.
- **Shri P.V. Jose, Pullan House, Chalakkudy, Perambra, Potta, Thrissur, Kerala**, is a progressive grower and conserving nutmeg types and fruit plants like mango, **banana**, rambutan, pulasan, mangosteen, custard apple etc. Kerala Agricultural University has made a detailed characterization of his “Pullan” nutmeg type and has approved it for release as a variety for cultivation in Kerala. He has received Plant Genome Saviour Farmer Reward in the year 2016 -17.
- **Shri Tulsi Das Sav, Basna, Bansula, Bansula Mahasamund, Chattisgarh - 493554**, has been engaged in the conservation and production of typical varieties of Banana, Mango, Papaya, Ginger and Turmeric with higher productivity and disease resistance. Farmer is engaged of conservation of above said crops and spreading awareness among farmers about agro-biodiversity and conservation of land races and farmer varieties. Therefore farmer was recognized and confers Plant Genome Saviour Farmer Recognition in the year 2012.
- **Shri K. Raman, Cheruvayal Raman, Mananthavadi, Wayanand, Kerala** awarded with Plant Genome Saviour Farmer Recognition in the year 2013. As farmer has involved in conservation of banana and Coconut farmer varieties and spreading awareness among farmers about agro-biodiversity and conservation of land races and farmer varieties.

- **Shri Aravind K.P.V. Kalam (H), Pombra, Palakkad, Kerala** is a progressive grower and conserver of local varieties of Banana, fruit trees, plantation crops, vegetables, medicinal and aromatic plant species. The local variety viz., Pisang Lilin conserved by him was used in the development of **Banana hybrids** viz., BRS1 and BRS2. He is also propagating the concept of natural living and biodiversity conservation. He received Plant Genome Saviour Farmer Recognition in the year 2014
- **Tamil Nadu Hill Banana Growers Federation (TNHBGF)** rejuvenated hill bananas viz., Virupakshi and Sirumalai in lower pulney hills, TN with the technical assistance from ICAR – NRCB, Trichy and TNAU, Coimbatore. They were recognized with Plant Genome Saviour Award in the year 2014.
- Plant Genome Saviour Farmer Recognition 2016-17, **Shri Prasad Rama Hegde, Kankodlu village, Hemmadi, Yellapur Taluk, Uttar Kannada, Karnataka**, awarded for growing and conserving germplasm of locally important species including Twelve types of black pepper, Six types of banana, 45 local varieties of mango, 20 varieties of lime, two varieties of semi- domesticated Dalchini etc.

Conclusion

In conclusion it is considered necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. Accelerate agricultural development in the country, it is necessary to protect plant breeders' rights to stimulate investment for research and development, both in the public and private sector, for the development of new plant varieties. India is one of the first countries in the world with a legislation granting rights to both breeders and farmers simultaneously under one Act. It is the only legislation in this area that grants formal rights to farmers in a way that prevents their self- reliance from being jeopardized while at the same time recognizing the efforts of the plant breeders in developing new plant varieties.

Indigenous ornamental bananas: Scope and new business opportunities

Ramajayam, D*, Saraswathi M.S*. and Anuradha C**

**Principal Scientist (Horti.,), **Senior Scientist (Agrl. Biotechnology)*
ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India - 620 102
Corresponding author: ramajayamd@gmail.com

International and national status of ornamental banana species

The search for novelty, originality, uniqueness, and beauty in plant species has increased in the recent past as the ornamental market is highly dynamic and demands constant novelties and new additions. Although banana has attained the status of the most consumed and highest produced and traded fruit on the earth, its ornamental potential is the least exploited. Out of the three genera of *Musaceae*, *Ensete*, and *Musa* are only present in India, and *Musella lasiocarpa*, commonly known as Chinese dwarf banana, golden lotus banana, or Chinese yellow banana, is the sole species under the genus *Musella* that is not reported in India. There are over 80 species and about 162 validly published taxa of *Musaceae* around the world, out of which 34 taxa (over two dozen species) are reported in India. The maximum diversity and distribution, representing about 90% of the total wild *Musaceae* diversity in India, exists in the Northeastern states with 30 taxa, of which 19 are endemic to this region.

The second highest *Musaceae* diversity in India is found in the Andaman and Nicobar Islands (three taxa are present, all of which are endemic), and the lowest in the Western and Eastern Ghats (three taxa, including one endemic taxon in each region). The family includes many valuable ornamental species that are yet to be fully exploited. Over one dozen species from the *Musa* section and two dozen species of the *Callimusa* section were recognized for their ornamental value. However, wild species from the *Callimusa* section have not been reported in India. Many of these crop wild relatives (CWRs) possess attractive bract colors like pink, red, bright red, orange red, orange, orange–pink, yellow, purple, and even green, with less frequency. In some cases of CWRs, the fruit itself is brightly coloured with pink, brown, and red, adding to the ornamental potential of these plants. In general, the CWRs with ornamental potential are smaller in stature in terms their height and girth; hence, they can be used as potted plants in home gardens. Several other appealing traits found in these CWRS are colored and variegated leaves, uneven colored or multicolored bracts, and mini fruits. The fruits from these ornamental *Musaceae* species are very seedy and unsuitable for human consumption. Most of the CWRs flower round the year, require less maintenance, and can easily be multiplied using rhizomes or corms.

Additional advantageous traits other than ornamental values;

- Cold tolerant & can be grown in northern parts of India
- Shade loving & can be grown under palms and other trees with even 10% diffused sunlight
- Prolific suckering (>20 suckers within 4 months) to start a nursery business
- High anthocyanin content in the leaves (80 to 120 mg/100g) to be used as a foliage for wall decorations or bio-plates with medicinal values (phenolics & antioxidants)

- Moderately drought hardy and can be grown up to pH-8.5. However, the plant growth is hampered severely at very high temperature of > 40 ^{0}C and > 8.5 soil pH.

Indigenous ornamental Banana species and their unique traits

The following one dozen CWRs from *Ensete* and *Musa* genus were recognized as having high ornamental potential based on their growth characteristics and bearing of colorful mini fruits and bright-colored bracts with upright inflorescence.

***Ensete* Bruce *ex* Horan.:** In India, only two species of *Ensete*— *E. glaucum* and *E. superbum*—are found. They are distributed in Northeastern and Peninsular India, respectively.

(i) Ensete glaucum (Roxb.) Cheesman

It is a non-stoloniferous monocarpic herb without suckering behavior. The conical pseudostem can grow up to 5 m in height, with a distinctly swollen base (up to 2 m circumference) and tapering top. Younger leaves arise with erect to intermediate angle and more than 2.0 x 0.5 m lamina size. The inflorescence is pendulous and grows up to a meter long with integral bracts and flowers. The fruit bunch is compact with straight fingers almost perpendicular to the axis. Fruits are yellow when ripe with seeds. In addition to Northeastern parts of India, This species is also distributed in China, Indonesia, Laos, Myanmar, the Philippines, Papua New Guinea, and Thailand. It is mostly grown as an ornamental plant in landscaping and home gardens across India for its conical-shaped stem and persistent greenish bracts. The flower buds and pseudostem are also used as vegetables by the people of the Northeast. This species is classified as Critically Endangered as it is being continuously destroyed in its habitat for *Jhum* cultivation.

(ii) Ensete superbum (Roxb.) Cheesman

It is also a monocarpic non-stoloniferous herb; however, it produces suckers when the apical meristem is cut at the base. The pseudostem looks dry appearances when the outer sheaths are dried with conical and distinctly swollen base. Leaf bases are symmetric with more than 3 m long lamina with an attractive pink or purple midrib. The inflorescence is pendulous or sub-horizontal with more than 1 m long with brown and pink–purple bracts. Compact bunch with seeded fruits almost perpendicular to the rachis and yellow when ripe. It is distributed in India (throughout peninsular India, the Western Ghats, and some parts of Gujarat), Myanmar, Thailand, and Vietnam. It is grown throughout India as an ornamental plant in home gardens and landscapes because of its large conical pseudostem and leaf arrangement. Its seeds are used as a remedy for various human ailments such as diabetes, leucorrhoea, kidney stone, and dysentery and fetch a higher market price ranging from Rs 200 to 400 per kg. In addition, its fruits, flower, and pseudostem are used as vegetables by the tribal communities of Southern India. This species is classified under the category of Least Concern as per International Union for Conservation of Nature (IUCN) criteria.

***Musa* L.:** Out of the 32 taxa reported in the *Musa* section, the following ten CWRs are recognized for their ornamental value:

(i) *Musa aurantiaca* G. Mann *ex* Baker

This plant species grows to a height of 0.7 to 2.5 m, is clump forming, and does not spread by running rhizomes. The inflorescence is erect with bright orange persistent bracts for 2-3 days and revolute before falling. Fruits are seeded, pointed straight upwards toward the erect rachis (i.e., negatively geotropic), 3-14 cm long, and slightly ridged. It is one of the most elegant species with a bright orange bud with high ornamental potential and is distributed in Arunachal Pradesh and Nagaland at 300 to 1300 m Mean Sea Level and classified as Near Threatened.

(ii) *Musa marukkuana* (M. Sabu, A. Joe & Sreejith) Hareesh, A. Joe and M. Sabu

This plant grows to a height of 0.8 to 1.6 m with a 15-20 cm circumference at the base. It is clump forming and does not spread by running rhizomes. Inflorescence is erect and maroon in color with pink bracts. The fruit bunch is compact, fruits are arranged in uniseriate, fingers are seeded and negatively geotropic, and immature fruit peel is maroon, becoming light maroon or pink or purple at maturity and is not self-peeling. The plant is distributed in Northeastern India, and the erect inflorescence with pink bracts and purple fruits makes it a potential ornamental plant with a Least Concern status.

(iii) *Musa ornata* Roxb.

This species grows to a height of 1.0 to 2.5 m with a 19 to 32 cm circumference at the base and does not spread by running rhizomes. The inflorescence is erect and bracts are lilac with a yellow apex or pale lilac with a cream base and not revolute before falling, with prominent bract scars. Fruits are seeded and negatively geotropic with a green peel at maturity. This species is the oldest and most popularly cultivated as an ornamental plant. It travelled to Europe and to other continents a long time ago. It is distributed in Bangladesh, India, and Myanmar and is classified as Endangered.

(iv) *Musa rubra* Wall. ex Kurz.

This species grows to a height of 30 cm to 2.2 m with a 15-20 cm circumference at the base and spreads by running rhizomes. The inflorescence is erect and the bracts are red to brick red with a yellow apex, lifting 1-2 bracts at a time, revolute during the female phase and not revolute during male phase before falling, and the whole bud degenerates before fruit maturity. Fruits are seeded and negatively geotropic with a green peel at maturity. M. *rubra* is grown as an ornamental plant and has a Least Concern status.

(v) *Musa sanguinea* Hook.f.

This species grows to a height of 90 cm to 1.2 m with a 12-20 cm circumference at the base, is clump forming, and does not spread by running rhizomes. The inflorescence is erect with bright red bracts and scarcely protrudes beyond the leaf sheath. The bunch is erect with a few hands (3-4) and fruits per hand (3); fruits are seeded, negatively geotropic uniseriate arrangements with a pale yellow–green peel at maturity. The plant is endemic to India with an Extinct in Wild status. There have been no recent reports of its occurrence in the wild.

(vi) *Musa velutina* H.Wendl. & Drude

This species grows to a height of 45 cm to 1.5 m with a 12-15 cm circumference at the base, is clump forming, and does not spread by running rhizomes. The inflorescence is erect with a cream,

creamy pink, pink, or red color; with hairy and flower bud degenerate before maturity of fruits. The color of the bract is pink or reddish pink and it is revolute before falling. Fruits are seeded, negatively geotropic, and uniseriate. The fruit peel is pink or red in color, hairy, and splits open at maturity, exposing the white pulp and seeds. The plant is distributed in Myanmar and Northeastern India and grown as an ornamental with a Least Concern status.

(vii) *Musa velutina* H.Wendl. & Drude var. *variegata* A. Joe, M. Sabu & Sreejith

This plant grows to a height of 60 cm to 1.5 m with an 8-16 cm circumference at the base, is clump forming, and does not spread by running rhizomes. The inflorescence is erect, whitish pink, and densely pubescent with white hairs; the flower bud degenerates before the maturity of fruits. The color of the bract is dark red with whitish pink or pink striations. Fruits are seeded, negatively geotropic, and uniseriate. The fruit peel is pink or red in color with short white hairs and it splits open at maturity, exposing the white pulp and seeds. The plant is endemic to Tinsukia district of Assam, India, and grown as an ornamental with a Critically Endangered status.

(viii) *Musa argentii* Gogoi & Borah

The plant height is 1.5 to 2.3 m, it is clump forming, and does not spread by running rhizomes. The inflorescence is pendulous, horizontal, bent, or arched and pink, red, or green in color with purple tinges. Bracts are attractive with a pink, pink–purple, or red–purple color with slightly pubescent or glabrous. Fruits are seeded, 8.2 to 10.1 cm long, curved backward or upright on an erect axis (i.e., negatively geotropic), and peels are greenish with pink tinge or pinkish or green with a purple tinge. The plant is endemic to Arunachal Pradesh and is classified as Critically Endangered.

(ix) *Musa mannii* H.Wendl. *ex* Baker

The plant grows to a height of 0.85 to 1.1 m with a 14-16 cm circumference at the base, is clump forming, and does not spread by running rhizomes. The inflorescence is bent to one side, horizontal, or pendulous with slightly hairy and crimson red bracts. The fruit bunch has a few number of hands (2-4) and fruits per hand (2-6); fruits are seeded, 4.4 to 4.7 cm long, uniseriate, and slightly ridged with light green color peels. This species is used as an ornamental plant, and although endemic to India, is very rare and currently found only in one locality in Changlang district of Arunachal Pradesh with a Critically Endangered status.

(x) *Musa markkui* Gogoi & Borah

This species grows to a height of 1.3 to 3.5 m with a 14-20 cm circumference at the base, is clump forming, and does not spread by running rhizomes. The inflorescence is erect during shooting, then a bend or pendulous during the first few bracts, again erect, and sub-horizontal or erect at least at the fruit-bearing stage. The flower bud degenerates before fruit maturity, bracts are pale pink to pink, cream to creamy pink, cream with a pink tinge, or creamy green with pink striations. Compact fruit bunch, seeded fruits in uniseriate arrangement and negatively geotropic. The plant is grown as an ornamental and is endemic to Northeastern India with a Critically Endangered status.

Exotic ornamental banana species

Musa acuminata L.A. Colla subsp. *zebrina* (Van Houtte) R.E. Nasution.

In addition to the indigenous CWRs, *Musa acuminata* subsp. *zebrina*, an ITC (The Bioversity International *Musa* Germplasm Transit Centre) introduction, also has great ornamental value and is being utilized in breeding programs to develop novel ornamental hybrids. This species is distributed in Tanzania and tropical and subtropical Asia. It grows well in full sun to partial shade and is not cold hardy. The pseudostem grows up to 3 m in height, is erect, shiny, and not waxy with a yellow–green color. The leaves are oblong, dark green with irregular bronze–red to purple blotches/stripes on the adaxial and brownish on the abaxial side. The plant has a horizontal rachis with a hairy peduncle, while the bract is purple–brown on the external surface and orange–red under the internal side. Fruits are small in size, bronze–red to purple colored, curved upward with a pointed apex and pronounced ridges. The fruit fades to green and turns orange colored when mature/ripe, with a cream-colored small pulp and without seeds. The plant is mainly cultivated for its ornamental foliage and colored mini fruits than as an edible banana.

Creation of interspecific ornamental banana hybrids using CWRs at ICAR-NRCB

The main constraints in the cultivation or adoption of these ornamental banana species is the difficulty in establishing them in the plains or out of their habitats. Additional drawbacks include lack of sufficient planting materials, no creation of variability through systematic breeding, and ignorance among floriculturists about the species' potential ornamental value. Breeding of the banana for ornamental purposes is still in its infancy. Therefore, the ornamental banana breeding program at ICAR-National Research Centre for Banana has mainly focused on exploiting the variability found in the wild *Musa* species to generate climate-resilient new and novel hybrids with high ornamental value and resistance to major pests and diseases.

Keeping this in mind, a systematic breeding works for ornamental banana was initiated in 2017 with the following four interspecific *Musa* crosses: *M. rubra* × *M. acuminata* subsp. *zebrina* (RZ), *M. ornata* × *M. rubra* (OR), *M. ornata* × *M. acuminata* subsp. *zebrina* (OZ), and *M. ornata* × *M. velutina* subsp. *markkuana* (OV). The number of seeds per fruit varied highly within the hand and within the cross-combinations.

Multi-location testing of interspecific ornamental banana hybrids

Based on the molecular, quantitative and qualitative traits, 63 novel ornamental hybrids were short-listed from the four crosses-RZ (10), OR (14), OZ (35), and OV (4) for their potential ornamental use. These short-listed ornamental hybrids were supplied to ICAR - Indian Institute of Oil palm Research (15 hybrids), New Delhi Municipal Council gardens (55 hybrids), and a few State Agricultural Universities such as the Tamil Nadu Agricultural University, Coimbatore (55 hybrids); University of Horticultural Sciences, Bagalkot (55 hybrids); Anand Agricultural University, Gujarat (43 hybrids); and Dr. Y.S.R. Horticultural University, Andhra Pradesh (55 hybrids). Additionally twelve unique interspecific ornamental hybrids—four each from RZ and OZ crosses and two each from OR and OV crosses - were also supplied to the following ten Centres of All India Coordinated Research Project on Floriculture for multilocation evaluation; (i) ICAR-Directorate of Floricultural Research, Pune, Maharashtra, (ii). Bidhan Chandra Krishi Viswavidyalaya, West Bengal, (iii) Assam Agricultural University, Kahikuchi, Assam, (iv) Punjab Agricultural University, Ludhiana, Punjab, (v) Dr Y.S.Parmar University of Horticulture & Forestry

Himachal Pradesh, (vi) Kerala Agricultural University, Vellanikkara, Kerala, (vii) ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, (viii) ICAR-Central Island Agricultural Research Institute, Port Blair, Andaman and Nicobar Islands (ix) ICAR-Indian Agricultural Research Institute, New Delhi and (x) Odisha University of Agriculture & Technology, Bhubaneshwar, Odisha. Furthermore, unique interspecific ornamental hybrids from RZ, OZ, and OR crosses were supplied to ICAR-Krishi Vigyan Kendra, Kollam, to conduct an OFT (On Farm Testing) in ten farmers' fields for the "Assessment of ornamental banana hybrids in Kollam district of Kerala."

Categorization of interspecific ornamental banana hybrids for New Business Opportunities

The short-listed interspecific ornamental hybrids were also field/glasshouse screened for their reaction to main pest and diseases, and clustered into the following categories of use on the basis of a few important morphological and biochemical parameters.

Potted plants

The interspecific ornamental banana hybrids can be used as a potted plants since majority of the hybrids plant height, pseudostem diameter at collar region and the stalk length was inferior to 145 cm, 25 cm and 35 cm, respectively, with minimum number of leaves per plant (≤ 15), fruits per hands (≤ 6), and hands per bunch (≤ 4). Furthermore, presence of other ornamental traits such as attractive leaf and fruit colour, bunch position (erect or angled) and fruits on the crown (mostly uniseriate instead of biseriate or both), size, shape and color of the bracts and heart gives unique look when grown as potted plants. Because of their shorter height and smaller girth with erect inflorescence, they can be introduced successfully as potted plants in home gardens. They are also shade loving and/or tolerant and grow well between 3000 to 50000 lux light intensity.

Cut flower

Some hybrids from *M. ornata* × *M. rubra* and *M. ornata* × *M. velutina* subsp. *markkuana* crosses were short-listed because of their upright rachis with fruits pointing upward towards an erect axis (i.e., negatively geotropic), presence of highly attractive, persistent, and non-revolute persistent bracts, and flowers of inflorescence that last up to 1-3 months. Additional characters, such as length of the stalk superior to 20 cm, diameter of the stalk inferior to 4 cm, number of hands per bunch (≤ 4), number of fruits per hand (≤ 6), size and shape of the heart, presence of imbrication, number and opening of floral bracts, and color of the fruits and heart, were also considered for short-listing the progenies.

Cut foliage

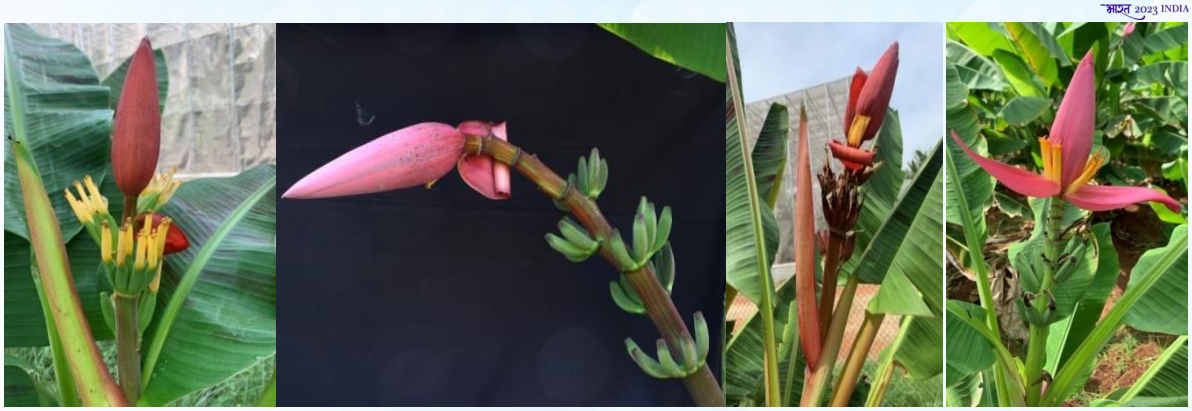
For cut foliage, the hybrids with high anthocyanin content (80 to 120 mg/100g FW) in the abaxial side of leaves with eye-catching variegated dark brown stripes on leaves adaxial were selected. The leaves can be used for wall decoration, bouquet preparation, or as bioplates with high medicinal value owing to the significant presence of pigments, phenols, and antioxidants.

Landscaping

Unlike their parents, the hybrids from *M. rubra* × *M. acuminata* subsp. *zebrina*, *M. ornata* × *M. rubra*, and *M. ornata* × *M. acuminata* subsp. *zebrina* were growing well under open field conditions even in alkaline soil pH (>8.5). Another important characteristic for this category is their tillering capacity with profuse suckering (> 20 suckers within 6 months of planting). All the hybrids progenies were also cold tolerant and can be grown in the Northern parts of India. They are also shade loving and can be grown under palms and other trees with just 10% of diffused sunlight.

Mini fruits

Besides genotypes with appropriate characteristics for landscape plants, potted plants, and floral arrangements, there are several hybrid lines in all the three cross-combinations that produce very small fruits in green and red color that can be used as ornamental plants. These hybrids are characterized by having inflorescences that are erect or at least at the base in the case of colored progenies, with fruit pointing toward the bunch apex and well distanced between the hands. These hybrids also typically have relatively fewer fruits and are best known for their green or red colored fruits with brightly colored bracts, a feature that makes them popular as ornamental plants. The banana mini fruits for floral arrangements are a novelty, mainly due to their originality, representing an innovation for the flower and ornamental plant market, but they have not been commercially explored.



Ensuring export quality banana bunches through certification of tissue culture - raised plants by virus indexing and genetic fidelity

Selvarajan R*, Balasubramanian, V and Saraswathi M S*****

*Director, **Senior Research Fellow, ***Principal Scientist (Hort.,)
ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India- 620 102
Corresponding author: selvarajanr@gmail.com; selvarajanr@icar.org.in

Introduction

Globally banana and plantains are the most important fruit crops, and they serve as a staple food as well as an instant energy source to the millions of people living in the tropical and sub-tropical regions of the world. India leads the world in banana production with an annual output of about 31.50 million tonnes, contributing about 26.28% of the world's banana production (FAOSTAT, 2020). In India, banana occupies 13.17% area among the total area under fruit crops (NHB, 2020). Diseases are the major production constraints in banana across the world. Among diseases, viral diseases are a major threat to tissue culture (TC) bananas if the mother plants are not indexed. Tissue culture technology in banana has revolutionized banana cultivation and increased production and productivity tremendously. The planting material used in banana farming is mostly conventional suckers (ca. 70%) and the remaining (ca. 30%) is met from tissue culture (TC) plants. The annual requirement of planting material for banana cultivation in India is 343.6 million, which shows that there is huge potential to produce TC-raised planting materials to meet the current demands of farmers. Majority of TC companies are engaged in mass multiplication of banana. It covers almost 70% of the total production of TC plants. The demand for TC plants is enormous as the insect pests like weevils and nematodes, and pathogens like fungal and bacterial origin are also eliminated through shoot tip culture. Viruses are the major problem in tissue culture banana causing a severe loss in production. In this chapter, the economic significance of virus infection in bananas, and the need for virus indexing and genetic fidelity to ensure quality plants that increases productivity and production are outlined. The diagnostic techniques and markers for genetic fidelity developed at our center are employed in the certification services. Preliminary impact analysis of this technology and the success of rejuvenation of Hill banana in lower Pulney hills and supply of elite BSMYV free high yielding TC Poovan are also highlighted.

Viral diseases emerge as a serious threat to the banana industry

Bananas are affected by four major well-characterized viruses such as Banana bunchy top virus (BBTV), Banana streak Mysore virus (BSMYV), Cucumber mosaic virus (CMV), and Banana bract mosaic virus (BBrMV) that cause severe economic losses to the banana growers across the banana growing regions. Banana bunchy top disease (BBTD) caused by BBTV is one of the most serious, globally recognized viral diseases in banana. In India, BBTV has been believed to be introduced from Sri Lanka to Kerala and slowly spread to entire Kerala state and then to the adjoining lower Pulney regions where the famous 'Hill Banana' (syn. 'Virupakshi', AAB, Pome) has been grown as a shade crop in coffee plantations. In 1970's BBTV infection in Hill banana was noticed and within a decade of its introduction, this disease forced the Virupakshi banana to near

extinction in lower Pulney hills of Tamil Nadu. The area under this banana dwindled to 2000 ha from 18,000 ha. An outbreak of BBTD in tissue culture (TC) plantations in Jalgaon, Maharashtra, and Kodur, Andhra Pradesh, India, in 2007–2011, caused an annual loss of production worth US$50 million. This outbreak was suspected to be due to the use of non-indexed mother cultures for the mass propagation. Though, the certification of tissue culture banana was operative in India, some of the non-recognized tissue culture production units (TCPUs) were not adopting this certification system. In Kodur, Andhra Pradesh, one tissue culture banana company who imported mother cultures cv. Grande Naine from Israel, mass propagated and supplied a few million plants to the growers, but at bunch emergence stage almost 60-90 per cent of plants expressed bunchy top symptoms and ended up with 100 per cent loss. This rampant incidence has forced the tissue culture firm to close the production unit. Yield losses have been found to vary with cultivars and climatic conditions that prevail during the growing seasons.

BBrMD causes yield loss ranging from 30–70% in French plantain cultivar Nendran. CMV causes mosaic or infectious chlorosis disease. An epidemic of CMV in TC plants of Grande Nain banana was recorded in Jalgaon, Maharashtra, during 2008–2010, and it re-emerged in early 2015 in Bengaluru causing a huge loss to the growers. CMV has re-emerged in an epidemic proportion during July-August 2020, in Jalgaon, Maharashtra, and Burhanpur, Madhya Pradesh. Subsequently, in 2021 and 2022, CMV disease incidence was recorded to be very high and almost 50-100 lakhs infected plants were uprooted by the farmers during the second or third month after planting. The incidence ranged from 11 to 100% in many plantations. BSV species are the causal agents of leaf streak disease in banana and plantain. BSV infections cause 10 - 90% of yield losses in various banana cultivars across the world and cv. Poovan in India. These viruses are primarily being transmitted through planting materials like suckers, tissue culture plants and corms. Moreover, the planting materials which act as reservoirs for these viral pathogens also aggravate the incidence.

Importance of virus indexing

Viral pathogens cannot be eliminated through shoot-tip culture which is a widely adopted technique by the industries for mass propagation. If the mother plants are indexed and assured free of viruses before micropropagation, the TC plants are undoubtedly superior to suckers. Most of the banana viruses reside in the host in latent form, i.e. without exhibiting any visual symptoms in the host for some period. Unlike other plant pathogens, there are no direct methods available to control viruses. Use of quality planting materials is very important for enhanced production and productivity. The success of banana virus disease control is almost entirely dependent on the availability of accurate, sensitive, specific, low cost, and simple diagnostic techniques, which enable early detection of virus infection in planting materials.

Indexing techniques for the early detection of banana viruses

Serological and molecular diagnostic techniques are available for the detection of plant viruses. Choosing the right method of detection is the most crucial step in indexing for plant viruses. Purification of viruses from banana is cumbersome process as the host has high quantity of polyphenols, polysaccharides and secondary metabolites which interfere in the process of purification. Moreover, viruses like BBTV occur at very low concentrations and limited to phloem

cells which is a serious barrier of viral purification. Various forms of enzyme linked immunosorbent assays (ELISA) were established using recombinant antibodies raised against coat protein of BBTV, BBrMV and CMV and viral associated protein of BSMYV. There are modified versions of ELISA, such as dot immune binding assay (DIBA), Tissue immuno blotting assay (TIBA) and Immuno-sorbent Electron Microscopy (ISEM) have been developed and applied for detecting banana viruses in samples of field-grown and tissue culture (TC) plants. Lateral flow immuno assays (LFIA) are used for qualitative or semi-quantitative detection and monitoring of pathogens in non-laboratory environments (Fig.1). We have developed LFIA for two banana viruses namely BBrMV and CMV. The result could be evaluated visually by seeing the pink bands developed on the LFIA strips within 5-10 min.

Nucleic acid-dependent methods (targeting the genome) (Fig. 1) such as polymerase chain reaction (PCR) and reverse transcriptase (RT)-PCR have been applied for detecting banana viruses. Other genome targeted methods such as Immuno capture (IC) PCR and IC-RT-PCR have been developed for simultaneous detection of all four banana viruses. RT-PCR was more sensitive for the detection of BBrMV followed by IC-RT-PCR, and DIBA than DAC-ELISA. Multicomponent (all six genomic components) multiplex PCR-based detection of BBTV was developed and validated. Multiplex RT - PCR has been developed for the detection of two DNA viruses (BBTV and BSMYV) and for all four banana viruses. This method is applied for detecting BSVs to avoid false positives arising out of eBSV sequences. A simple, rapid, and solvent-free nucleic acid (NA) extraction protocol suitable for BBTV detection in PCR has been developed. The extracted NA template is suitable for detecting BBTV in quantitative PCR using SYBR Green chemistry and loop-mediated isothermal amplification (LAMP) assay. Methods have been developed based on nucleic acid spot hybridization (NASH) for the detection of BBTV and BSMYV using DNA probes, and BBrMV and CMV using RNA probes. Quantitative detection of banana viruses has been reported using real-time PCR (qPCR) assay with SYBR green and TaqManTM chemistries. Among the two methods, TaqMan® probe was more sensitive than SYBR Green chemistry which was validated using infected samples. Rolling-circle amplification (RCA) based approach can be used for the detection of BBTV and BSMYV. RCA technique has shown to overcome these limitations for the detection and subsequent characterization of BSV isolates infecting banana. RCA can discriminate between integrated and episomal BSVs genome, specifically detecting the latter in several banana cultivars. Multiplexing to detect two circular DNA viruses (BBTV and BSMYV) infecting banana using RCA coupled with restriction digestion with single cutting enzyme has been standardized.

Loop-mediated isothermal Amplification (LAMP) is a relatively new DNA amplification technique, and it is simple, rapid, specific and cost-effective nucleic acid amplification method. In contrast to the PCR technology in which the reaction is carried out with a series of alternating temperatures or cycles, whereas LAMP is carried out at a constant temperature, and does not require a thermal cycler. LAMP-based detection was developed at our lab for BBTV, BSMYV, BBrMV and CMV. This assay was 100 times more sensitive than PCR and RT-PCR. Another promising method is recombinase polymerase amplification (RPA) is a relatively novel DNA amplification and detection technology, which utilizes an enzymatic mixture of polymerase and DNA recombination proteins.

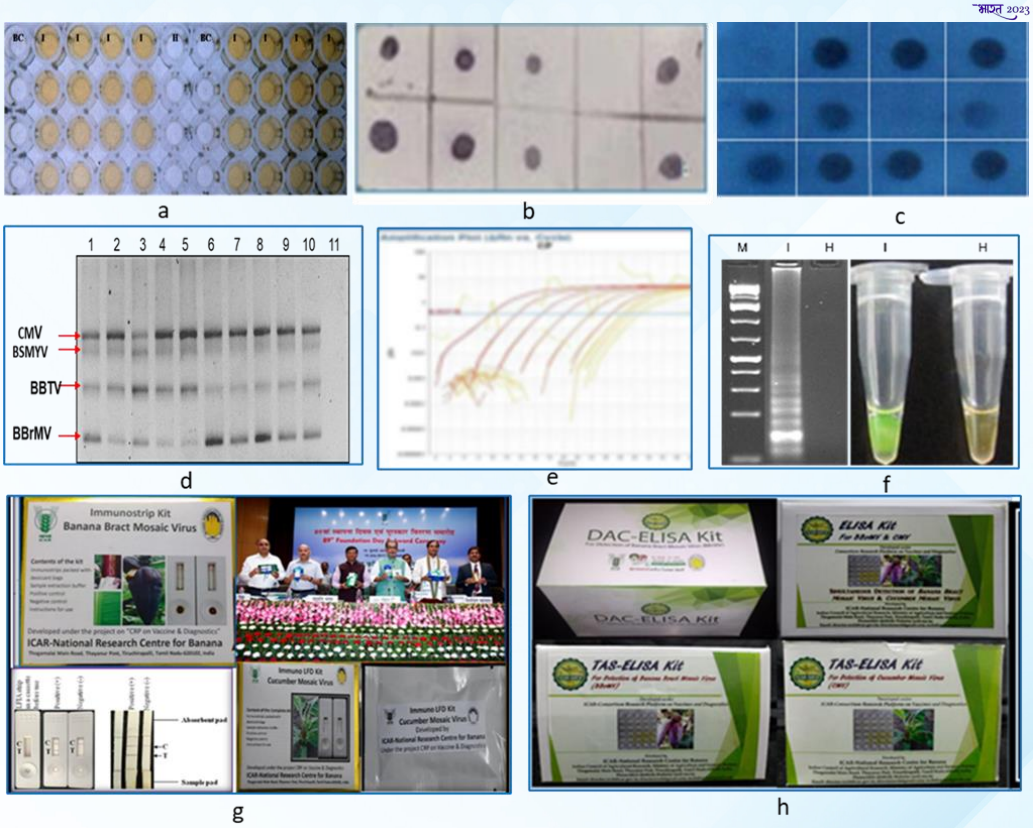


Fig.1 Pictorial representation of virus indexing techniques and kits developed at Molecular Virology Lab, ICAR-NRCB.(a) ELISA; (b) DIBA; (c) NASH; (d) Multiplex RT-PCR; (e) Quantitative PCR; (f) LAMP assay- Agarose gel electrophoresis (Left) & Visual Diagnosis (Right). (g).Lateral flow immunostrip developed for the onsite detection of BBrMV and CMV; (h) ELISA-based virus detection kits

RPA produces result in less than 30 min using only a fixed-temperature heater or incubator. RPA assay was developed and evaluated for the detection of all four banana viruses. These assays have the potential to serve as point-of-care diagnostics in low-resource settings.

Genetic fidelity

Variation among plants generated from cultured cells or tissues is defined as 'somaclonal variations which are heritable in nature. They occur in all methods of *in vitro* culture *viz*. callus, suspensions, adventitious shoots, somatic embryos, and also in regenerated plants. Due to the somaclonal variations, genetic integrity of the material is lost with a change in both qualitative and quantitative characters at morphological, cytological, biochemical, and molecular levels. There is a greater variation with respect to varietal susceptibility to somaclonal variants. Acuminata triploids, especially the Cavendish subgroup succumb to this variation quite often leading to dwarf types, floral deformities, abnormal leaves, etc.

Uniformity in TC planting material is important in order to plan the production cycle of crop by the farmers. Somaclonal variations are considered as a major factor for inducing genetic variability in the TC plants, thus, affecting its yield in the farmers' fields. Sometimes variants continue to multiply in the form of *in vitro* culture which leads to the production of the variant population within the batch. Such variants need to be detected in TC plants before supply to farmers

through PCR-based analysis. Various molecular markers such as Inter Simple Sequence Repeats (ISSR) and Inter Retroposon Amplified Polymorphisms (IRAP) are being used for genetic fidelity testing. ICAR-NRCB has standardized protocol for genetic fidelity testing using ISSR markers and services are being provided to various tissue culture companies as per the DBT-ATL norms to produce quality planting material.

Shoot tip culture preserves genetic stability much better than callus or cell suspension cultures, yet somaclonal variation seems to be widespread among plants regenerated from banana shoot tip cultures. Off type frequencies varied from 1-74% and it is not desirable as it defeats the purpose of clonal reproduction. It is a potential hindrance for in vitro propagation, since majority of off-types are agronomically inferior to parental clone. Generally 3-5 % is permissible in any micropropagation programme but in banana upto 10% is permitted owing to flexible genetic makeup of the crop. It is strongly influenced by the genetic stability of each cultivar and its frequency is amplified by growth regulators concentration, duration of culture etc. In general the abnormalities expressed are,

- Plant stature
- Leaf shape abnormalities
- Leaf pigmentation abnormalities
- Pigmentation on pseudostem
- Shooting deformities
- Floral dysfunctions (non-flowering)
- Fruit deformities
- Crop duration

The somaclonal variations are heritable in nature, therefore genetic fidelity testing in tissue culture bananas is essential for quality certification besides virus indexing. ICAR-NRCB, Trichy has developed fingerprints for all commercial varieties cultivated pan India using PCR based ISSR and IRAP markers. This is being used as reference for the genetic fidelity testing. ICAR-NRCB has also developed protocol for multiplexing of three SSR markers for easing the process of genetic fidelity testing. The services are being rendered to various tissue culture companies as per the DBT-ATL norms to produce quality planting material. Till date, almost 6000 batches of samples have been tested and fidelity reports have been issued which has led to considerable revenue generation to the Institute.

Banana certification system for producing good quality tissue culture banana plants

Tissue culture technology in banana offers great promise to produce quality planting material free from diseases and somaclonal variations. The mother plants are indexed and assured to be free of viruses before micropropagation and the resulting TC plants are undoubtedly superior to suckers. The tissue banana culture industry in India could sustain its growth since the molecular diagnostic technologies helped to produce virus-free planting materials. The need for a certification programme for the tissue culture plants is imperative since inadvertent micropropagation of virus infected plants will not only result in poor performance, but also in inadvertent spread of viruses wherever such plants are grown. To contain the disease spread through the TC plants the Ministry

of Agriculture, vide Gazette of India Notification dated 10th March 2006 , had notified as "In exercise of the powers conferred under section 8 of the seeds Act, 1966 (54 of 1966), the Central Government hereby authorizes Department of Biotechnology, Ministry of Science and Technology, Government of India to act as Certification Agency for the purpose for certification of the tissue culture-raised propagules at laboratory level. To provide support to the tissue culture industry for the commercialization of tested virus free and high quality planting material, National Certification System for Tissue Culture Plants (NCS-TCP) has been developed for the first time, not only in the country but also globally, where there was no such organized structure exists for certification of Tissue Culture material. Since 2003, the Molecular lab, ICAR-NRC Banana with an aim to supply of disease-free quality planting material in India, has been offering virus indexing and genetic fidelity services for tissue culture production units and to the farmers. The Centre has developed indigenous serological kits for banana viruses using recombinant viral coat proteins, PCR based kits and put them into use in national certification system for certification of tissue culture banana plants (NCS-TCP) implemented by DBT, Govt of India and also used them to screen large *Musa* germplasm available across India. Also it supplied large volume of virus detection kits to the banana tissue culture industries, state horticultural departments, AICRP- Fruits centres having banana germplasm and tissue culture production units. We have performed virus indexing of banana samples collected during the survey's and tested more than 1.93 lakh tissue culture samples received from tissue culture industries and certified a total of 295.98 million TC plants under the certification program. Timely detection and elimination of positives have helped the farmers and TCPUs to avoid the loss due to viral diseases and occurrence of somaclonal variants through TC plants. Therefore, virus-free source materials carefully selected by virus indexing are used to avoid perpetuation of viruses in apical shoot meristem culture (Fig 2). Indexing has been done for the 25 different banana cultivars including Grande Nain, Hill banana, Monthan, Nendran, Ney Poovan, Poovan, Robusta, Red banana and Williams etc.

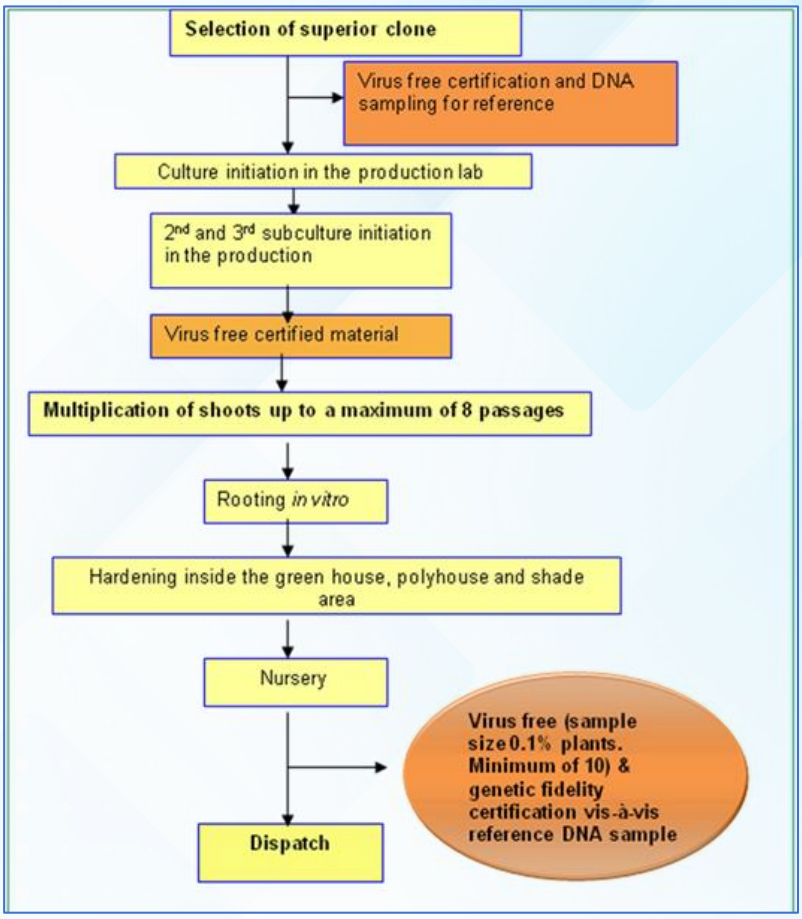


Fig 2. Generic scheme for the production of virus-free micro propagated banana in TC industry

Rejuvenation of GI tagged Hill banana (Virupakshi)

The Hill banana (Virupakshi, Geographical Indications 0124) was wiped out due to the BBTV infection in the lower Pulney Hills and it has been rejuvenated with the collaborative efforts of the state government of Tamil Nadu, Hill banana grower's federation with technical support of ICAR-NRC Banana and TNAU. During 1997-98, the Govt. of Tamil Nadu, implemented the rejuvenation of Hill banana scheme with the objective to revive the hill banana cultivation in Lower Pulney Hills. ICAR-NRC Banana has offered the services of testing Hill banana against BBTV and supplied virus free mother plants to TCPU's. ICAR-NRC Banana has established the virus free mother block for 'Virupakshi' plants and multiplied at the research farm and supplied to hill banana growers and TCPUs. More than five lakh BBTV free tissue cultured plants were supplied at the Lower Pulney hills for which the banana growers' association bagged the prestigious **"Plant genome Saviour award"** in 2014 from the Protection of Plant Varieties & Farmers Right Authority (PPV&FRA), New Delhi. Preliminary survey and impact analysis study showed that the virus indexed hill banana plant yields significantly higher than the conventional suckers and infection percent is also lesser in the first crop.

Supply of Elite BSMYV free high yielding TC Poovan (ABB, Mysore subgroup) clone

In India, ca. 17 per cent of the total banana area is occupied by Poovan (AAB, Mysore sub-group) which is highly susceptible to banana streak disease caused by BSMYV. It is a leading commercial cultivar grown throughout the country with location-specific ecotypes like Palayankodan in Kerala, Poovan in Tamil Nadu, Karpura Chakkarakeli in Andhra Pradesh, Alpon in North Eastern Region and Champa in Assam. It is generally cultivated as a perennial crop (1+2 or 3 crops). Tamil Nadu is the leading producer of banana cv. Poovan owing to its climatic and marginal soil condition. Poovan is also commercially cultivated for the leaf industry throughout Tamil Nadu and in certain parts of Kerala. it is highly susceptible to diseases caused by BBTV, BBrMV, and BSMYV, which cause considerable reduction in yield loss and affect the leaf quality. Fifteen years of field trial conducted at ICAR-NRCB lead to the selection of this clone, which is high yielding and free from BSMYV. This has been multiplied through TC and compared with TC plants of streak virus infected clone at Trichy. Based on the three years of data of its evaluation at 6 centers revealed its superiority in yield compared to local Poovan clones besides there was no expression of BSMYV symptoms in all the three years. An increase of 22-28 per cent yield has been recorded in all the centers. The Centre has supplied 3000 TC plants of Elite Poovan clone and distributed for taking up FLD in farmers' fields of respective states and also in KVKs.

Preliminary impact analysis on certification of banana planting materials

In case of the cv. Grande Naine banana, a preliminary survey was conducted to study the impact of the use of virus-indexed certified plants at Theni District. The certified tissue culture banana plants have outperformed than sucker grown plants. The farmers are of the opinion that certified TC plants are better than non-certified as there are no incidences of viruses and somaclonal variations in former one. Nearly 80% of the TC plants planted in Theni district were certified by ICAR-NRCB- ATL, whereas one decade back, the problems of virus incidence and somaclonal variants in TC plants were a major hurdle in banana production in Theni region which was informed

by the banana farmers while impact analysis survey. Based on our virus testing record the percentage of positives to virus in mother culture in TC banana has reduced from 12.76 to 0.01 significantly. The virus disease incidence has come down over the years after the implementation of virus indexing in the certification programme. The banana production in India was 18.9 million tonnes in 2005 and increased to 33.73 million tonnes in 2021. This production increase is mainly attributed to the adoption of quality clean and healthy banana and plantain planting materials. There has been a tremendous impact of banana tissue culture farming on profitability and improvement in livelihood of banana growers. It has enabled to increase in the income of the farmers by 5-6 fold and with further development in post-harvest facilities and cold storage infrastructure, there is huge scope to bring more area under banana cultivation for export purposes.

Conclusion

A wide range of molecular diagnostic techniques are available for many plant viruses. However, it is important to develop cost-effective, easy-to-use, reliable and sensitive techniques for routine virus indexing. Ensuring TC banana plants free of viruses is one of the foremost quality criteria for improving the yield and decreasing the spread of viruses in banana. NCS-TCP operating in India is a successful certification programme for ensuring the production of virus free planting materials of commercially important banana varieties. The tissue culture production facilities should also mass propagate the indigenous banana varieties such as Rasthali, Poovan, Nendran, Virupakshi, Thella Chakkararakeli, Ney Poovan and Plantains etc. To strengthen the system of quality clean planting material this certification method has to be extended to conventional suckers also. Capacity building for technicians involved in tissue culture plants production on selection of mother plants and virus indexing is necessary at regular intervals. In future, the TCPUs have to develop technical expertise to index their plants on their own for in-house quality control. However, certification of plantlets has to be done only through NCS-TCP Accredited Test Laboratories. Novel onsite detection techniques like dipsticks/LFIA, and LAMP which are users friendly needs to be introduced for ensuring the planting of quality TC plants of banana at farmer's level. Nanopore sequencing could be employed for the discovery of new viruses in germplasm collected during explorations. Biomarkers can be developed based on proteomics and transcriptomics studies for viruses like BBTV and BSVs. With respect to genetic fidelity, the currently used markers are able to detect only somaclonal variations. So, we need to develop Sequence characterized amplified region (SCAR) markers to identify the type/ nature of variant present in a particular batch of TC banana.

Post-harvest management of fresh banana and codex standards for export

Shiva K N*, Suresh Kumar P*, Kamaraju K, Uma S* and Selvarajan R*****

*Principal Scientist (Hort.,), **Technical Officer, ***Director
ICAR - National Research Centre for Banana, Tiruchirapalli - 620 102, Tamil Nadu
Corresponding author: bananashiva5@gmail.com

Introduction

Bananas and plantains form the staple food for millions of people across globe, providing balanced diet than any other fruit or vegetable. It is endowed with rich source of carbohydrate, vitamins and minerals and potassium. Being fat free, it has a calorific value of 90 kcal per 100 g fruit. The dessert bananas are generally eaten as fresh fruit, while plantains or cooking bananas are boiled, steamed, fried or roasted. The plants are considered as the symbol of 'prosperity and fertility'. **It has greater socio-economic value and multifaceted uses, hence referred as '*Kalpatharu*' (Plant of Virtues). India is the largest producer of banana in the world, producing 32 million tons from an area of 9.00 lakh hectares with a productivity of 36 MT/ha. India exported 2.0 lakh MT valued at Rs. 1000 crores in the last year.** Adoption of recent varieties/technologies in production, post-harvest management, and processing has significantly contributed for increasing production and productivity of banana with improved quality. Of late, banana is emerging as an industry and has greater contribution to the economy through livelihood and nutritional security.

Post-harvest management

The post-harvest life of fruit starts from the time it is cut from the mother plant. Banana being a climacteric fruit is highly perishable and has got a short shelf life after harvesting. The post harvest losses are high (to the tune of 25%) due to faulty handling adopted by farmers, traders and retailers. In terms of value, it is more than Rs.2500 crores annually.

The post harvest losses are estimated to be highest at retailer's level (10-15%). The loss at farmers' level is due to mishandling during harvesting and loading which is estimated to be about 8-9%. Besides these losses, there is an invisible loss due to the physiological loss in weight (PLW) during ripening phase. In order to reduce the post harvest losses and to enhance the shelf life, it is essential to adopt scientific technologies of post harvest handling of fruits.

Maturity and harvesting

The quality of bananas is influenced by many factors. The stage of maturity is of prime importance which depends on whether the fruit is meant for long distance transport or local consumption. Bananas to be marketed locally can be harvested at a higher maturity stage than those to be transported for long distance markets. Generally fully mature bunches (90-95%) are harvested for domestic market, while for regional markets, the fruits have to be harvested at 80-85% maturity. For long distance transportation and export, the harvesting has to be done at 70-75% maturity (about 30 days shipment) or 75-80% maturity (about 15 days shipment) depending upon the destination to reach.

Maturity indices

Several parameters have been suggested for determining the maturity of banana fruits on the basis of their external appearance and chemical constituents at the time of harvest. These indices also differ considerably among different varieties and even strains of fruits. Some of the indices used in different parts of the world are as follows:

1. Age after shoot/ flower emergence: It takes 90 to 140 days depends on variety and prevailing climatic conditions.

2. Angularity of the fingers: The disappearance of the angularity (prominent edge) of the fruits attaining the maturity is the criteria for most of the varieties in banana.

3. **Diameter and Length of fingers (Caliper grade):** Both the parameters increase towards the maturity of the fruits. Caliper grade (mm) is used to measure the girth of the finger and correlated with the maturity.

4. Heat Units: It is measured in degree days. The heat unit approach or remainder index method is also known by other expressions like growing degree days (GDD), growth units, thermal time or degree days.). Changes in banana production cycle is expected with the temperature variability across banana growing regions in the coming years. Therefore, temperature based indices using the sum of daily temperature like helio-thermal units (HTU), photothermal units (PTU) and growing degree days (GDD) could be computed and successfully employed to elucidate the phenological behaviour and yield

Growing degree days (GDD) = $\Sigma (T_{Max} + T_{Min}) /2 - T_{Base}$

GDD requirement from flowering to fruiting among the varieties varied from 1125 (Popoulu) to 2031 (Ney Poovan) degree days.

Harvesting and Field handling

Banana bunches are harvested with a curved knife leaving about 6-9 inches of stalk attached to the bunch which serves as a handle for carrying. Improved handling methods have greatly reduced the bunch injuries. In some cases, the harvested bunches are carefully placed on 10-12 cm thick bed of banana leaves on ground or a thick foam bed to allow the latex to flow from the cut ends. After latex flow ceased, the bunches are carried to the packing shed in baskets lined with foam, if it is nearby, whereas for the long-distance market, the de-handing is done in the field itself and packed in plastic crates by covering the hands with foam sheet and taken to pack house in a van/lorry.

Pack house

De-handing and pre-storage treatments

De-handing is cutting off the hands from peduncle of the bunch. In order to avoid crown rot and finger drop, it is essential to cut the hands along with a portion of peduncle. Care should be taken not to inflict any injury on the fruits. Usually, sickle is used for de-handing purpose. However, **'Banana - comb/hand cutter'** developed by CIPHET, Ludhiana (Punjab) is being used to ease the de-handing process. The hands may further be trimmed into required number of fingers based on the size and shape of the packaging cartons. The cut hands or fingers are to be placed on the banana leaves or foam / rexin sheets on tables or ground in such a way that the tips of the fingers and cut end portion of the hand rest directly on the floor or table. The latex from the cut end should not be drop or stain the fruits. The de-latexing can be done by allowing the latex to ooze out

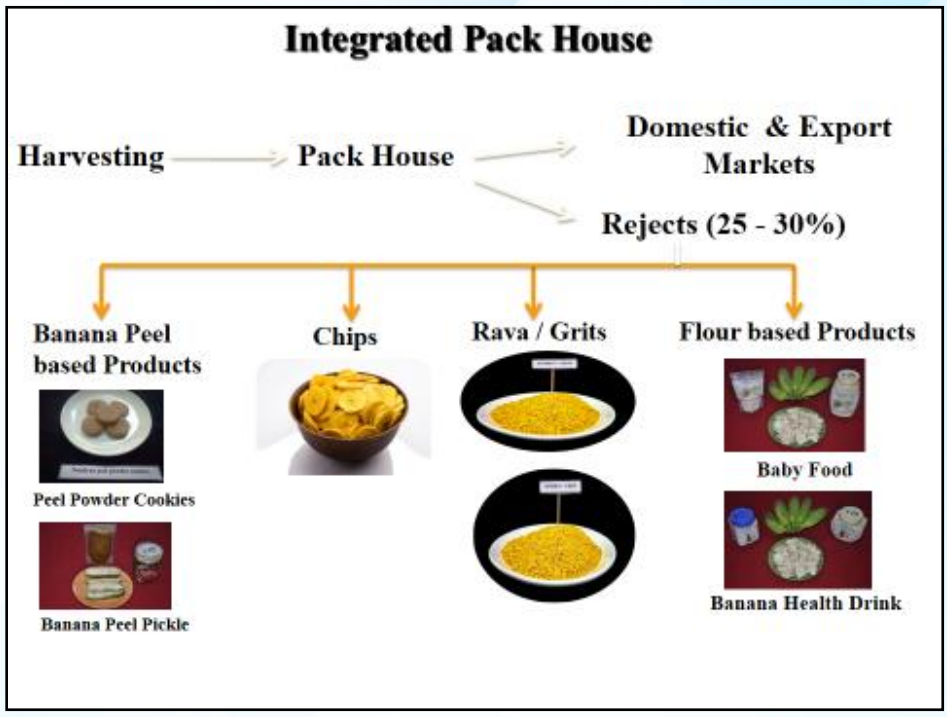
or it can be floated in a tank containing detergent or sodium hypochlorite solution, where the latex gets washed out. In India for domestic market, de-handing is not commonly practiced. But, for export trade, de-handing is essential by which defective, damaged and under developed hands are culled out. **Selected hands are then washed in tanks containing any surface disinfectant like 100 ppm sodium hypochlorite solution or 10 ppm chlorine and systemic fungicide solution at least for 5 minutes as prophylactic measure against crown rot and anthracnose diseases during transport and storage.** The hands are dried using the blast of air from pedestal fans or blowers. Care should be taken not to leave any droplets of water on the surface or in between fruits/pedicels.

Packaging

First, the hands are graded based on size and quality and then packed in layers in special ventilated cartons with plastic (PUF) padding to minimize bruising. In Indian banana marketing system, the concept of packaging is yet to be practically adopted. A major quantum of bananas is traded either naked or just wrapped with banana leaves. No systematic grading and packaging are followed while it plays a very important role in marketing of the produce and appropriate packaging can lead to high price realization. In some cases, for domestic market, hands are packed in plastic crates while for distance/export market, it is done in 5-ply CFB boxes by placing two sachet of ethylene scrubber and partially vacuuming with vacuum cleaner. For long distance market, the CFB boxes are stacked and palletized. Modified atmospheric packaging (MAP)/Active packaging and Controlled atmospheric packaging (CAS) techniques are also used for export of banana.

Pre-cooling and storage

Rapid cooling after harvest is generally referred to as pre-cooling and particularly benefits rapidly respiring fruits like Mango, banana, etc. Pre-cooling is essential as refrigerated ships, land vehicles and containers are not designed to handle the full load of field heat but are designed to merely maintain pre-cooled produce at the selected carriage temperature. Out of various methods of pre-cooling, forced air cooling is widely practiced in banana. Banana after packaging in carton should be pre-cooled in pre-cooling chambers till the core temperature of banana attained the storage temperature (13-14^{o}C), which can be checked using needle thermometer. Care should be taken to ensure that pre-cooling should be done gradually for a period of



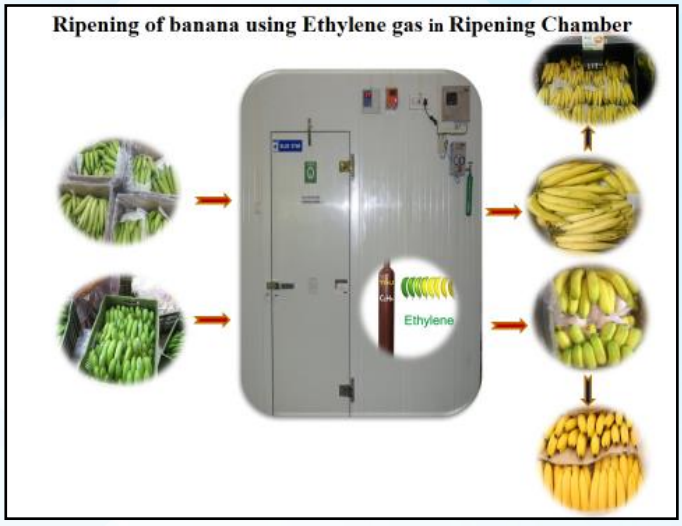
4-6 hours to avoid internal damage of the tissue. Pre-cooling or storage below 13ºC predisposes the banana fruit to chilling injury. Generally, pre-cooling is not adopted for banana.

Storage life of banana can be extended by packaging in sealed polyethylene bags with ethylene absorbent and placing at **13 - 14ºC with 85% relative humidity**. Harvesting of bunches at 75 – 80% maturity, storage at low temperature, modified atmosphere storage, packaging in film bags of **400 gauge thickness** to create modified atmosphere, pre-treatments with fungicides and chemicals and coating the skin with waxes are some of the methods highly useful in extending the storage life of bananas up to 2 – 3 months. Integrated pack house is a recent concept in which the rejects/wastes (20 to 25%) can be converted into intermediate/minimally processed/finished products in the pack house itself by adding minimal processing facilities.

Integration of postharvest treatments like harvesting at 75% maturity, de-handing of bunches, systemic fungicide at 500 ppm, heat-shock treatment at 46-51ºC, and storage at **13.5 º C in sealed polybags of 400 gauge thickness with ethylene scrubber** can extend the shelf-life of green bananas up to two to three months, depends on cultivar. The cold stored carton boxes are stuffed into the reefer container (40ft container can hold 20 MT) maintaining the same temperature of 13-14ºC till reaching the destination after obtaining PSC at APEDA approved pack house and clearing seaport formalities. At destination, the CFB boxes are unloaded from the container and cold stored. As and when required, the fruits are ripened and distributed. For domestic market, the fruits are ripened in the plastic crates itself and distributed after color break.

Ripening

Fruit ripening is a natural process. However, intentional exposure is primarily used to ripen harvested fruits. When the un-ripened fruit reaches physiological maturity in the plant, it starts ripening. Ethylene is considered as safe fruit ripening hormone, which presents in the physiologically matured un-ripened fruit ranging from 0.1 to 1.0 ppm. Since ethylene produced naturally within fruit is not sufficient to ripen quickly and uniformly, application of additional **exogenous application of ethylene gas @ 100-150 ppm for 18 to 48 hrs is recommended to merely accelerate the normal ripening process.**



Exposure of green mature banana fruits (Grand Naine, an export variety) to ethylene gas at 100 ppm for 24 h, followed by storage at 18-20 º C and 90-95% RH ensures faster and uniform

ripening in 48 hrs with development of uniform color, flavour, desirable firmness and consumer acceptability. However, untreated control fruits were hard textured and poor in color and quality.

The most important thing in this technique is temperature and relative humidity control inside the ripening chamber, which should range between 15-25^{0}C and 90-95% relative humidity, depending upon the fruit type/cultivar. There is no health risk associated with fruits ripened with ethylene, because it is a natural gaseous hormone, which triggers only the fruit ripening process and escapes into the atmosphere without leaving any harmful residue in the fruit tissues; hence use of Ethylene gas to promote ripening of fruits and vegetables is sanctioned under FDA Regulation 120.1016. However, use of ethrel/ethephon in the form of dip/immerse or spray is banned for ripening of fruits as per FSSAI Act. Calcium carbide is also banned as it is carcinogenic and smoking is an unhygienic method of ripening.

Codex standard for bananas

(CODEX STAN 205-1997, AMD. 1-2005)

1. Definition of produce

This Standard applies to commercial varieties of bananas grown from *Musa* spp. (AAA), of the *Musaceae* family, in the green state, to be supplied fresh to the consumer, after preparation and packaging. Bananas intended for cooking only (plantains) or for industrial processing are excluded. Varieties covered by this Standard are included at the end of this chapter.

2. Provisions concerning quality

2.1. Minimum requirements

In all classes, subject to the special provisions for each class and the tolerances allowed, the bananas must be:

- whole (taking the finger as the reference);
- sound, produce affected by rotting or deterioration such as to make it unfit for consumption is excluded;
- clean, practically free of any visible foreign matter;
- practically free of pests affecting the general appearance of the produce;
- practically free of damage caused by pests;
- free of abnormal external moisture, excluding condensation following removal from cold storage, and bananas packed under modified atmosphere conditions;
- free of any foreign smell and/or taste;
- firm;
- free of damage caused by low temperatures;
- practically free of bruises;
- free of malformation or abnormal curvature of the fingers;
- with pistils removed;
- with the stalk intact, without bending, fungal damage or desiccation.

In addition, hands and clusters must include:

- a sufficient portion of the crown of normal coloring, sound and free of fungal contamination;
- a cleanly cut crown, not beveled or torn, with no stalk fragments.

2.1.1 The development and condition of the bananas must be such as to enable them:

- to reach the appropriate stage of physiological maturity corresponding to the particular characteristics of the variety;
- to withstand transport and handling; and
- to arrive in satisfactory condition at the place of destination in order to ripen satisfactorily.

2.2 Classification

Bananas are classified in three classes defined below:

2.2.1 "Extra" Class

Bananas in this class must be of superior quality. They must be characteristic of the variety and/or commercial type. The fingers must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package.

2.2.2 Class I

Bananas in this class must be of good quality. They must be characteristic of the variety. The following slight defects of the fingers, however, may be allowed, provided these do not affect the general appearance of the produce, the quality, the keeping quality and presentation in the package:

- slight defects in shape and colour;
- slight skin defects due to rubbing and other superficial defects not exceeding 2 cm^2 of the total surface area. The defects must not, in any case, affect the flesh of the fruit.

2.2.3 Class II

This class includes bananas which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements specified in Section 2.1 above. The following defects, however, may be allowed, provided the bananas retain their essential characteristics as regards the quality, the keeping quality and presentation:

- Defects in shape and colour, provided the product retains the normal characteristics of bananas;
- skin defects due to scraping, scabs, rubbing, blemishes or other causes not exceeding 4 cm^2 of the total surface area. The defects must not, in any case, affect the flesh of the fruit.

3. Provisions concerning sizing

For the purposes of sizing bananas of the Gros Michel and Cavendish sub-groups, the length of the fingers is determined along the outside curve from the blossom end to the base of the pedicel where the edible pulp ends and the diameter is defined as the thickness of a transverse section between the lateral faces. The reference fruit for measurement of the length and grade is:

- for hands, the median finger on the outer row of the hand;
- for clusters, the finger next to the cut section of the hand, on the outer row of the cluster.
- The minimum length should not be less than 14.0 cm and the minimum grade not less than 2.7 cm.

4. Provisions concerning tolerances

Tolerances in respect of quality and size shall be allowed for produce not satisfying the requirements of the class indicated.

4.1 Quality tolerances

4.1.1 "Extra" Class

Five percent by number or weight of bananas not satisfying the requirements of the class, but meeting those of Class I or, exceptionally, coming within the tolerances of that class.

4.1.2 Class I

Ten percent by number or weight of bananas not satisfying the requirements of the class, but meeting those of Class II or, exceptionally, coming within the tolerances of that class.

4.1.3 Class II

Ten percent by number or weight of bananas satisfying neither the requirements of the class nor the minimum requirements, with the exception of produce affected by rotting, major imperfections or any other deterioration rendering it unfit for consumption.

4.2 Size tolerances

For all classes, 10% by number or weight of bananas not satisfying the requirements as regards sizing, but falling within the size immediately above or below those indicated in Section 3.

5. Provisions concerning presentation

5.1 Uniformity

The contents of each package must be uniform and contain only bananas of the same origin, variety, and quality. The visible part of the contents of the package must be representative of the entire contents.

5.2 Packaging

Bananas must be packed in such a way as to protect the produce properly. The materials used inside the package must be new *(recycled material of food-grade quality)*, clean, and of a quality such as to avoid causing any external or internal damage to the produce. The use of materials, particularly of paper or stamps bearing trade specifications is allowed, provided the printing or labelling has been done with non-toxic ink or glue.

Bananas shall be packed in each container in compliance with the Recommended International Code of Practice for Packaging and Transport of Fresh Fruits and Vegetables (CAC/RCP 44-1995, Amd. 1-2004).

5.2.1 Description of containers

The containers shall meet the quality, hygiene, ventilation and resistance characteristics to ensure suitable handling, shipping and preserving of the bananas. Packages must be free of all foreign matter and smell.

5.3. Presentation

- The bananas must be presented in hands and clusters (parts of hands) of at least four fingers. Bananas may also be presented as single fingers;
- Clusters with no more than two missing fingers are allowed, provided the stalk is not torn but cleanly cut, without damage to the neighboring fingers;

- Not more than one cluster of three fingers with the same characteristics as the other fruit in the package may be present per row.

6. Marking or labelling

6.1 Consumer packages

In addition to the requirements of the Codex General Standard for the Labeling of Prepackaged Foods
(CODEX STAN 1-1985, Rev. 1-1991), the following specific provisions apply:

6.1.1 Nature of Produce

If the produce is not visible from the outside, each package shall be labeled as to the name of the produce and may be labeled as to name of the variety.

6.2 Non-retail containers

Each package must bear the following particulars, in letters grouped on the same side, legibly and indelibly marked, and visible from the outside, or in the documents accompanying the shipment.

6.2.1 Identification

Name and address of exporter, packer and/or dispatcher.
Identification code (optional) (*The national legislation of a number of countries requires the explicit declaration of the name and address. However, in the case where a code mark is used, the reference "packer and/or dispatcher (or equivalent abbreviations)" has to be indicated in close connection with the code mark*).

6.2.2 Nature of Produce

Name of the produce if the contents are not visible from the outside. Name of the variety or commercial type (optional).

6.2.3 Origin of Produce

Country of origin and, optionally, district where grown or national, regional or local place name.

6.2.4 Commercial Identification

- Bananas in fingers (when appropriate);
- Class;
- Net weight (optional);

6.2.5 Official Inspection Mark (optional)

7. Contaminants

7.1 The produce covered by this standard shall comply with those maximum levels of the Codex General Standard for Contaminants and Toxins in Food and Feed (CODEX STAN 193-1995).
7.2 The produce covered by this standard shall comply with those maximum pesticide residue limits established by the Codex Alimentarius Commission.

8. Hygiene

8.1. It is recommended that the produce covered by the provisions of this Standard be prepared and handled in accordance with the appropriate sections of the Recommended International Code of Practice - General Principles of Food Hygiene (CAC/RCP 1-1969, Rev. 4-2003), Code of Hygienic Practice for Fresh Fruits and Vegetables (CAC/RCP 53-2003), and other relevant Codex texts such as Codes of Hygienic Practice and Codes of Practice.

8.2. The produce should comply with any microbiological criteria established in accordance with the Principles for the Establishment and Application of Microbiological Criteria for Foods (CAC/GL 21-1997).

List of the main groups, subgroups and cultivars of bananas for dessert

Groups	Sub - groups	Main cultivar
AA	Sweet-fig	Sweet-fig, Pisang Mas, Amas Date, Bocadillo
AB	Ney Poovan	Ney Poovan, Safet Velchi
AAA	Cavendish	Dwarf Cavendish, Giant Cavendish, Lacatan, Poyo (Robusta), Williams, Americani, Valery, Arvis
	Gros Michel	Gros Michel, Highgate
	Pink Fig	Pink Fig, Green pink Fig
	Ibota	
AAB	Apple Fig	Apple Fig, Silk
	Pome (prata)	Pacovan, Prata Ana
	Mysore	Mysore, Pisang Ceylan, Gorolo

Source: Codex Alimentarius (First Edition, 2007). Fresh Fruits & Vegetables. WHO & FAO, Rome (ISBN 978-92-5-105839-8). Pp. 18 - 23.

Conclusion

Both banana and plantain provide food, nutrition and social security to millions of people across the globe. Profitable banana farming can be done by adopting high yielding varieties coupled with modern and hi-tech production and post-harvest technologies. Post harvest losses can be minimized by adopting improved post-harvest handling practices in integrated pack house, processing and value addition; thereby the fresh banana and processed products can be stored for long time without deterioration in quality. Export of fresh bananas and by diversification into product development will create additional rural employment, revenue generation and also improve the nutritional and livelihood security of banana producers and consumers. In addition, Agri-Business Incubation (ABI) Centre will function as platform for converting smart ideas into smart start-ups and developing successful entrepreneurs.

Artificial Intelligence (AI) and Sensors: Tools for next generation Horticulture

Shuprajhaa T* and Suresh Kumar P**

*Senior Research Fellow; **Principal Scientist (Hort.,)
ICAR-National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India - 620 102
Corresponding author: psureshars@gmail.com

Introduction

In this modern era, with the ever-growing pace of sophisticated advancements in every field, there has been an unprecedented growth in the amalgamation of engineering aspects in the horticultural domain which covers perennial as well as annual crops including variety of fruits, nuts, vegetables, flowers, spices, plantation crops, exotic crops etc. When compared with other agricultural domains, horticulture, though grown in relatively smaller crop zone, remains hot in terms of high financial value as well as rich nutritional value. A major shift in area from food grain cultivation towards the horticultural crop cultivation has been witnessed in India. Over the last decade, the area under horticulture in India grew by 2.6% per annum and annual production increased by 4.8%. As per the estimates of Area and Production of various Horticulture Crops, released by the Department of Agriculture, Cooperation and Farmers Welfare, total horticultural production of 2019-2020 was expected to be at 320.48 million tons (i.e) a surge of 3.13% higher than the last year. Fruit production in particular was expected to be 99.07 million tons. This is due to the increased production of Banana, Apple, Citrus and Watermelon.

In traditional horticultural practices, critical decision-making necessity exists among the cultivators to decide on how effectively to prepare the soil, sow the seeds, cultivate crops and harvest crops at the right time. Various factors such as rainfall, temperature, humidity, geographical conditions play an important role in this decision-making process. In addition, resource management including water, nutrient resources should be effectively handled to have healthy crops. Lack of proper irrigation and nutrients could lead to perish besides, weed and pest control also plays an important role. Inclusion of technological methods and current ideas into the horticulture sector to circumvent the above issues in managing variability, crop production as well as crop protection has opened up new ventures to ease out human intervention in the entire process. With the need for better crops, the adoption of years old agricultural methodologies would no longer suffice. Necessity to cope with the tremendous need for healthy food, automated farming practices came into picture in the early twentieth century.

Soft computing techniques and Artificial Intelligence – a gist

Soft computing is a term that is coined for computational decision-making techniques based on knowledge and observations mimicking human thinking capability. Such techniques are different from the conventional decision-making computing methods as the conventional methods require approximate mathematical or physical model of the subject under consideration for arriving at conclusions. Some of the few techniques of soft computing include fuzzy logic, Genetic Algorithms (GA), Particle Swarm Optimization (PSO), Evolutionary programming (EP), Artificial Neural Networks (ANN), and machine learning (ML) techniques. Artificial Intelligence, the recent buzz

word revolving in almost all domains of human life could be explained in simple words as an intelligent machine-like system which has capability to think, act and decide like humans. With the advent of AI, scientists/farmers can manage/ solve various complex problems without human intervention; provided, the AI machine is given the required updated information.

AI in crop planning

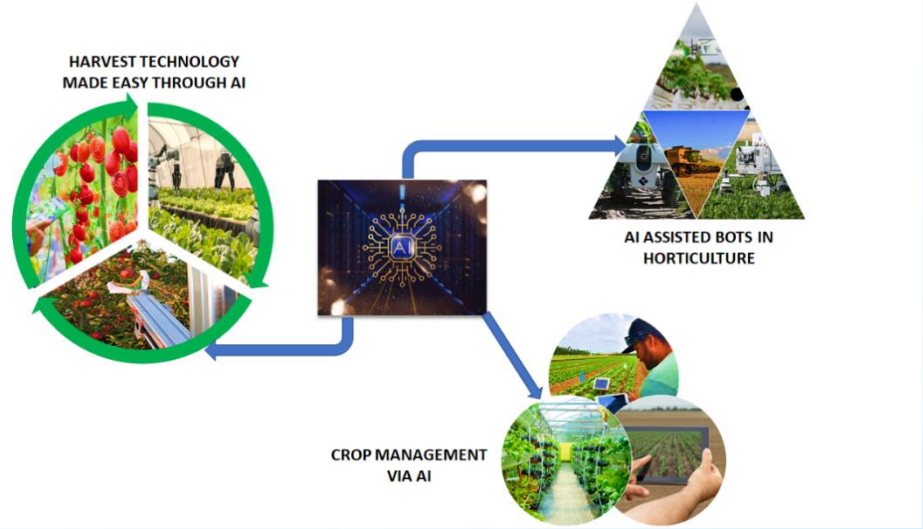
Crop planning is the process of how optimally horticultural land is allotted among various competing crops that are desired to be grown on the land. This is highly essential as ignorance of topographical conditions and prediction of weather changes can cause a huge loss in produce and finance. Farmers are bound to take critical decisions on which horticultural crop variety to be grown in what proportion in order to enhance the productivity. Owing to the influence of various external factors on this critical decision, it is highly complicated to evaluate and arrive at conclusion on what variety could be grown to meet the growing demand and hence profitable yield.

The objective of AI assisted devices is to suggest the cultivator's effective crop planning strategies to combat the issues of effective resource allocation for the forthcoming period of cultivation. Crop planning is inherently an optimization problem and hence optimization techniques such as Linear programming approach, Dynamic programming, simulated annealing, Evolutionary programming, GA, PSO etc. are used to obtain optimal solution. The AI device is trained initially with necessary expert knowledge inclusive of previous records of crop cultivation, resource requirement of horticultural crops, geographical knowledge of the area under cultivation, climatic and weather conditions. The optimization algorithm coded in the AI device now acts upon the available information and provides an optimal solution of crop planning. Thus, AI assisted crop planning is a merge of machine with human expertise. An effective crop planning can potentially save human labour, time and also eliminate weather risks.

AI enabled irrigation

Adequate irrigation is the key for crop growth and better yield. However, with the rapid population increase, there arises a need to effectively utilize natural water resources. This creates a potential need to develop smarter technology to assist automatic and scheduled irrigation techniques. Soil moisture sensors are placed at different locations in the field near to the root zones of the crops to monitor the moisture content of the soil. The data from the sensors are transmitted to the AI assisted controller for irrigation. Optimization techniques incorporated in AI operates the controller. The role of these optimization algorithms is to decide upon the optimal amount of water to be irrigated based on the ambient prevailing environmental conditions and the moisture content measured by the sensors. Based on the already trained expert knowledge, the optimization principle-based AI controller, is capable of arriving at a conclusion on the rate of irrigation to be performed. This device could also be further enhanced with scheduled irrigation facility. When the prescheduled time arrives, the moisture sensor reads the data and sends to the optimization algorithm. The algorithm processes further and decides when and how much irrigation must be done for the crops.

Soft computing and AI in crop management



Crop management refers to the activity of enabling an effective growing environment with conducive climatic conditions for the crops. An important aspect of crop management is the pest control. Conventional crop pest management techniques involve manual observation, classification and effective control actions being adopted. With the AI assisted sophistication, farmers can adopt to use visionary imaging system integrated with AI techniques to enhance crop management on a larger scale. Usually, texture of leaves is adopted as a measure for the identification of pest activity in plants. This could be automated with AI by the incorporation of neural networks and fuzzy logic techniques. With the images obtained from the visionary system, the neural networks run the classification algorithm based on the neurons and associated weights. Fuzzy logic operates on IF-THEN conditional statements and comes to conclusion of pest affected or not affected crops based on the already trained algorithm built from expert knowledge. With such AI assisted crop management, it becomes easier to identify whether a pest has affected the crop or not and identification of what kind of pest has affected. AI assistance enables the farmers to spray chemicals only for crops that have been affected by pests. This explicitly reduces the usage of chemical spraying on the entire farm. This lessens the dependency of farmers on agricultural experts for consultation as the expert knowledge has been converted to computing techniques and AI has replaced the expert knowledge.

Smart technologies for smart farming and remote market access

Many smart and advanced techniques could be made available to the farmers just at the touch of a button. With the fragmentation of land and shrinking areas under farming, making the farming lucrative and attractive is essential to bring youth to horticulture with the application of new technological tools. Smart techniques have found a quite wide frontier of application ranging from monitoring a small plant cell to a larger hectare level of global remote survey and automated decision-making systems. Of late, observation and remote monitoring of crops involving environmental machinery and incorporating an advanced intelligent technology has gained more attention. Also, lacking horticultural infrastructure and the unorganized retail market has made India stand one among the top nations of post-harvest food losses. In addition, the degrading natural resources, the demanding competition for its usage and the exacerbating climatic pattern make the horticultural economy stumble upon.

AI could also assist the farmers to predict the expected financial trend for any particular crop and plan accordingly. A major part of horticultural revolution happened with the introduction of soft computing, sensors and artificial intelligence (AI). Combination of machine learning (ML) and AI is nowadays used in precision horticulture to impart data. It helps farmers to monitor and optimize crops and keep up with changing environmental factors. AI has deep benefited applications in all parts of horticulture right from crop calendar planning, sowing, irrigation, weeding, pesticide application and crop quality management. This article provides an insight of current state of various soft computing techniques and next generation AI in agricultural practices for better crop protection and improvement.

ANN based prediction of crop quality

Crop yield forecasting is an important step in effective farming and plant management system. Numerous factors such as the area under cultivation, proper irrigation system, amount of rainfall, quality of seeds, topographic attributes, application of pesticides and fertilizers, disease occurrences in plants etc. contribute its effect on the crop yield. Although accurate crop yield estimation is highly tedious, artificial neural networks have been trained using statistical data to bring out a relationship between crop yield and some of the above said contributing factors. Multi-layer perceptron (MLP), a feedforward neural network is trained initially with already existing different plantation area and the crop yield of a particular crop being grown. The network learns and updates itself based on the huge sum of training data given by the expert system, (i.e) human knowledge. Upon effective training, multi-layer perceptron neural network is able to predict the crop yield given, a particular cultivation area and few other supporting data.

AI in post-harvest handling

Postharvest loss is a major challenge hampering production of horticultural crops in most developing countries with country losing more than 75000 crores every year due to poor handling of the produces. Incorporation of specialized post-harvest technological practices and treatment methodologies are necessary to enhance the shelf life of the produce. When such specialized techniques are failed to be practiced, loss in a huge rate is experienced. AI techniques including Block chain management and traceability are employed in post-harvest technology to enhance better crop quality improvement. The main objectives of including AI systems in post-harvest technology includes, implementing effective crop management system that maximizes the yield without affecting the quality, employing optimal post-harvest handling practices to maintain quality and safety of the produce. AI are also developed to predict the storage conditions and hence suitable preventive actions to be taken to avoid rotting of the stored food products. AI systems are also engaged in the micro management of storage environment remotely with the use help of sophisticated smart sensors and other AI machinery.

Conclusion

In a nutshell, soft computing and AI is an integration of biological human thinking ability with computational techniques. In all the above stated techniques, human expert knowledge of crop yield, management and protection are converted as machine readable information. The intelligent system operated with soft computing techniques is made to read and trained with the information

from expert system. With the adequate information about the crops and effective training, the AI assisted machine is now independent enough to take decisions without manual intervention. AI and soft computing techniques are continuously doing wonders with horticulture thus making farming cozier and more comfortable. Hence, AI assisted horticultural practices could be effectively used in, "**Next generation Horticulture**" with intelligent sensors and decision-making support system. Employment of such advance technologies not only ease out the farmers work but also enable them to improve the yield and protection measures of the farms. An efficient public-private partnership model can enable to bridge the gap between technological advancements and India's horticultural sectors. AI joined hands with horticulture can create a big transformation in terms of uplifting its level of production. In a country where suicide of farmers is a day-to-day news, introduction of such cutting-edge technological AI s could actually allow farmers to minimize risk and loss in terms of prediction of weather as well as market demand. AI on the whole, is definite to usher the horticultural community massively.

Phytosanitary measures to be followed in export of Banana

Thangavelu R*, Loganathan M* and Selvarajan, R**

*Principal Scientist (PP), **Director
ICAR - National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India - 620102
Corresponding author: rtbanana@gmail.com

Bananas succumbs to many biotic stresses especially fungal diseases such as Fusarium wilt eumusae leaf spot pitting, freckle, cigar end rot crown rot, anthracnose besides viral and bacterial diseases. A vast number of chemicals have been applied to control fungal diseases. But success of their applications depends on correct diagnosis, choice of chemicals and persistency. Residues are the major concern in export of any commodity in the global market. Therefore, here we cover diagnosis of fungal diseases of banana, possible good agricultural practices (GAP) for management of the diseases and future prospectus.

Symptoms

Correct identification is a primary need for successful management of any disease and it can be achieved through proper diagnosing the symptoms. Here important fungal diseases which would have role in deciding export quality and their key identifications symptoms have been summarized in table.

Symptoms of important diseases of banana

S. No	Diseases	Symptoms	Remark
1.	Fusarium wilt (*Fusarium oxysporum* f. sp. *cubense*)	**Symptoms of *Foc* Infection** **External symptoms** • Yellowing of lower older leaves from margin and progressing towards the midrib usually starting approximately 5 months after planting. • Petiole turns brown and buckles. • Longitudinal splits on the pseudostem just above soil level. • Dead leaves hang down around the pseudostem showing a skirt like appearance to the infected plant. • Young leaves often stand usually erect, giving the plant a 'spiky' appearance. • Newly emerging leaves of infected plants show pale appearance, reduced in size, exhibit wrinkling and distortion and eventually emergence of leaf ceases. • Generally, infected plants produce no fruit bunches and if produced, the fruits will be very small and only a few fingers develop from which fruits ripen	Race 1 - infects Gross Michel, Rasthali, Karpuravalli Race 2 - infect Bluggoes bananas Race-3 - infects *Heliconia* Race 4 - infect Cavendish clones and race 1 and race2 susceptible varieties

		irregularly and the flesh is pithy and acidic. **Internal symptoms** • Purplish brown discolouration of the vascular bundles which is visible in the cross-section of the corm, pseudostem and sometimes in the bunch stalk are the typical internal symptoms. • These symptoms can be seen within one or two months of the emergence of suckers. In the corm, the discolouration appears as a collection of tiny reddish or brownish dots and streaks. • The discolouration of the rhizome is most severe where the stele joins the cortex.	
2.	Eumusae leaf spot (*Pseudocercospora eumusae)*	• Earliest symptoms appear on the third or fourth leaf from the top. • Symptoms start with pale yellow or greenish-yellow streaks parallel to the veins on the upper surface of the leaves. Then, these streaks darken and become more or less elliptical brown spots. • The primary lesion is a brown streak that expands to form large brown spots and as the disease progresses, the spots become grey in the centre surrounded by brown border. Later on, the centre of these spots turn to light grey colour surrounded by a yellow halo. • Finally, the lesions coalesce and cover a large area of the leaf and finally the leaf hangs down.	In India only *P. eumusae* leaf spot has so far been recorded.
3.	Crown rot (*Lasiodiplodia theobromae* and *Colletotrichum musae)*	• A major problem in export banana. • It attacks the region where the hands unite with peduncle *i.e.* “Crown”. • Its infection starts from harvest and rotting establishes in due course mainly during shipping where physiological changes take place. Initially, the rotting establishes in the crown and later it spreads to peduncle and fruits. The infected crown region shows grey to white or pink mycelial growth and necrotic black rotting. • Severely infected banana fruits may detach from peduncle or rot completely.	Occurs as post-harvest diseases

4.	Anthracnose (*Colletotrichum musae*)	• Sunken black lesions with acervuli or spore masses in the lesions. • Normally infection starts from fruit development and remains quiescent till the fruit ripens. • Severely infected fruits turn black and become unmarketable.	Mostly occurs as post-harvest diseass
5.	Cigar End Rot *Verticillium theobromae*	• Necrosis of pistillate flowers and immature finger tip. • Fruit pulp shows dry rot. • Necrotic rotting at the fruit tip covered with white ashy mycelia and conidia which alike burnt cigar end. • The zone between rotting and healthy is demarked by black zone. • Later the necrotic rotting covers entire fruit.	Occurs as preharvest disease
6.	Pitting Disease (*Pyricularia angulata*)	• Formation of circular or oval sunken or depressed reddish-brown or black or dark brown dry spots surrounding with yellowish-brown or reddish-brown zone and their outer zone used to be water-soaked halo. • Sometimes splitting is seen in the centre of the pit. • On fruits, generally 70 days or more (from shooting) old fruits show the symptoms while young fruits exhibit only slight pitting. • Pitts may extend to finger stalk as well.	Occurs as preharvest disease
7.	Freckle spot (*Phyllosticta cavendishii*, *Phyllosticta musarum*, *Phyllosticta maculata* and *Guignardia stevensii*)	• Initially, it forms reddish-brown spots (0.5-1 mm diameter) on the upper surface of the leaf, later the spots turn in to dark brown or black. • Sometimes it produces dense spots. • Normally the spots contain sac-like structures, which filled with the fungus spores and they protrude from the leaf surface and feel rough to the touch, like sandpaper. • Black spots develop on green fruit and fruit stalks and may completely cover the fruit by the time of harvest. • The severity of the disease increases as the fruit matures. • Marketability of fruit is affected as it spoils the appearance of the fruit but the eating quality is not affected.	Occurs as preharvest disease

Integrated approaches for the management of the diseases

Effective management of this disease is possible only when the integration of different management strategies available and are followed, since no single method so far been developed is able to effectively contain the disease. This approach not only reduces the initial inoculum but also increases the plant resistance, delay the disease development and reduce the effectiveness of initial inoculum (Agrios, 1997). Therefore, the following integrated management practices are recommended to contain the disease effectively and also to avoid the indiscriminate application of several chemicals which may lead to accumulation of residues in the products and which may in turn affect severely the export market of the fruits.

Fusarium wilt disease

- Quarantine the infected to avoid spreading of the disease from infected areas to healthy fields All implements (knives, spades etc.) and the foot wares used in these areas must be decontaminated with a detergent degreaser (eg.'*Farm cleanse*' made by Castrol) before leaving the infested site.
- Use tissue culture plantlets instead of suckers as planting material to avoid spread through infected suckers. If suckers are to be used they should be taken from the disease free garden.
- Crop rotation of either paddy or sugarcane once or twice followed by a banana for two to three cycles is found effective.
- Bio–priming of banana plants with NRCB consortia consisting of *Trichoderma asperellum* Prr2 + *Bacillus subtilis* bioformulation and also at 2^{nd}, 4^{th} and 6^{th} month after planting @50 g per plant.
- Use leaf extracts of Zimmu (*Allium sativum* × *Allium cepa*) at 50% concentration @ 1 to 2 litres per plant at o^{th} , 2^{nd}, 4^{th}, and 6^{th} month after planting

Eumusae leaf spot

- Removal of dried disease infected leaves from the banana plant from fouth months onwards and destroying by burning outside the field.
- Following appropriate spacing for each banana cultivars, timely removal of side suckers, weed-free cultivation and proper drainage conditions may reduce the disease severity.

ICAR – NRCB spray schedule as mentioned below is effective against the leaf spot

Days after planting	Qty of chemicals/ litre of water
150 days	Propiconazole 1 ml + Mineral oil 10 ml
175 days	Carbendazim + Mancozeb 1 g + Mineral oil 10 ml
200 days	Trifloxystrobin + Tebuconazole (Nativo) 1 g + Mineral oil 10 ml
225 days	Difenaconazole 1 ml + Mineral oil 10 ml
250 days	Propiconazole 1 ml + Mineral oil 10 ml
275 days	Carbendazim + Mancozeb + Mineral oil 10 ml
300 days	Difenaconazole 1 ml + Mineral oil 10 ml

Crown rot

- Constant removal of dried hanging leaves and floral remnants, packing fruits in trash-free boxes, and use of chlorine-treated water for washing fruits and delatexing may reduce the fruit contamination.
- Other management practices include bunch sleeving using perforated plastic films and, use of sharp tool to dehand the bunch and neat trimming.
- Modified atmospheric packaging practices for export are increasing CO2 concentration (10 - 13%), absorbing ethylene and reducing oxygen level (3–7%).

Anthracnose

- Sorting out damaged fruits during harvest and transportation.
- Field sanitation by removing dead leaves, proper weeding, providing good drainage and removal of male buds.
- Harvesting the bunches at correct stage of maturity.
- Spray of Copper Oxychloride 50 % WP @ 0.25%

Cigar end rot

- Field hygiene through removal of dead leaves and flower.
- Covering bunches with polythene bags.
- Removal of accumulated trash in the bags.
- Clean maintenance of ripening chamber and pack houses
- Some fungicides such as Trifloxystrobin +Tebuconazole, Thiabendazole, Difenoconazole and Propiconazole were effective against the disease.

Pitting disease

- Removal of dead leaves and trashes
- Field cleaning including removal of transition leaves and bracts during the rainy period.
- Spraying of fungicides (thiophanate methyl, mancozeb, COC etc.) on bunches and covering with fungicide dusted perforated polyethene films.

Freckle spot

- Bunch covering immediately after the emergence of the last hand
- Periodical removal and destruction of infected leaves.
- Spraying of 0.1% Propiconazole or 0.25% Mancozeb for two to three times

Integrated management of pre and post-harvest diseases

- Manual removal of male flowers and withered styles and perianth (called tipping), which are present at the end of each finger by hand 10 days after finger emergence. The male flower is removed with last 1–2 small hands with clean cut. This practice i) reduces the occurrence of diseases like anthracnose, crown rot, stem end rot and cigar end rot as the inoculum level is reduced considerably ii) reduces the flower thrips and mites which are present inside the flowers iii) increases not only the quality of the fruit but also the bunch weight.

- Adopting good cultural practices including removal of dead trash leaves from the plants
- Spraying the bunch with Carbendazim @ 0.1% added with sticking agent or with talc-based formulation of biocontrol agent *Trichoderma asperellum* @ 50 g/L of water added with sticking agent 2 - 3 times at 15–20 days interval
- Bagging bunches as soon as possible after the male bud has been removed to help prevent fruit infection

Conclusion and future line of works

Graded banana with superior quality will fetch more prices in export market. To attain the quality, field hygiene and other GAPs are to be followed. But to certain issues like many new generation fungicides/combined fungicides effective against post-harvest diseases are not having label claim of CIRBC. To ease the process of registration and wide use of such fungicides/combinations, recommendations of the national institute like ICAR - NRCB recording efficacy and residues data of other non-label claim fungicides shall be considered.

Quarantine and phytosanitary measures in export of Banana

Mohanasundaram M* and Giribabu P*

*Senior Scientist (PP)
ICAR - National Research Centre for Banana, Thayanur (Post), Tiruchirapalli - 620 102
Corresponding author: entosundaram@gmail.com; 9931830749

Introduction

The World Trade Organization - Agreement on application of Sanitary and Phytosanitary Measures (WTO - SPS Agreement) facilitates movement of plants, planting materials globally. Increased volume of trade poses greater risks of introduction of exotic pests/diseases in the country. Plant quarantine operations in India are carried out by the **Directorate of Plant Protection, Quarantine and Storage**, which functions under the aegis of the Ministry of Agriculture.

Pest

Any form of plant or animal life or any pathogenic agent, injurious or potentially injurious to plants or plant products. A pest may be fungus, bacterium, virus, weeds, nematode, insects, mites and other harmful animals. (IPPC)

Quarantine

Quarantine is a restriction imposed by duly constituted authorities, whereby the production, movement, or existence of plants / plant products, animals / animal products, or any other article or material, or the normal activity of the persons is brought under regulation, in order to prevent the introduction or further spread of a pest or pathogen.

Plant quarantine

Plant quarantine may be defined as the restriction imposed by duly constituted authorities on the production, movement and existence of plants or plant materials, or animals or animal products or any other article or material or normal activity of persons and is brought under regulation in order that the introduction or spread of a pest may be prevented or limited or in order that the pest already introduced may be controlled or to avoid losses that would otherwise occur through the damage done by the pest or through the continuing cost of their control

Quarantine pest

A quarantine pest is defined as a pest of national economic importance to the country endangered thereby and not yet present there or present but not widely distributed and being actively controlled. (IPPC)

Quarantine regulations

Plant quarantine regulations are promulgated by the National and the state governments to prevent the introduction and spread of harmful pests and pathogens. Plant quarantine will be justified only when the pest has no natural means of spread.

Based on these factors, plant quarantine regulates the introductions as follows:

***Complete embargo/prohibition*:** When the pest risk is very high, the safeguards available in the country are not adequate and, therefore, import is prohibited.

Post-entry quarantine: The risk is very high but adequate safeguards in the form of post-entry isolation growing facilities are available.

Restricted: Pest risk is not high and import permit is required stipulating conditions for entry, inspection and treatment.

Unrestricted: Import permit is not required, and material may enter without restriction

Main activities of plant quarantine

- Tracing, identification and control of quarantine pests. Pest risk analysis, evaluation and determination of quarantine conditions for imported and transit plant shipments.
- Inspection, sampling, testing and undertaking quarantine regulations on imported and transit agricultural shipments.
- Supervision and under taking post entry quarantine regulations on plants which are subject to the regulations.
- Inspection, sampling, testing and issuing Phytosanitary certificate for exporting plant consignments

Forms of quarantine/The legislative in different countries

Five classes

- ***International quarantine-*** Legislation to prevent the introduction of new pests and weeds from foreign countries
- ***Domestic quarantine-*** Legislation to prevent the spread of already established pests, diseases, and weeds from one part of the country to another.
- ***Farmer's quarantine-*** Legislation to enforce farmers to apply effective control measures to prevent damage by already established pests.
- ***Food quarantine-*** Legislation to prevent the adulteration and misbranding of insecticides and determine their permissible residue tolerance levels in food stuffs.
- ***Quarantine for pest control operations-*** Legislation to regulate the activities of people engaged in pest control operations and application of hazardous insecticides.

Plant quarantine system in India

- The awareness to quarantine measures in India started in early 20th century when the Indian Government in 1906, ordered compulsory fumigation of imported cotton bales to prevent the introduction of the dreaded Mexican cotton boll weevil (*Antonymous grandis*). On February 3, 1914 Comprehensive Plant Quarantine Act, known as Destructive Insects and Pests Act, (DIP Act) become operative

- 1946- The Directorate of Plant Protection, Quarantine and Storage, under the Ministry of Food and Agriculture were set up.
- On December 25, 1951 the first plant Quarantine and Fumigation station in India was formally inaugurated.
- In August, 1976 the ICAR-National Bureau of Plant Genetic Resource (NBPGR) was created
- Under the DIP act, the Directorate of Plant Quarantine and Storage (DPPQS), Faridabad, headed by Plant Protection Advisor to the Govt. of India (under the Department of Agriculture and Cooperation, Ministry of Agriculture) is responsible for enforcing quarantine regulations and also for making rules for quarantine inspection and disinfestations of any article or class of articles in respect of which a notification has been issued by the Central Government.
- There are 29 Plant Quarantine Stations (10 are located at airport, 10 are at seaport and 09 at land route) under DPPQS. The NPQS, New Delhi and RPQSs at Chennai, Kolkata, Amritsar and Mumbai have been strengthened with modern equipment for plant quarantine testing, etc., to facilitate speedy clearance of imports and exports under the FAO-UNDP Project.
- ICAR-National Bureau of Plant Genetic Resources (NBPR), New Delhi, which is the nodal institution for exchange of plant genetic resources, has been empowered under PQ order to handle quarantine processing of germplasm and transgenic planting material being imported for research purposes in the country.
- As per the recent amendments made under the PQ order, the ICAR-Advanced Centre for Plant Virology at IARI, New Delhi, ICAR-IIHR, Indian Institute of Horticultural Research, Bangalore and CSIR-IHBT, Institute of Himalayan Bio-resource Technology, Palampur have been identified for ensuring virus-free status in the imported *in vitro* material.

The main features of the existing plant quarantine regulations in India are as follows

- No consignment of seeds/planting materials shall be imported into India without a valid 'Import Permit', which is to be issued by a competent authority, to be notified by the Central Government from time to time in the Official Gazette.
- No consignment of seeds/planting materials shall be imported into India unless accompanied by a 'Phytosanitary Certificate', issued by the official Plant Quarantine Service of the source country.
- All consignments of plants and seeds for sowing/propagation/planting purposes shall be imported into India through land customs station, seaport, airport at Amritsar, Bombay, Calcutta, Delhi and Madras, and such other entry points as may be specifically notified by the Central Government from time to time, where these shall be inspected and, if necessary, fumigated, disinfested/disinfected by authorized plant quarantine officials, before quarantine clearance.

- Seeds/planting materials requiring isolation growing under detention, shall be grown in post-entry quarantine facility approved and certified by the Designated Inspection Authority (DIA) to conform to the conditions laid down by the Plant Protection Adviser to the Govt. of India.
- Hay, straw or any other materials of plant origin shall not be used as packing material.
- Import of soil, earth, sand, compost, and plant debris accompanying seeds/planting materials shall not be permitted. However, soil can be imported for research purposes under a special permit issued by the Plant Protection Adviser to the Govt. of India.
- The DIP Act empowers the Central Government to make rules for regulating the import of seeds/planting materials into India and also the movement of the materials from one State to another within the country. The State Governments are also empowered to enact rules/regulations to regulate the movement of materials from one region/area to another within a State.

International Agreements / Conventions related to plant quarantine

- International Agreement of Plant Protection in Rome, 1914
- International Convention of Plant Protection, 1919
- International Plant Protection Convention (IPPC), 1952
- Plant Protection Agreement for South East Asia and Pacific Region, 1956

National Acts on plant quarantine

- Destructive Insects and Pests Act, 1914
- Environment Protection Act, 1986
- Plants, Fruits and Seeds (Regulation of Imports into India) Order, 1989
- Biodiversity Act, 2002
- Plant Quarantine Order, 2003
- Seed Bill, 2003

Domestic quarantine for diseases of banana

Under the DIP Act, the Directorate of Plant Protection, Quarantine and storage has the responsibility to take the necessary steps and regulate the inter-state movement of plants and plant material in order to prevent the further spread of destructive insects and diseases that have already entered the country. The sole object of enforcing domestic quarantine is to prevent the spread of these diseases from infected to non-infected areas. Currently, domestic plant quarantine exists in banana diseases, *viz*., bunchy top (virus) of banana from 1959 and mosaic (virus) of banana from 1961. Most of the states in India have plant quarantine laws to avoid entry of plant pests and diseases

Banana Bunchy top Virus (BBTV)

The export and the transport from the States of Assam, Kerala, Orissa, West Bengal, Tamil Nadu to any other State of Banana plant or any other plant of the genus *Musa*, including sucker,

stem, leaf, flower, and any other part thereof which may be used for propagation, or the materials of banana plant or any other plant of the genus *Musa*, which are used for packing and wrapping, excluding the banana fruit is prohibited.

Cucumber Mosaic Virus (CMV)

The export and transport from the States of Maharashtra and Gujarat of any plant of Banana or any other plant of genus *Musa* including the sucker, stem, flower and any other part thereof, but excluding leaf and fruit thereof is prohibited; vide Government of India notification No. F. 6-10-PPS dated the 11thApril, 1961.

Export oriented pest of banana

Plant parasitic nematodes

Plant parasitic nematodes microscopic animals, attacking mostly roots and other below ground parts of the plant, thereby affecting the uptake and transportation of water and nutrients, which ultimately affect the yield. They are one of the important biotic constraints of crop production throughout the world as they cause annual yield loss of 12.3% (Sasser and Freckman 1987), which was estimated in to 80 billion US$ per year (Nicol *et al*. 2011) and 157 billion US $ (Abad *et al*. 2008). Prevention of transport of infested planting materials and treatment of planting materials were traditionally followed prophylactic measures against nematodes.

Importance of nematodes in plant quarantine

Plant parasitic nematodes survive and spread through propagation materials such as seeds, corm, bulb, suckers etc. Therefore, import of any plant materials must be accompanied with the official 'Phytosanitary Certificate' containing declaration that the material is free from nematode pests.

Nematodes of quarantine importance in India

Nematode	Crop
Red ring nematode (*Rhadinaphelenchus cocophilus*)	Coconut
Pine wood nematode (*Bursaphelenchus xylophilus*)	Pine
Citrus burrowing nematode (*Radopholus citrophilus*)	Citrus
Peanut testa nematode (*Aphelenchoides arachidis*)	Peanut
Tobacco cyst nematode (*Heterodera tabacum*)	Tobacco
Stem and bulb nematode (*Ditylenchus dipsaci*)	Onion & Garlic
Potato rot nematode (*Ditylenchus destructor*)	Potato
Beet cyst nematode (*Heterodera schachtti*)	Sugarbeet
Soybean cyst nematode (*Heterodera glycines*)	Soybean
Foliar nematodes (*Aphelenchoides fragariae, A. ritzemabosi*)	Chrysanthemum
Cactus cyst nematode (*Cactodera cactii*)	Cactus

Nematodes of quarantine importance within India

Nematode	Crop
Potato cyst nematodes (*Globodera rostochiensis* & *G. pallida*)	Potato

Nematodes problem in Banana

Burrowing nematode (*Radopholus similis*)
Spiral nematode (*Helicotylenchus multicinctus*)
Root lesion nematode (*Pratylenchus* spp.)
Root knot nematodes *(Meloidogyne* spp.)

Nature of damage

- Nematode causes reddish-brown to black, elongated lesions which are readily seen when the roots are split open. Roots eventually blacken and die.
- Attacks by nematodes, combined with the effects of secondary rot organisms, destroy or weaken much of the root system.
- Infested plants lack vigour and fruiting is poor.
- Such plants are readily blown over and the roots are exposed

Meloidogyne incognita

Nematode damaged corm

Corm weevil - *Cosmopolites sordidus*

Nature of damage

- Newly planted banana fields are easily susceptible to infestation
- Infestation begins at the base of the outermost leaf-sheath and in injured tissues at the lower part of the pseudostem.
- Initially the young grubs make several longitudinal tunnels in the surface tissue until they are able to penetrate to adjacent inner leaf-sheaths
- Then they bore into the pseudostem base and rhizome/corm, but also into the base of suckers and into roots.
- Larval tunnels may run for the entire length of fallen pseudostem.
- Infested plant shows yellowing and withering of leaves, slowed plant growth, root destruction, reduced fruit production
- Young infested suckers often wither and fail to develop.
- Plants are easily blown down by mild to strong winds.
- An economic threshold of 3 weevils per cut banana corm or pseudostem placed in the field overnight will trigger control action

Banana corm weevil damage and symptoms

Banana corm weevil

Fruit rust thrips

Nature of damage

- The early symptoms appear as water-soaked smoky areas where the colonies congregate to feed and oviposit between touching or adjacent fruit. These areas then develop the typical rusty-red to dark brown-black discoloration.
- Further rusty growth of the fruit and yellowing of leaves.
- While the taste and texture of the fruit within these peels remains unaffected, the exterior discoloration reduces the marketability of affected fruit.
- In severe cases the skin develops longitudinal cracks and sometimes fruit may split

Banana flower thrips

Symptom of banana flower thrips

Post-harvest pest of Banana

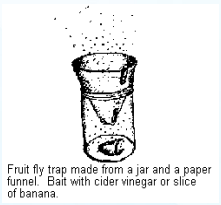
Banana fruit fly - *Bactrocera musae*, Tephritidae, Diptera

Biology and Behavior

- Fruit flies are common in homes, restaurants, supermarkets and wherever else food is allowed to rot and ferment.
- Adults are about 1/8 inch long and usually have red eyes. The front portion of the body is tan and the rear portion is black. Fruit flies lay their eggs near the surface of fermenting foods or other moist, organic materials. Upon emerging, the tiny larvae continue to feed near the surface of the fermenting mass.
- This surface-feeding characteristic of the larvae is significant in that damaged or over-ripened portions of fruits and vegetables can be cut away without having to discard the remainder for fear of retaining any developing larvae. The reproductive potential of fruit flies is enormous; given the opportunity, they will lay about 500 eggs. The entire lifecycle from egg to adult can be completed in about a week
- Fruit flies are especially attracted to ripened fruits and vegetables in the kitchen. But they also will breed in drains, garbage disposals, empty bottles and cans, trash containers, mops and cleaning rags. All that is needed for development is a moist film of fermenting material.

Infestations can originate from over-ripened fruits or vegetables that were previously infested and brought into the home. The adults can also fly in from outside through inadequately screened windows and doors.

- Fruit flies are primarily nuisance pests. However, they also have the potential to contaminate food with bacteria and other disease-producing organisms



Banana fruit fly **Banana fruit fly damage** **Banana fruit fly trap**

Pest management program during export of fresh banana in the department of agriculture republic of the Philippines

Pre - harvest and Post - harvest Application

- Pseudostem sanitation to eliminate refuse and breeding sites of insect pests.
- Fruit obstruction removal (FOR) to prevent fruit damage as well as eliminate bridges that may be utilized by the pest to infest the fruit
- Application of Insecticide to prevent pest infestation for fruit care protection
- Chlorpyrifos - impregnated polyethylene (PE) bags are used to cover the fruit bunches after bunch spray to prevent infestation of insects. When needed additional Chlorpyrifos - impregnated (PE) material (in form of "strip" or "square") is installed on the fruit as additional control against insect pest.
- Harvestable bunches are inspected for the presence of insect pests. Bunched with mealy bugs, scale and other insects are rejected / discarded during harvest.
- Upon arrival of fruit at the packing plant, fruit bunches are sprayed with high pressure water to eliminate any possible insect infestation. While bunches are waiting to be de - handed, the “fruit inspector” in the packing plant will check for insect damage, particularly mealy bug infestation, on individual bunches.
- During de - handing, individual hands are thoroughly inspected for possible mealy bug, scale insect infestation and any other evidence of insect damage.
- After de - handing individual hands are cleaned (by brushing / foaming) by the fruit selector and further cleaned with high - pressure water to eliminate possible infestation of mealy bugs.
- The individual hands are kept dried (using dryer / blower) and again inspected to confirm that fruits are free from mealy bugs and other insect during weighing and immediately before packing inside the box.
- Unused pallets and those that are clean, dry and free from trash, soil, weed seeds and non - weeds contaminants are utilized by the industry.

- Packed fruits are stored in a clean, insect - proof storage / container van or at cold storage. Wharf areas are maintained, kept clean and are situated away from population areas and farms.
- Vessels and container vans are cleaned with the recommended disinfectant before loading.

Phytosanitary emergency over pests in bananas in Costa Rica

There has been an increase in the incidence *Diaspis boisduvalii* and *Pseudococcus elisae* mealybug in crops on the Atlantic slope In Costa Rica. The State Phytosanitary Service of the Ministry of Agriculture has declared a national emergency for the term of one year, due to increasing populations with the *Diaspis boisduvalii* and *Pseudococcus elisae* mealybug which are causing severe damage to banana crops. It is estimated that the impact has affected about 24 thousand hectares, according to data provided by CORBANA and the National Commission of Musaceae.

They formalized the state of emergency which will allow the streamlined importation of bags impregnated with Bifenthrin and Buprofezin which will help mitigate the effects of these pests whose populations have increased following the climate change experienced on the Atlantic slope, from Talamanca to Sarapiqui.

Phytosanitary certificate

- Phytosanitary Certificate is an official document required when shipping regulated articles such as plants, plant products or other regulated articles. A phyto certificate is an official document that is generated from the exporting country's Department of horticulture, agriculture, food or water resources. It can only be issued by an authorized officer from a government department that is authorized by a National Plant Protection Agency (NPPO). The agency is in force to protect the threat of spreading pests, contamination or diseases into the country of import.
- The importer will require a phytosanitary certificate to import regulated articles including commodities such as plants, bulks & tubers or seeds for propagation, fruits & vegetables, cut flowers & branches, grain and growing medium.
- They may also be required for certain plant products that have been processed and have a potential for introducing regulated pests (examples include cotton or wood).
- Sometimes they can also be required to cover contaminated articles such as empty shipping containers, vehicles or other organisms. If the shipper cannot provide a phytosanitary certificate to the importer, it's highly likely that the goods will not be cleared through customs.
- The goods may be seized and completely destroyed. Phytosanitary certificates can be in paper form or, where it is accepted by the NPPO of the importing country.

Role of plant quarantine in the export of agricultural commodities

International Plant Protection Convention (1951) of FAO, UN. Article V of the convention makes it mandatory for member countries to issue Phytosanitary certificate (PSC). PSC should be

conformity with Plant Quarantine Regulations of importing country. Agricultural commodities during export should be accompanied by PSC.

General requirement of PSC

- Inspected Agrl. Commodities should be free from pest/diseases
- Takes time for inspection - seek prior guidance from plant quarantine authorities in India

Special requirements of PSC

- Additional declarations required from importing country for freedom of commodities from specific pests/diseases
- Obtain complete details of requirements of importing country

Technical limitations

- Rules not relaxable. No compromise with principles of Plant Quarantine

Procedure for getting PSC

- Application to be submitted to Plant Quarantine and Fumigation station
- Will be scrutinised, samples drawn and examined for pest, diseases, weeds
- If free PSC issued
- If found infested - rejected, PSC not issued
- Sometimes treatment (fumigation) given and PSC issued

Authority to issue PSC

Union Govt. of Agrl. has authorised officers in Central and State Govt. and UT PPA to Govt. of India - Heads of Unit

Airports	Seaports	Land frontiers
Amristar	Bombay	Amristar Rail
Bombay	Tuticorin	Attari Rail
Calcutta	Bhavnagar	Attari Road
Hyderabad	Calcutta	Bongaon
Chennai	Cochin	Gede
New Delhi	Chennai	Kalimpong
Patna	Nagapattinam	Panitanki
Varanasi	Rameswaram	
Tiruchirapalli	Visakhapatnam	
Trivandrum		

Information on phytosanitary certificate for export

No. _____

Plant Protection Organization of _____

TO: Plant Protection Organization(s) of _____

Description of Consignment

Name and address of exporter: _____

Declared name and address of consignee: _____

Number and description of packages: _____

Distinguishing marks: _____

Place of origin: _____

Declared means of conveyance: _____

Name of produce and quantity declared: _____

Botanical name of plants: _____

Certifying statement

This is to certify that the plants, plant products or other regulated articles described herein have been inspected and/or tested according to appropriate official procedures and are considered to be free from the quarantine pests specified by the importing contracting party and to conform with the current phytosanitary requirements of the importing contracting party, including those for regulated non-quarantine pests.

Indian Banana - A mission to achieve a billion dollar market share in by 2025

Azhar Pathan

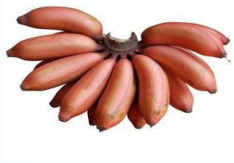
Business Head Export
Banana Export Business Expert
Corresponding Author: azharp.pathan@gmail.com;+91 8275681367

Introduction

Banana (*Musa* sp.) is the second most important fruit crop in India next to mango. Its year-round availability, affordability, varietal range, taste, nutritive and medicinal value make it the favorite fruit among all classes of people. Due to all these characteristics, it also has a great export potential. Hi-tech cultivation of this crop is an economically viable enterprise leading to increase in productivity, improvement in produce quality, and early crop maturity making it possible to fetch the premium price.

The crop has evolved in South-East Asia, where India was one of its centers of origin. The cultivation spread to Egypt & Africa in the seventeenth century & now it's being cultivated throughout the warm tropical regions of the world.

Nendran



Red Banana

Yellaki

Rasthali

Why India?

- India is the leading producer of Banana in the world.
- The total production is approx. 30 MN MT -2019-20
- The country is in a very strategic location, where the Middle East, China, Russia and South East Asia becomes natural market.
- Shortest transit time 4 days to 21 days comparing to Central American and South East Asian countries.
- Large landscapes with round the year production possibilities, ensuring consistent supplies.
- AP, Maharashtra, Gujarat, MP, Tamil Nadu and Chattisgarh have been major banana producing belts (vart G-9) growing states with more than 75% of production share.
- Less than 1% of total production is getting exported, showing a huge potential business to be explored.

Domestic production and productivity

In India, Andhra Pradesh, Gujarat, Tamil Nadu, & Maharashtra have been the major growers of banana. These states produce more than 75% of the total quantity of bananas. The quantity & % share data is as below:

Sr. No.	State	Production (tons)	Avg. productivity (Mt/ha)	%age share
1	Gujarat	4185520	64.70	14.4%
2	Andhra Pradesh	4143550	48.00	14.2%
3	Tamil Nadu	3640730	38.33	12.5%
4	Uttar Pradesh	3078730	45.68	10.6%
5	Maharashtra	3072490	51.14	10.5%
6	Karnataka	2489500	24.52	8.5%
7	Madhya Pradesh	1646890	67.74	5.6%
8	Bihar	1550650	44.12	5.3%
9	Kerala	1224130	15.02	4.2%
10	West Bengal	1195600	24.40	4.1%

Source: (Indiastat, 2018)

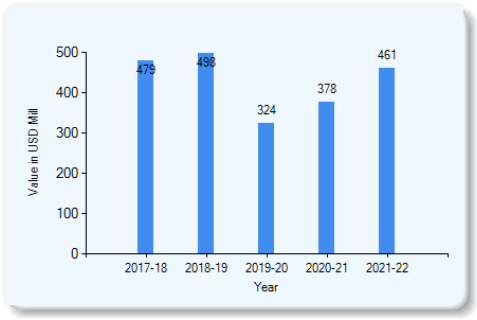
The production & productivity trends have been variable over the span of last five years. The production & productivity has seen a decline in Tamil Nadu. In Maharashtra & Gujarat constant. In contrast to that, Andhra Pradesh has seen a boom both in production & productivity over the same span.

However, on national level, the average production has remained consistent around 29 million tons.

Production: India being a largest producer of banana, has a capability to produce over 29 million metric tons per year.

Source: Comtrade

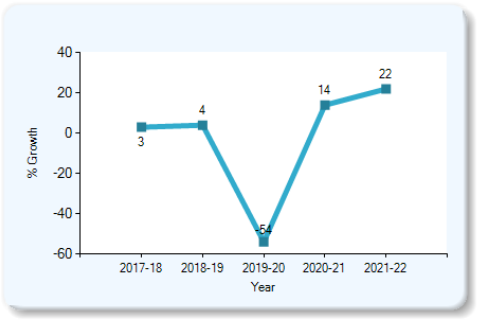
INDIA'S EXPORT TREND IN LAST 5 YEAR



Source: DGCIS

Source: DGCIS

INDIA'S EXPORT GROWTH TREND IN LAST 5 YEAR



Source: DGCIS

Location benefit: India, has a unique location advantage where Middle-East becomes natural market because of its transit time 4 to 11 days as compared to supplies from American continents (27 days). In the recent years, India's exports of banana to Middle Eastern countries have seen a boom. A snapshot for export volumes can be visualized as:

Country	Qty MT 2016-2017	Qty MT 2021-22
UAE	24368.00	70000
Iran	15838.00	208000
Oman	12937.00	22900
Kuwait	10463.00	6000

Saudi Arabia	10280.00	16000
Qatar	3761.00	5000
Bahrain	2610.00	2000
Malaysia	2000	1000
Total	**110871**	**330000**

Source: (Indiastat, 2018) and Collected Actual Port Data

New Markets to Explore:

1. Russia 2. CIS Countries 3. European Countries 4. South Korea and Japan

Challenges and to overcome them - Domestic and export markets

I. **Infrastructure unavailability:** To establish a full value chain for banana, there must be a proper infrastructure in place. The infrastructure will include pack houses, pre-cooling chambers, cold stores, and skilled workforce. Most of the Banana clusters are lack of these basic facilities.

II. **Volatility of procurement prices:** The Price fluctuates on daily basis. The price volatility during procurement, not allowing exporters to sign off annual Agreements with importers. Therefore, exporters can't build supply trust with importers.

III. **Skilled labor availability**: To produce the best quality banana, a lot of technical operations are involved, especially in fruit care Pre and Post-harvest. To perform those activities, availability of skilled labor will be critical. The non-availability of skilled labor can hamper the quality of produce. Skill training is needs to be imparted to rural/local women labor force for export sorting, grading and packing.

IV. **Fruit Care**: The area's leading is export only they are following Fruit care activities. Majority of farmers not involved in fruit care activities. Fruit care help to improve quality and reduce post-harvest losses.

V. **Plantation schedule**: Currently, most of the farmers have a similar schedule of plantations, which results in a highly skewed supply pattern. It results in the demand-supply gap & irregularities in supply to the customers.

VI. **Post-Harvest**: Farmers grow very good crop in 11 months. Our harvest labor spoil the quality within 15- 30 minutes. As Indian farms are small (2 to 5 acres), we have to develop an alternative for the cable way harvesting. At present bunch is harvested and carried by labor on his shoulder, which initiate neck break and bruising. When he carry bunch on his shoulder from one end to the other, on the way he hits and damages all the bunches and bruise them badly. Which decrease the quality of fruits and fresh and old bruising is observed.

December to March due to winter season in Maharashtra, MP and Gujarat fruits will get chilling injury and not fit for export market.

Limitation of international market access: We have natural markets available Middle East and South East Asia. However, China has huge volume demand need to be opened for export. CIS countries, Russia and Europe should also be explored.

Once we have an access to all these markets, then, India can definitely lead in export which allow doubling farmer's income.

Knowledge transfer to farmer community

Technical know-how: The fastest way to improve agricultural practices in a crop is to bring in the technical know-how from best producer countries. For technical know-how of Plant and fruit care activities. From last one decade the best practices are being communicated to farmers, which has resulted in 30 % average increase in yield and 70% quality improvement as compared to earlier in Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh and other banana growing states.

Fair trade Practices: In most of the cases, farmers are unaware of the right price for their produce. This gives an opportunity for middlemen to exploit them. However, FPC can have an agreement with Companies for best and fair prices to the farmer.

Market risk hedging: As agriculture is a seasonal business with perishable produce, the farmers are dependent on middlemen. In most cases, these farmers are forced to carry on distress sale of their produce, & don't get the good prices due to information asymmetry. Here, FPC/ banana Cluster farmers can work with export companies by providing the farmers alternate market to sell their produce at open/fair market price. This intervention hedges the market risk for farmers & provides market access.

Other job creations: Apart from the benefits to farmers, Banana business creates lot of other jobs in its areas of operation. Develop infrastructure, e.g. pack houses, cold stores, ripening chambers, etc., which requires manpower to run the daily business. Hence, the local people will get a new avenue for employment in form of many roles such as: farm labors, field officers, pack house in charges, quality supervisors, cold store operators, ripening executives etc.

Agricultural extension services: We have to educate banana farmers for Plant and fruit care activities, to help them to increase their production capabilities 3 crops in 2 years & quality for export markets.

To Double the Export and Double the farmers Income: Things to be done by Govt -Legislative, financial, regulatory, or any other support- policy issues.

1. Mandatory for all the exporters to pack best quality of banana, which will create "**India brand image** "in International market.
2. Regular Meeting of National Level **Banana Export Council** and State level "Technical committee" on Market Intelligence and Strategy development.
3. **Indian consulate** in different countries should help Banana exporter for market intelligence and promotional activity.
4. **Develop Centre of excellence** in each cluster for Farmers training to technology. Can be done by PPP model.
5. **Financial support to Exporter in Newer markets** for Logistic and Packing material.

6. **Financial support first 3 years to FPC to motivate "Fruit care".** To develop export quality fruits, fruit care Operation (BI, Bunch Spray, Fruit obstacle removal, de handling, deflowering, ribbon, bunch cover) is required which cost additional per kg.
7. **Infrastructure and Facility Development**: Financial support to FPC or PPP model 4 and 5 line pack house in all cluster for 400 acres each. Precooling facility within 4 hours travel time and adjacent Cold storage facility for a 8 to 10 days stock storage (vessel schedule is different for different countries).
8. **Skilled Labor**: Financial support for export packing skill development to local workforce.
9. **Encourage and support CONCOR for International Refer rail rack** and shipping containers movement. Which will reduce cost, time, improve quality, create India brand image.
10. **Chemical Residue analysis labs**. Establish in each cluster, Label claim chemicals for Banana crop.
11. Access to China Market is important, because China is worlds 2nd biggest importer. Also special Export incentive to develop New markets like EU, Russia, and other CIS markets.
12. **At present Logistic cost is** more than Product cost. Refer rail min 5 to 10 containers with reasonable cost of 5 to 10% of product cost will help to increase access from South to North for Domestic and Export markets.
13. **Export packing material (box, vacuum bag, PE foam ethylene sachets, water absorbing paper) cost is 70 to 80%.** For fruit life extension, reduce PH losses and to be competitive in International market GOI should support exporter in this cost.

For Export quality fruit care is most important activity

II
Opportunities in banana processing and allied products

Functional food products from banana: Wealth from export rejects

Suresh Kumar P*, Amelia Keran D, Sivananth C***, Shiva KN* and Kamaraju K#**

*Principal Scientist (Hort.,), **Senior Research Fellow, ***Research Associate # Technical officer
ICAR - National Research Centre for Banana, Tiruchirappalli - 620 102, Tamil Nadu, India
Corresponding author: psureshars@gmail.com

Introduction

Banana is part of the daily diet to more than 400 million people around the world and is the fourth most important global food commodity after rice, wheat and milk, in terms of the gross value of production. They are grown in around 140 countries. Banana and plantain, are continuously exhibiting a spectacular growth worldwide. World leading banana and plantain producers are India, China, Uganda, Ecuador, Philippines, and Nigeria. In India, it is the second important fruit crop next to mango in terms of production. For the last two decades, India has remained as the largest producer of bananas in the world and contributes 48% of the total production in Asia from 39% of total area. After harvesting the fruit bunch, huge plant bio-waste is generated, out of which **pseudostem (30-34%), flower & bracts (2-5%), leaf (22%) and rhizome (12-14%)** together they contribute 50 per cent of the banana plant biomass. Currently less than 2% of these wastes production is used for human consumption and for production of fiber, the remaining are incinerated and wasted. Peel left over in chips industry is also goes waste.

India hardly processing banana into a value added product due to its high domestic demand. However, the need for processing arises with the change in consumer behavior and food consumption pattern. The market glut often forces farmers to put his produces in distress sale. The waste generated after harvesting banana bunch could also be used for generation of wealth. Currently less than 2% of these wastes production is used for human consumption and for production of fiber, the remaining are incinerated and wasted. According to an INIBAP survey, about 5% of total world production of dessert banana and 24% of plantain is processed. The most popular value added product is chips with production capacity of 2.0 lakh tones valued at Rs. 500 crores per annum and other products such as flour, fig, pickles and juice are also made from bananas and plantains.

Banana is a very popular fruit in the world market and is consumed as staple food in many countries. The bananas are mostly consumed fresh are exported to different parts of the country. Quantifiable volume of bananas are rejected during the export due to different export standards. The export rejects are found to be raw material for food processing industry. We can produce value added processed products from both raw and ripened bananas of export reject.

Reasons for rejection of bananas

Normally bananas in export rejected due to following reasons,

- Bananas not having size and criteria as specified in codex standard 205 (Usually bananas having grade less than - Glass II).
- Defects in shape and colour due to various cultural practices and biological factors

- Skin defects due to scraping, scabs, rubbing, blemishes or other causes leads to affect the flesh of the fruit.

The following points which have negative impact on banana fruit quality are also considered seriously during screening of bananas for export,

Peel browning

Occurrence: Peel browning is a physiological disorder occurring during maturation process when the fruit is handled. Some varieties seem to be more sensitive than others. Peel browning is caused by a stress related at low temperature or relative humidity. Peel browning can be assessed by storing ripened bananas in a room at ambient temperature (20 °C) and low relative humidity (50%). Fruit handling will promote browning if the variety is sensitive.

Importance: Browning limits shelf-life of the banana and reduces its commercial value. Thus, browning is easily detectable by sellers and consumers but is not attractive, curbing act of purchase.

Symptoms: Bananas peel browning is reflected in a brown discoloration of the peel triggered by a peel handling. Browning intensity increases day after day when bananas are stored in dry conditions. Symptoms develop the entire banana surface.

Peel bruising

Occurrence: Banana bruise damages appear essentially during bananas commercialization, on the market stalls during the handling of fruits. Bruises damages results of a mechanical contact of the fruit with other bodies. Peel bruising can be assessed by impacting ripened bananas, harvested at optimal thermal sum, with a small steel ball (19mm) down a guiding tube from a range of standard heights at several energies. The weaker impact energy to produce bruising is, the more sensitive banana is.

Importance: Peel bruising has been identified as a major cause of quality loss, resulting in a decreasing commercial value. Peel bruising is superficial, thus damages are perceptible from the outside and can prevent potentially the act of purchase. Moreover, damaged tissues area key factor to pathogen invasion.

Symptoms: Bruise susceptibility is not exactly a physiological disorder since that it results from a mechanical damage, more especially an impact which could be paired with a skin rupture. Bruising leads to the appearance of a brown to black impact on the fruit surface. That occurs rapidly after the damage and spreads on all the impact area. Symptoms are observable on the banana peel but do not impact necessary the fruit pulp

Peel cracking

Occurrence: Genetic, environmental, morphologic and physiologic factors affect peel cracking sensitivity but post-harvest peel splitting is mainly attributable to the environmental conditions of storage. It occurs only between the third and the sixth day after maturation induction. Generally,

peel cracking is induced by high relative humidity. Some cultivars are more sens itive than others. Peel splitting could be assessed by storing green bananas harvested at the optimal thermal sum into a perforated polyethylene film contained in a carton. Ripening is induced by exposure to ethylene. Then, polyethylene film is closed in order to induce splitting by saturate humidity conditions (90 - 95 % RH). The percentage of splitting could be calculated as the number of splitted bananas relative to the total banana number.

Importance: Fruit cracking is one of the main physiological disorders limiting post-harvest fruit quality and quantity. Peel splitting results in open wounds promoting rapid moisture loss and opportunistic pathogens infection. Moreover, cracking fruit is not attractive to consumer and also decreases its marketability.

Symptoms: Peel cracking is a physiological disorder reflecting by a longitudinal split of the peel and exposing the pulp. Generally, it begins near the pedicel, and more especially at peel junctions between two flat segments.

Finger drop

Occurrence: Finger drop occurs during banana ripening. Susceptibility varies according to the cultivar and has been reported in the diploid, triploid and tetraploid cultivars. However, it seems that tetraploid cultivars were more sensitive than others. Post-harvest environmental conditions impact this physiological disorder intensity. High relative humidity stimulates finger drop. However, water content in the peel does not seem to be implicated in this process. High ripening temperature and ethylene promotes weak neck. Hands physiological age influences the sensitivity: more mature they are, more sensitive they are. Weak neck may have three possible

Importance: Bananas are generally marketed by 5 or 6 fingers attached together, called cluster. Finger drop is a process leading, during fruit maturation, to a finger break off from the cluster crown. This reduces the market value and increases the potential risk of pathogens contaminations.

Symptoms: Finger drop assessment could be realized by subjecting a ripened cluster to a 3-5 manual shaking. Recording the number of fingers dislodged allow to calculate the percent of fingers drop per cluster. Another method is to determine the force (N) required to break up the pedicel of the finger.

Chilling injury

Occurrence: Tropical and subtropical plants exhibit a marked physiological dysfunction when exposed to low or nonfreezing temperatures below about 10 to 12°C. This dysfunction has been of great concern for many years with harvested plant parts because lowered storage temperatures are generally an effective means of extending the post-harvest life of fruits and vegetables. Chilling injury

(CI) is the term used to describe physiological damage to fruit tissues resulting from the exposure of chilling-sensitive fruits to temperatures below a critical threshold. In banana (Musa spp.), CI can occur in unripe or ripe fruit and may reduce fruit quality and market value.

Importance: Chilling injury avoidance represents a key economic step in the banana food chain. Indeed, this physiological problem is only evidenced during fruit maturation and each storage place particularly after ripening induction (e.g. at the market place) must clearly avoid a storage under this critical temperature (i.e. 13 °C for Cavendish). This highly sensitive fruit should be definitely be stored separately to the other non-sensitive fruits stored at very low temperature.

Symptoms: Postharvest losses resulting from CI are probably greater than has been recognized. Quite often, CI symptoms may not be apparent while the produce is still in cold storage; the symptoms show up later, only after the produce has been transferred to market where the temperature is higher. Symptoms of chilling injury become apparent after a few days of storage at the injurious chilling temperature or after transfer of fruits to non-chilling temperatures. When chilling is not severe, which is true in the majority of cases in the conditions used by the banana export industry, the banana green fruit develops surface lesions such as pitting in the first layer of the green epicarp and the color of the peel becomes dull yellow to grayish-yellow or gray during ripening.

Quality loss in bananas due to poor post-harvest handling practice

Value added products from Banana and Plantain in India

India, with its rich source has traditional processed products from banana. Other than that, ICAR- NRCB has developed many values added products such as fig, juice, bar, jam, jelly and sweet c*hutney* from pulp of ripe banana; flour, baby food, health drink, soup mix, sauce, pickle and chips from unripe banana. Banana contains considerable amount of resistant starch (non-digestible starch) and non-starch polysaccharides, which have low glycemic index and this property makes it an appropriate ingredient for different functional and convenience foods like cookies, bread, cake, extruded foods and chips, *etc*.

The various value-added products developed from the different parts of banana plant can be divided into mainly three categories namely, (i) Plantain-based value-added products, (ii) Banana-based value-added products and (iii) Products from other parts of the plant. The brief description of ICAR-NRCB developed technologies and nutritive values of each value-added products are summarized.

Traditional Products

There are numerous products that could be produced through processing of raw and ripe banana and from waste. The list is as mentioned below;

Products from raw/ plantain banana: Chips/ Crisps, *bhajji*, banana flour, banana flour-based biscuits, health drinks and a baby food, health drink, soup mix, pasta, bread, noodles.

Products from ripe dessert banana: banana fig, banana powder, banana juice, banana fruit bar, jam, Jelly, fruit candy, sauce, clarified juices, RTS, Banana bar, leather, sweet chutney, fermented beverages like wine, beer etc.

Products from banana waste*:* banana fiber, fiber-based handicrafts, banana flower *thokku*, peel pickle, fruit pickle, stem pickles, central stem candy, peel-based products, central stem juice etc.

Popular Processed Products

Chips/Crisps

Chips/crisps is the only processed banana product widely manufactured on commercial scale in India as well as in the Philippines. Banana chips/crisps are made by deep-frying of raw banana slices in a suitable cooking medium. 'Nendran' banana is widely used for preparation of banana chips. Cooking varieties like Monthan are also used in for chips making. Banana chips manufacturing have developed into a cottage industry in the states of Kerala and Tamil Nadu with an estimated quantity of more than 2.0 lakh tones of banana chips every year. It is totally under unorganized sector without any licensing. Major part of it goes for domestic consumption while little quantity is exported to gulf countries. Of late, the semi-ripe banana is also being used for making chips which have a sour-sweet taste. The advancement in processing and packing technologies like vacuum frying and nitrogen flushing have resulted in increased shelf-life without having any deterioration in quality.

Suitable varieties: Nendran and Popoulu

Banana Flour

Banana flour/powder can be made from both ripe as well as unripe fruits of banana and plantain. Even immature fruits of banana can be converted into flour that would form raw material for other value-added products such as baby food, health drink and soup mix. Nendran is the best variety suitable for flour preparation. Banana flour is prepared from mature green bananas with high starch content, which also be blended with other cereal flours for making bread, unleavened *chapattis* and *rotis*. Banana flour is as intermediary product used in preparation of several products like biscuits, cakes, bread, custard, *chapattis*, *papads*, baby food, health drink, soup-mix, '*pazham pori*' ready to mix, snack foods, extruded products, *etc*. Banana flour has been made for export in Ecuador, Colombia, Canada and Switzerland. Since long, the powder is being exported to Gulf countries from Kerala.

Suitable Varieties: Grand Naine, Monthan, Nendran, Saba

Banana Fig (Dehydrated ripe banana)

Banana fig is a dehydrated fruit prepared immature or mature unmarketable ripe fruits of banana. Figs are prepared by peeling, disinfection and dehydration in hot air oven or solar dryer. Dried/dehydrated bananas can also be prepared by dipping in honey. The figs are highly nutritious and help in providing nutritional security by supplying all the nutrients of banana in a concentrated form. It can be adopted by small and medium scale entrepreneurs/ industries and can create rural employment opportunities.

The Ecuador is the leading producer of fig in the world. It is cheaper than existing dry fruits available in the market. It helps in nutritional security by providing all type of nutrients [such as carbohydrate, vitamins, minerals and dietary Fiber. It can be incorporated in many recipes such as cakes, biscuits, *payasam*, *kesari* and ice creams as a substitute for raisin. The product can be recommended particularly for school and adolescent children other than for defense personnel.

Suitable Varieties: Udhayam, Karpuravalli, Ney Poovan, Rasthali and Poovan

Banana Puree

Bananas for puree production ideally should be harvested at color index 6 and 7 are preferred for making puree. Bananas are then blanched with either food grade steam or boiling water until a center temperature of 93°C is reached. Blanched bananas are then cooled and peeled. The puree is then obtained by passing peeled blanched bananas in commination machines. Banana purees has an attractive color, fine texture and retain its fruity flavor. Banana puree developed must be further treated to ensure their preservation until the moment of final utilization and processing. The puree can be frozen, canned or aseptically packed. The puree is used for beverage industry, baby foods, snack foods, jam and sauces.

Suitable Varieties: Red banana, Rasthali, Karpuravalli and Grand Naine

Innovative, Prebiotic and Emerging Products from Banana

Minimally processed banana products (unripe-fruit, flower, central core stem & rhizome/ corm)

With the emergence of quick service restaurants (QSR), convenient foods are need of the hour for working women. Minimal processing of unripe plantain slices, its male inflorescence (flower), inner central core stem and rhizome has tremendous domestic and export market opportunity. Pre-treatment of the above parts with mild chemicals like potassium metabisulphite (KMS, 0.05%) and/ or citric acid (0.05%) has the possibility to enhance the shelf life of the products up to 10 days when packed in HDPE bags and store under refrigerated condition (7±1°C). Natural extract like garlic extract could also be used.

Low-fat banana chips (Microwave/ Vacuum)

Snack industry is expected to witness a stellar growth from 500 to 5000 crores in near future owning to change in food habits and consumption patter. Endowed with unique flavours, banana chips are gaining attention in domestic and international market. Owing to consumer inclination towards healthy foods, low fat chips in market shelves can

have added advantage. Surface treatment of unripe banana slices (Nendran/ Popoulu) with hydrocolloids can render less oil absorption during deep fat frying and reduce oil percentage by 25%. Similarly, microwave treatment and vacuum frying can also render less oil absorption in banana slices. HDPE pack with nitrogen flush can maintain the chips nutritive and sensory attribute intact up to 60 days.

Functional green banana flour-based products

Utilization of green banana and plantain for its flour is of interest as a possible resource to make healthy functional products with its higher resistant starch and low glycemic index. By simple dehydration of raw banana slices in hot air oven and grinding it can yield green banana flour with higher resistant starch, fiber and minerals. Green banana flour could be considered as an ideal supplement in the products such as pasta, bread, spaghetti, cookies, noodles and baby foods. Dessert banana flour could be used in variety of industrial applications with its better thermal characteristics like lesser cooking time than the other flours. A combination of malted maize, soybean and roasted groundnut flour along with unripe green banana flour can be a recommendable weaning food for infants. In similar way, its suitable combination with other ingredients paves its way into the market shelf in the form of health mix drink and soup mix. It is also a preferable replacement of all-purpose flour (up to 40%) in bakery products (bread, cookies, muffins etc.) and extruded products (Pasta, spaghetti, noodles etc.). As millets are gaining importance, banana flour could be a better option to enhance the shelf life and to make better composite flours, which could be used for making variety of products.

Banana starch and modified starch

Starch, a white powder, without out any taste or odor becomes household name and not new to anyone today. With the growing demand, new sources are being explored for starch extraction and utility. Unripe green bananas are found to be an excellent reserve material, contains up to 80–90% starch (DWB). Banana starch has a great potential, from its digestion and functional pre-biotic properties, to have application in processed foods and become a commercially viable starch product with higher resistant starch.

Being a non-conventional source, it has numerous uses as an ingredient in food systems and other industrial applications. It is unique enough both nutritionally and functionally. With the advantageous features for unripe green banana as a source of starch. and its further modification can definitely be considered as a fortunate thing to the starch starving sectors which looking for an

alternate biological starch source for a long period. This can be added with ice-cream, pasta, extruded products, excipient in pharmaceutical and symbiotic food development

Dehydrated ripe banana

The emerging trend among consumers to select protein and fiber enriched snacks is fueling the demand for dry fruits Market. Dehydrated ripe banana or banana fig are leathery and dry product with a competing potential in global market. Traditional banana like Karpooravalli and Elakki (Neypoovan) with high sugar content are much suitable for banana figs. Further value addition of honey dip, and green tea extract coating can further improve its market value. This can be a multi dense food with lesser weight. Best wholesome dry fruit for defense personnel and school children to impart immediate energy.

Banana fruit sugar

Fruit sugars are gaining attention due nutraceutical benefits. The natural matrices of ripe banana powder contain a high amount of carbohydrates and bioactive compounds with potential pre-biotic beneficial effects on human health and can be used as functional ingredient in food preparation. Conventional driers like tray driers takes long time to dry, due to their dense physical structure and high sugar content. Foam-mat drying of banana pulp with addition of permissible hydrocolloids could be a better choice with product quality on par with freeze and spray drying. With intense tase and indulgent natural flavours the product is of very good choice for pudding, fudge, pan cake and bakery filling along with all-purpose flour. It can also be suggested for compaction into tablet forms for nutraceutical consumption. The prominent secondary metabolites in fruit sugar can facilitates the decrease in oxidative stress by scavenge the free radicals. In addition, it has better prebiotic activity score and opens up new vista of opportunity for using it to promote selective growth of specific beneficial organisms and to make probiotic rich synbiotic foods.

Basil seed suspended banana ready to serve (RTS) beverage with no added sugar

The processing of tropical fruits into clarified and concentrated juice is an important route of development and valorization of products. Fruit juices have gained much popularity recently and provided an alternative substitute to caffeinated beverages. Commercially banana RTS with basil seed suspension is least available. The TSS, acidity, optical density and shelf life of banana RTS beverage increases with increase in sugar levels. The complication in suspending basil seeds is that, due to density differences with beverage, it is common tendency for seeds to either settle at the bottom or to float at the top. With proper packaging and storage condition this product can rule the retail market shelves which are previously filled only with fruit flavoured basil/chia seed suspended beverage with added sugars.

Wine and vinegar

As an alternative to full-strength wine, tropical fruit wines with a reduced alcohol content offer a number of potential social and health benefits for consumers and have been commercially available for over two decades. Considering the immense potential health benefits of banana, the aerobic fermentation of its enzymatic clarified juice with *Saccharomyces cerevisiae* has the ability to yield banana wine with medium alcohol content and high phenolic content. With changing consumers perception for high-quality nutritional content wine with diverse flavours, taste and appearance besides dominant commercial red wine leads to a new horizon for further tropical fruit wines.

Apple cider vinegar may be the most well-known type of fruit vinegar, but banana can also be competitive product for making fruit vinegar. It can impart a yielding flavor when added in different global cuisine. It also has many health benefits on top of its potent flavor. Banana vinegar can be a better choice than synthetic vinegar with immense nutrient content like potassium and magnesium.

Low - sodium banana stem and flower pickle

Increased promotional activities by the main manufacturers have increased the popularity of cross-cultural cuisine. Eating low-sodium pickle is the great way to add more essential minerals & vitamins into the diet and improving digestion and maintain blood pressure. Banana inflorescence and central core stem with rich bioactive properties can be utilized for the development of pickles (*thokku).* Even the industrial player who are ruling the retail market shelves with variety of pickles have not displayed these exotic pickles from banana parts. The usage of sea salt alternative salts with low sodium content at definite proportions without compromising on sensory properties adds additional market value and consumer preference to these products. MSME could utilize the opportunity with these products to maximize their profit and sustainability.

Central core stem juice

India shares 20 % of the world banana production, and generates>80 million tons (MT) of pseudostem biomass, which is more than double the quantity of bunch harvested (30 MT). 2007). In India, banana central core stem is used in various ayurvedic and siddha formulations to cure kidney related disorders, worms in intestine, diseases related to mental health, burn injuries and wounds. The phenol, flavonoids and antioxidant activities are known to be higher in it. This part of banana contains up to 92% of moisture. Hence a simple extraction or mechanical crushing can give maximum yield of banana stem juice. Banana central core stem juice could be potentially utilized as an effective source of antioxidant, anti-inflammatory, anti-urolithiatic and antitumor agent.

Pectin from banana peel

Pectin is an approved food additive (INS 440) capable of forming gels with sugar /acid and therefore is being used as a gelling agent. Pectin has shown to improve cholesterol metabolism and supports normal blood pressure. New applications of pectin in functional foods, pharmaceuticals

and biomedical continue to emerge, making pectin extraction and commercialization an attractive investment. Exploring the opportunities to use banana peel for the extraction of pectin would be a most sustainable and profitable alternative way of adding value to the industrial waste, besides fulfilling the demands of the pectin industry.

Cellulose from banana fiber

Banana fibres present important advantages such as low density, appropriate stiffness and mechanical properties and high disposability and renewability. Additionally, they are recyclable and biodegradable. These natural fibres of banana are rich source of cellulose. They can be used in the textile industry. Cotton, linen, and other natural fibres may be used directly or processed to make rayon. Microcrystalline cellulose and powdered cellulose are used as drug fillers and as food thickeners, emulsifiers, and stabilizers. Personal hygiene products, non-woven fabrics could be made using banana fiber and its derivatives. It can also be used in composites and epoxy industries.

Edible Banana Flowers

Banana flowers are healthy and edible. Just like the stem, flowers have so much fiber in them. Banana flowers are rich in fibers and antioxidants. Bioactive compounds can be extracted from the flowers which can be used in cosmetic and pharmaceutical industries. Minimal processing of banana flowers will extend its reach to the urban and semi urban markets. NRCB has developed technologies for minimal processing of flowers to attract the urban and semi urban markets.

Bananas peel powder

With its high calcium, banana peel powder is a healthy powder. It is used in food, pharmaceutical and medical drugs. The quality of banana powder is determined by the colour, flavor, texture and moisture content. These are affected by the varieties of bananas and processing operations specially blanching process. Good quality powder is produced from the bananas of right variety and degree of ripeness. Immature or over ripe fruits should be excluded from the bulk.

Peel and other waste as a source of Xylooligosaccharides

Xylooligosaccharides (XOS), a Prebiotic, is the only nutraceutical that can be produced from lignocellulosic biomass. Production of XOS from agricultural residues offers great scope to the nutraceutical industries as the raw material is cheap and abundantly available. The major advantages of XOS consumption, apart from elective growth stimulation of beneficial gut microflora, include reduction of blood glucose and cholesterol, reduced pro-carcinogenic enzymes in gastrointestinal tract, enhanced mineral absorption from large intestine and immune-stimulation. The sweet taste of XOS enables it to be used as an artificial sweetener. Similarly, vinegar could be produced from the banana wastes with the solid fermentation process.

Animal feed

The utilization of available raw material such as agricultural waste reduces the dependence on the costly imported feed and banana by-products could be one of the potential raw materials for feedstock production for most of the banana producing countries. Enhancement of nutritional value of banana waste through microbial fermentation is an important step in order to create high nutritional quality feedstock from low quality materials; protein and sugar content can be increased comparable to the soybean meal, which is a common ingredient in most animal feeds. Banana leaves are the best fodder because of its low partition factor, high ATP and high microbial biomass.

Dietary fiber from banana stem

Over recent decades, the preference for westernized diet has changed our co-evolved gut microbiota. This includes preference in consumption of ultra-processed foods that are typically impoverished of dietary fiber, and associated reduction in the intake of fiber-replete plant-based foods. Banana central core stem is rich source of both digestible and non-digestible dietary fiber which has positive outcome with healthy gut microbiome, favorable body weight and overall metabolic health. Its intake also associates with a reduced risk for the development of cardiovascular disease and mortality. Enzymatic hydrolysis with α-amylase and amyloglucosidase can produce dietary fibers of high-quality ad purity from banana central core stem. The dietary fiber extracted by this method tend to possess neutral taste and flavor profile.

Conclusion

The objective of doubling the farm income could be achieved through minimizing the expenditure incurred and maximizing the profit realized by adopting the right technology. Innovation in managing such a vast amount of agricultural waste or biomass is a continuous challenge and recent trends favor the utilization of this biomass for value added purposes to fulfill the need in the areas such as renewable energy, fiber composites and textiles, food alternatives and livestock feed. Smallholder farmers in developing countries need to improve their position in food value chains in order to improve their margins and as a strategy for coping with agricultural food price volatility through innovations within the chains. Value chain mappings and gross margin analysis are necessary to keep the business viable and sustainable. Weak linkages within the banana value chains with poor integration of value chain actors and minimal involvement with regional markets and high-value domestic chains such as supermarkets make the business more volatile. Value addition in terms of agro processing at small scale levels using rudimentary techniques limiting the final product to low value markets. It is suggested to strengthening linkages within the value chains, collective marketing, penetration into high-value chains and improved processing techniques may provide a potential avenue for enhancing banana value chains in India and around the world.

Raw Banana Flour Based
Homemade Delicacies

Starch & Pectin :
New Innovative Options

Healthy Extruded Products

Blended Juices

Basil Seed
Suspended Juice

Banana Wine &
Fruit Vinegar

Ripe Banana Based
Functional Foods

Low Glycemic
Bakery Products

Fabricated Products :
Low Fat Chips &
Fortified Grits

Low Sodium Pickles

Banana Central Core
Stem Juice & Candy

Banana Fiber : Boon for
Handlooms & Textiles

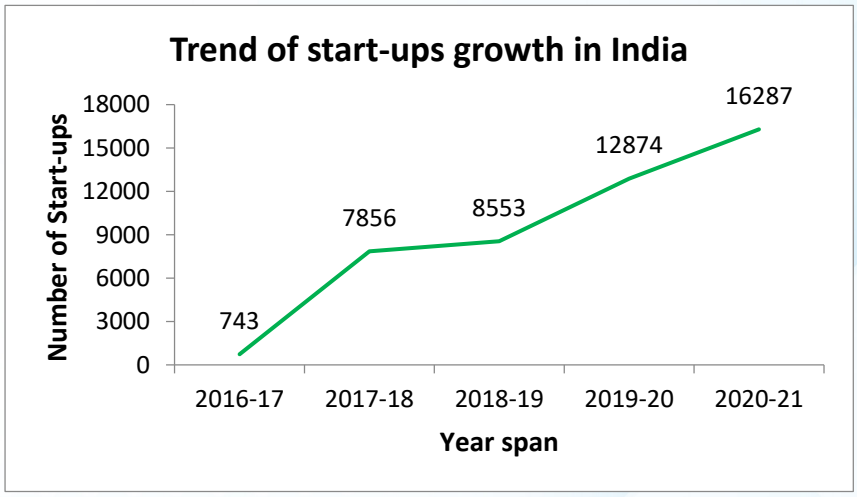
Trends in Indian start-up ecosystem with special opportunities on banana handling and processing

Arthee R*, Suresh Kumar P and Saraswathi M S****

*Senior Research Fellow; **Principal Scientist (Hort.,)
ICAR-National Research Centre for Banana, Tiruchirappalli, Tamil Nadu, India - 620 102
Corresponding author: psureshars@gmail.com

Introduction

India has become a pulsating entrepreneurial landscape with the population involved in start-up ecosystems. India is one among the developing/emerging; lower-middle income economy; newly industrialized country with a gross domestic product (GDP) expected to register a growth rate of about 7% in 2022-23. Interestingly, India will surpass China as the biggest population in the world by 2024 with the present statistics of 1.417 billion. According to Global Entrepreneurship Monitor (GEM) India Report, the total entrepreneurial activity rate (percentage of adults (aged 18–64) who are starting or running a new business) increased from 5.3% in 2020 to 14.4% in 2021, thus making India the third largest start-up ecosystem in the world after US and China with over 72,000 start-ups.

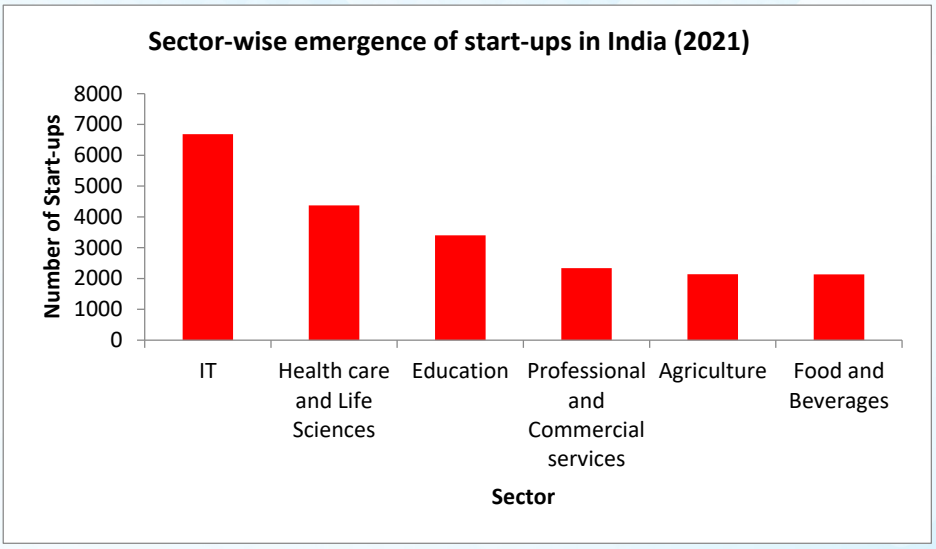


India is the fifth largest economy in the world, an inspiring achievement post-independence, but still ranking 142 out of 197 countries in per capita income. Also India ranks 63 out of 190 economies on the ease of doing business index whereas it ranks 107 out of 121 countries in Global Hunger Index. India has responded with profound resilience and has emerged as one of the fastest rebounding economies post-pandemic amidst inequalities. **Progressive Government initiatives such as Startup India, Atal Innovation Mission, a dedicated Women Entrepreneurship Cell in NITI Aayog and numerous startup-dedicated investment schemes such as** Atma Nirbhar Bharat Schemes **for increasing investment prospects has paved way for merger of Innovation, Digitalization and Entrepreneurship in India.**

Paradigm shift in Indian consumer's preference for processed food and beverages

1. ***Uniqueness of the commodity*:** This depends on the distinct characters of the fruit in other words could be ethnic, seasonal and region-specific to be GI tagged; could be of distinct taste, flavour, aroma, colour, shape and overall distinctive ness-based preference.

2. ***Malnutrition and Obesity Awareness*:** Balanced cereal intake along with prioritized intake of protein rich foods and horticulture foods to eliminate malnutrition including undernutrition, wasting (low weight-for-height), stunting (low height-for-age) and underweight (low weight-for-age) and obesity in children. Besides, the other extreme of octogenarian population would require readily chewable, swallowable and digestible food.



3. ***Increasing Annual house hold consumption*:** India would become the fifth largest consumer in the world and the annual house hold consumption is expected to triple by 2030. Urban culture of preference shown for packed and certified foods; functional, immunity booster and designer foods; e- food order n delivery; organised food retail sector and increasing DINK (dual income no kid) households.

Skyrocketing of fruit and vegetable start up trends in food processing sector

India is the world's largest producer of pulses, mangoes, banana, milk, ginger, buffalo meat and 2nd largest producer of rice, wheat, potato, garlic, cashew nut, groundnut, dry onion, green peas, pumpkin, gourds, cauliflowers, sugarcane, and tea in the world. India holds 17 and 14 per cent vegetable and fruit global production respectively including 40 and 30 per cent mango and banana global production. This leading scenario paves way for a humongous food ecosystem stimulating growth, employment opportunity, fiscal incentives, and investment platform in sectors of food processing, food retail leading to dynamic reframing of economic policies in a fast-track mode.

Key statistics which unlocks the trend

The total production in horticulture sector was 320.48 MMT with the processed fruit and vegetable industry value of 15.4 billion USD (2019-20). In general more than 40,579 food processing units and increasing are in registered sectors, across India. The contribution of the food processing sector has increased continuously with Gross Value Added (GVA) in food processing sector from Rs.1.34 lakh crore in 2014-15 to Rs. 2.37 lakh crore in 2020-21 at a Compound Annual Growth Rate (CAGR) of 9.97%. India's food service market is expected to reach USD 79.65 billion by 2028, growing at a CAGR of 11.19 per cent from USD 41.1 billion in 2022.

Key schemes which support the entrepreneurs

Under Ministry of Food Processing Industries (MoFPI)

(i) *Pradhan Mantri Kisan SAMPADA Yojana (PMKSY)* which aims in creation of modern post-harvest infrastructure, value addition, providing better returns to farmers, creation of off-farm employment opportunities etc. including, Integrated Cold Chain and Value Addition Infrastructure and Creation/ Expansion of Food Processing/ Preservation Capacities (Unit Scheme).

(ii) *PM- Formalization of Micro Food Processing Enterprises (PMFME) Scheme* under Support to Individual Micro Enterprises and Branding and Marketing for providing financial, technical and business support for setting up/upgradation of two lakh existing micro food processing enterprises across the country on One District One Product (ODOP) approach with an allocation of INR 4600 crores till March 2026.

(iii) The newly introduced, *Production Linked Incentive Scheme for Food Processing Industry (PLISFPI)* to support creation of global food manufacturing champions commensurate with India's natural resource endowment and support Indian brands of food products in the international markets with an outlay of Rs.10900 crore up to 2026-27.

- The first component relates to incentivising manufacturing of four major food product segments viz. Ready to Cook/ Ready to Eat (RTC/ RTE) foods including Millets based products, Processed Fruits & Vegetables, Marine Products, Mozzarella Cheese.
- The second component is for incentivising Innovative/ Organic products of SMEs across all the above four food product segments including free range - eggs, poultry meat & egg products.
- The third component relates to support for branding and export to incentivise the emergence of strong Indian brands.

(iv) *Operation Greens Short term interventions under Aatma Nirbhar Bharat* - to protect the growers of fruit and vegetable crops including Banana from making distress sale and to reduce post-harvest losses. The eligible entities include production cluster and also individual farmers, group of farmers, FPOs, FPCs, cooperative societies, State Marketing/ Co-operative Federation, Food Processors, licensed commission agent, exporters and retailers. The Ministry will provide subsidy @5 0 % of the cost of the following two components, subject to the cost norms notified by the Ministry: (i) Transportation of eligible crops from eligible production cluster; and/or (ii) Hiring of appropriate storage facilities for eligible crops (for maximum period of 3 months).

(v) *Invest India* - Foreign Direct Investment (FDI), the Government has put in place an investor-friendly policy wherein 100% FDI is allowed for food products' manufacturing under the automatic route, and 100% FDI under Government approval route is allowed for retail trading, including through e-commerce, in respect of food products manufactured and/or produced in India. A dedicated Investor portal 'Nivesh Bandhu' and Investment Facilitation Cell is being set. The total FDI inflow in the food processing sector during last 5 years ending 2021-22 is USD 3.54 billion.

Under Ministry of Agriculture & Farmers' Welfare Government of India

Agriculture Infrastructure Fund upto 2029-30 - under Agri entrepreneurs and start-ups

- With a dedicated source of funding, entrepreneurs will push for innovation in agriculture sector by leveraging new age technologies including IoT, AI, etc.
- It will also connect the players in ecosystem and hence, improve avenues for collaboration between entrepreneurs and farmers

Under National Bank for Agriculture and Rural Development (NABARD)

Loans for Food Parks and Food Processing Units in designated Food Parks

- It is to be noted that this scheme rolls out for existing designated Mega Food Parks (Mega Food Parks (23 operational , 18 in progress)[3] under PMKSY, MoFPI scheme.

Under Mission for Integrated Development of Horticulture (MIDH)

Integrated Post-Harvest Management - these projects will be entrepreneur driven and provided credit linked back-ended subsidy.

- Integrated pack house with facilities for conveyer belt, sorting, grading units, washing, drying and weighing. Rs. 50.00 lakh per unit with size of 9Mx18M Credit linked back-ended subsidy @ 35% of the cost of project in general areas and 50% of cost in case Hilly & Scheduled areas for individual entrepreneurs.
- Pre-cooling unit Rs. 25.00 lakh / unit with capacity of 6 MT. Credit linked back-ended subsidy @ 35% of the cost of project in general areas and 50% of cost in case Hilly & Scheduled areas for individual entrepreneurs.

Focal points to venture in value chain and supply chain management in banana enterprises

Agrarian to Processing: It should be noted that Agriculture sector utilizes maximum manpower contributing the lowest GDP. This paradox scenario needs a change by merging processing into agriculture leading to value chain and improved supply chain from farm to trade.

Focal points: Quality input supply (genetic advances in seed materials, nano-formulated chemicals); site-specific farming (automation and precision equipments - GPS, GIS system to create yield maps, utility of plant growth and soil moisture sensors, crop simulation models); designing VRT (variability rate technology); drone applications; clustering – FPOs,/FPCs; digital monitoring of demand/supply n trading forecast (creating suitable Decision Support System DSM) ; primary processing at farm level.

Rural Empowerment: Even though India holds majority population in rural, lack of opportunity and less profitability in agriculture business makes youth have a false but a dangerous illusion upon urban hype. This rural-urban divide should be dissolved by farm to retail interconnectivity being mechanized and digitalized using IoT platforms and creation of white/green/new collar jobs minimizing 'work- toil' at every node/vertex point of the supply chain management.

Focal points: Testing/Quality checking labs; primary and secondary processing set-up (thermal and non-thermal technology; functional food and beverage development); conveyor lines; modified atmosphere packing; green packing; refer vehicles; controlled atmosphere storage chambers; digital networking – customized 'block chain' development

Zeroing Post-Harvest Wastage: India witnesses 4.58 -15.88 per cent fruit and vegetable wastage which could be easily resolved by undertaking initiatives in quality management – developing 'on

farm' testing kits, building suitable cold chain and processing infrastructure including suitable packing technology at farm level, logistics, end product storage and point of retail.

Focal points: Quality input supply; Primary and Secondary processing unit; packing technology; studying trade dynamics; innovative waste management technologies – extraction of functional compounds; fibre rich functional, fermented foods and beverages, biofuel, bioplastics, biobricks, fibre textile, hand-made crafts.

Indian Economy stabilizing and on rise: There is an imperative need to act fast as India has tougher days ahead since under the tag of 'developing country' with soaring population and the latest adoption according to COP 27 to abide by usage of minimal fossil fuels and adopt greener energy and technologies.

Focal points: Green energy technologies – in processing unit, waste management, logistics; export of traditional and GI tagged bananas; certification; e-commerce; equilibrium market; single commodity multi-variant product retail outlet; product development for sustainable market.

Banana-preneurs!!! – Check out these Insights into the food and beverage processing sector

Smart manufacturing 4.0

In the global food industry, the orbit chart trend analysis (2006-2016) above, shown a steady decline in operating margin, inventory turns despite the benefit of declining oil prices. This scenario could lead to reduced profitability as a manufacturer. Thus it is required to transform the food business industry in FMCG (fast moving consumer goods) and CPG (consumer package goods) making companies in compliance with ESG (environmental, social and governance).

Learn that we need to adopt shift to newer technologies: to mention a few like weed-picking robots, autonomous vehicles, drone deliveries, smart refrigerators, robotics, AI, food safety – details on allergens, fortification, functionality: recent tech of Viome to check gut microbiome, 3 D printing, development of just walk-out stores, M2M (machine-to-machine) platform and Blockchain.

Utilize the rise in demand for plant-based food

In the scope of reducing food miles and consumption of **guilt-free foods**, invest in Fresh and Wellness. There are few target customers declining the intake of processed and multi-packed snacks and seeking wellness. Redesign the supply chain to deliver localized assortments of fresh products to deliver on the wellness goals. Re-imagine the way fresh, plant-based foods are grown, prepared, delivered, and ultimately brought to the table with lesser inorganic input and greener packing. Also, prepare, voice-out, display an array of **Processed Indian traditional foods (PITF)** in co-operating GI and traditional Bananas in the bucket list for their delivery which could boost the market.

Smart labelling and packaging

Consumers want the package label on the pack to match what is delivered. Label 'Transparency': clean labels with high ethical values are more important than ever, particularly to a growing segment of consumers with special dietary needs, which could mean, lab-created, artificial or natural or ethnic flavours, synthetic additives, carbs/ fast-release sugar per cent, other calorific and nutritive value. This will require reworking many elements of the supply chain, but it is going to be a requirement to drive growth.

Step-up and be an initiator. The food packaging industry is steering its way forward fulfilling the requirement of materials that help pack food safely with minimal impact on the environment. As learnt from long-term strategic forecast to 2028, the global packaging market is set to increase by almost 3 per cent per annum and reach over $1.2 trillion between 2018 and 2028. There will be a demand for flexible packaging due to its lightweight, convenience, and portability. Hence customize to use less packaging and to use biodegradable and reusable packing bio-plastics; viola! which could be made from banana waste with little grey-matter input.

Retail aspects

Know the retail channels: **Identify the platforms like** Omnichannel, brick-and-mortar- and online-only. Also know that D2C (Direct–to-Consumer) will continue to outpace all other distribution channels**.** Everyone seems to be taking part in this phenomenon, even farmers! CPG companies can make up for additional shipping costs with great logistics systems, fewer coupons and slotting fees, increasing margins while consumers pay less. Know the trends for restaurants: outdoor dining, delivery and ghost kitchen.

Build Outside-In Processes: Utilize channel data and sense demand. Recognize that there is a big difference in **syndicated and point of sale data**. Test and learn cross-channel, and mine unstructured text to listen to consumer sentiment. Form cross-functional teams--marketing, sales operations, quality, R&D - to test, learn and listen. The winner will not be the company that "yells" the marketing message the loudest. Instead, it will be about sensing and listening through outside-in processes. Break the monotony in using a single structured applications like Enterprise Resource Planning (ERP) and analytics for all the inventories: instead modify the structure, need based.

Aspects in e-commerce

Deliver what consumer intends to purchase: Match Physical to Digital. Consumers want the physical product to match the display that appears in online screen purchase. Reduce the gap between the physical world and the digital online experience. This requires a skilled hand from an inspirational worker cum leader.

Set and reset base prices and cease trade promo spending: Work in silence, let success make the noise and don't turn deaf! Learn back to listen. Traditional promotion drive increase the cost of delivery via the supply chain and the cost of product in marketing. Overhaul price/pack architectures and take the 20% of revenue spent on traditional trade promotions, and invest it in the consumer experience in the channel. Drive digital transformation.

Maintenance of feedback loop

Happier employee model: To have more agility in the business besides implanting cutting edge technologies it is first priority to enable and empower the employees sync work with technology with a delicate feed-back loop for better store execution and business. Secure your innovative product using IPR system and make business.

Happier Customer model: Each of your products when have excelled and having planned for line extensions: Keep it simple. Most line extensions added complexity and not value to the market and are the fundamental driver of higher costs. While the launches allowed marketing to check the box

on bringing a new product to market, most were not successful. Streamline the customer experience and rationalize the line extensions.

Bananas in making of innovative foods

In India, beyond the existing banana supply chain network, there is still a vacuum in fulfilling the actual nutritional needs of the Indian people. It is also high time we track down our farm produce to return back the income to the producer rather than being wasted rotting. The second choice of processing holds good not only saving the bananas but also recuperates the economy of the native producers since remuneration for processed banana based food products is higher. Also, focus on combating micronutrient deficiency *via* the food fortification system and requisite for low-glycemic index starch has facilitated taking up bananas to newer heights of validation in food industry.

Bio-fortification in bananas

Bio-fortification of bananas to ameliorate VAD (Vitamin A deficiency) is the talk of the town. Micronutrients such as iron, vitamin A, iodine and folate enhance the nutritional value of food and play a crucial role in the mother's survival in pregnancy and childbirth and in child's ability. Bananas are so diverse with varietal provitamin characters which could be harnessed for bio-fortification.

Potential prebiotic source

Bananas are rich in inulin type fructans which on partial enzymatic hydrolysis results in shorter chain carbs or non-digestible oligosaccharides which are well known prebiotics. The so formed short-chain fatty acids supply high amount of butyrate which is beneficial for colon functioning. These compounds escaped digestion in the upper gut, inducing change in the composition of fecal bacteria: supporting *Lactobacilli* and *Bifidobacteria* abundance rather than Clostridia and protein-degrading bacteroides, those capable of producing tumor-promoters from metabolites of proteins, thereby boosting the immune system. Nendran bananas with high fructan content (1433.3 mg per 100 g) were used in puree preparation and could exhibit industrial suitability for formulation of functional foods.

Unripe banana starch and flour

The unripe banana flour comprises of more than 50 per cent of dietary fibre followed by resistant starch and meagre fructan content. One could recently notice a number of news-paper editorials and blogs on utilization of raw banana flour in cafes' especially in food outlets focusing on gluten-free snacks. **ICAR-NRCB, Trichy, has popularized bakery products such as cookies, bread and puffs pastry made using raw banana flour as an ingredient.** Indian companies such as Kokos Natural, Nature's Basket have come up with marketing raw banana flour in different brand names such as Natirel Raw Banana Flour and Kadhali Mystique respectively and have takers too.

Bananas in synbiotic foods

***Probiotic strains*:** The genera and species that are common probiotics are *Lactobacillus,Streptococcus, Leuconostoc,Pediococcus, Propionibacterium, Enterococcus, Bifidob acterium,Bacillus, Saccharomyces cerevisiae, Candida pintolopesii, Aspergillus niger* and *A. oryzae*. The discovery process for new probiotics emphasizes strain selection and the survival of the culture during storage and post-consumption in case of synbiotic applications. For probiotic products to be identified as functioning, its concentration must be at least 10^6 viable cells (colony forming unit, CFU/g) of the product. Probiotics also offer an alternative to antibiotics.

Banana as prebiotic substrate: Fructooligosaccharides (FOS), galacto-oligosaccharides (GOS), trans-galactooligosaccharides (TOS), pectic oligosaccharides (POS) are the most common prebiotics. Bananas contain about 60–80% of their carbohydrates as indigestible carbohydrates, which contain prebiotic properties. Probiotic bacteria can digest such type of carbohydrates produce short-chain fatty acids including lactic acid, butyric acid, and propionic acid during fermentation and therefore promote the growth of probiotic itself. Banana peels (pectin), raw banana starch and flour (resistant starch), pseudostem (cellulose, hemicellulose and lignin), ripe banana (inulin and oligosaccharides) could all be potential prebiotic substrates in making of a synbiotic food.

Formulation: Synbiotic food comes under functional food category and formulation using encapsulation technology helps in aroma and flavour stabilization; increase its bioavailability and targeted delivery and extension of shelf life. Probiotic cells could be encapsulated to increase their viability protecting them from the acidic pH of the products and to create a physical barrier protecting the bacteria from adverse conditions during production processes and digestion. **Extrusion, spray drying, water in oil emulsion, impinging and freeze drying are the methods followed in encapsulation of probiotics.** Banana's resistant starch, dietary fibre and pectin compounds could serve as excellent wall/ coating material in encapsulation of probiotics.

Conclusion

The food industry is growing rapidly with the emergence and development of verticals like food and grocery delivery, personal chefs, box delivery, and on-demand meals; these are becoming popular day by day. There is a confluence of many successful food-tech-based start-ups currently operational in India along with several upcoming and promising ones. It is predicted that food start-ups will decide the course of diet of billions of Indian population in the coming years. Post-pandemic, food and export industries have remarkable economic growth compared to other sectors. The challenge is to ensure that the fruit and vegetable crop of the farmers is purchased and that there is adequate supply to the units processing these products. In addition, uninterrupted supply of ancillary inputs like packaging material has to be ensured and the logistics for retail and export has to be made completely operational and digitalized for reduced farm and market drudgery. In simple terms, Keep simple, be innovative, catch up with people, set the trend, change when required and never quit.

Banana fibre: A natural fibre with multiple utilities

Suresh Kumar. P*, Ravindra Naik Shiva K N* Kamaraju K*** and Uma S***

*Principal Scientist (Hort.,), **Principal Scientist (AS& PE), ***Technical Officer
ICAR - National Research Centre for Banana, Tiruchirappalli - 620 102
***ICAR - Regional Centre, Central institute of Agricultural Engineering, Coimbatore - 641 007*
Corresponding author: psureshars@gmail.com

Introduction

Annual production of lignocellulose fibre from crops in the world was about 4 billion tons (i.e., 60% agricultural produce and 40% forest produce), compared to other major commodities like steel (0.7 billion tons), and plastic (0.1 billion tons). The most important property of natural fibre is biodegradability and non-carcinogenic with an advantage of being cost-effective. The huge and wide range availability of natural fibre can reduce the pressure on forest and agriculture. The world's population will add additional 2 billion people between now and 2050. In comparison to the synthetic fibres the natural fibres are with added advantages for their stiffness, ready availability, low cost, and with renewable properties. Natural fibre from agro-waste exhibit excellent characteristics like good mechanical strength, stiffness, low density, non-abrasiveness, high disposability, renewability and are considered to be eco-friendly over synthetic fibres. Among the natural fibres, 90 percent are of plant origin and classified as seed fibres such as cotton, bast/skin fibres like flax, ramie, hemp, banana and jute. Among them 80 percent of fibre was constituted by cotton and remaining by other long fibres such as flax, jute, pineapple, hemp, ramie, coir, sisal and banana.

Banana: *kalpatharu* - to be reckoned more

Each and every part of the banana plant is used for variety of purposes other than its dessert and culinary purposes. The leaf is the most popular hygienic bio-plate for dining; male flower could be uses as vegetable; stem could be used as vegetable and other purposes with its therapeutic uses. Plant sap could be used as an indelible ink and the corm could be exploited as animal feed. Of all these, banana sheath, contributing more than 40% biomass after harvesting the bunches has lot of applications and uses. They are used in several food and non-food related applications, as thickener, colorant and flavouring agent, nutrient source, livestock feed, fibres, bioactive compound source, and other purposes. Additionally, all parts of the banana plant have some medical values, such as the flower can be cooked and consumed by diabetics, bronchitis, dysentery, and ulcer patients. It is also consumed as juice in fresh form. The banana central core stem finds use in south Indian cuisine and is consumed as fresh juice to prevent kidney stones. Banana stem is a rich source of fibre and helps to control obesity. It also aids to detoxify the body. The banana pseudostem sap can be orally taken or externally applied for stings and bites. The young leaf can be used for skin irritations (as a poultice). The roots, ashes of leaves, peels, and seeds also can be used for medicinal purposes in most of the Indian and Asian traditional medicine.

Potential of banana waste (Pseudostem) for natural fibre

After harvesting the fruit bunch, huge plant bio-waste is generated, out of which pseudostem (30-34%), flower & bracts (5%) and rhizome (12-14%) together they contribute 50 per cent of the

banana plant biomass. Currently less than 2% of these wastes production is used for human consumption and for production of fibre, the remaining are incinerated and wasted. However, these materials could in many cases represent an abundant, inexpensive and readily available source of renewable lignocellulosic biomass for different purposes. For every ton of banana fruit harvested, about 4 tons of biomass wastes (e.g., leaf, pseudo-stem, rotten fruit, peel, fruit-bunch-stem, rhizome, etc.) are produced. This means, for every cycle of banana fruit production, four times of biomass wastes are also produced. It is estimated that one hectare of banana farm could produce approximately 220 tons of biomass wastes. These wastes are usually disposed of by the farmer into lakes and rivers or simply burned. The banana trunk is called as pseudostem. The pseudostem is a cylinder-shaped structure made up of tightly bound leaf petioles.

India: Goldmine for waste utilization

India is the top most banana cultivator and it has about 8.3 lakh ha under banana cultivation. In our own estimates, for every 30-40 kg of banana bunches roughly 100 kg of waste is generated that needs to be got rid of. Therefore, banana plantations face the problem of disposing the pseudostem which goes as a waste after harvesting of the trees as on an average about 60 to 80 tonnes of pseudostem alone is generated per hectare. As per the estimate nearly over 1 billion tonne / year of banana stems are left to rot. The banana tree wastes if not properly managed can cause problem to the environment, because if they are dumped in wet conditions or burned can produce greenhouse gas, which can cause a problem to the environment. It is believed that this crop waste can be used in a more rational way, namely, as a source of cellulose fibre for further applications. Therefore, there is a need to dispose of this mammoth problem in India and elsewhere.

The stem of banana, commonly known as pseudostem is an aggregation of leaf stalk bases in cylindrical form. Pseudostem of Banana normally goes as waste though it could be used in pulp and paper industries due to its cellulosic content. Due to large area under cultivation, enormous amount of biomass produced thus banana and plantains have been regarded as source of major fibres for the near future. In India, we guesstimate that with the extractable pseudostem fibre yield of 400-600 kg fibres per hectare, 1.8 million tons of fibre could be produced which is otherwise dumped as a waste after harvesting the bunches. It is estimated that universally about 288 million tonnes of banana residues, banana skins, leaves and stems have been generated and wasted annually, rather it has potential for bio-energy production, composting and waste water treatment.

Banana Pseudostem

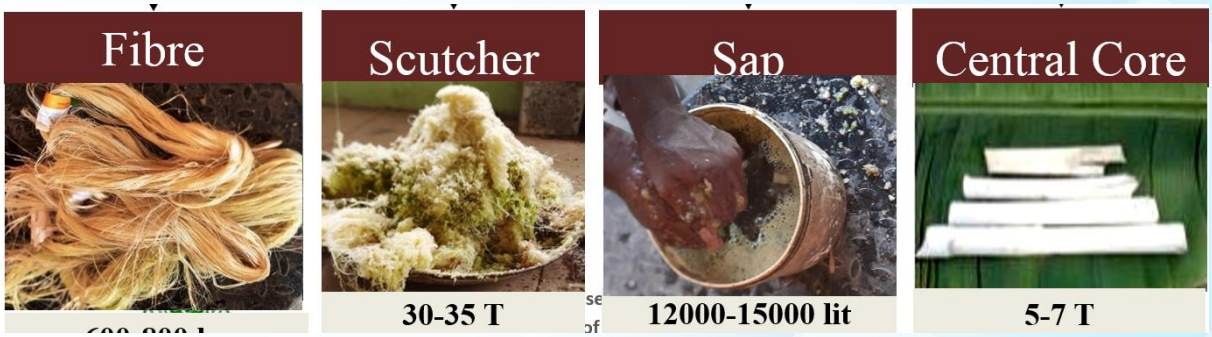
Sheaths from Pseudostem

Raspador machine for fibre extraction

Shade drying of extracted fibre

Extraction of fibre and utilization of auxiliaries

Essentially fibre with different dimensions can be extracted from banana pseudo-stem. During mechanical extraction of banana fibre from pseudostem, scutcher waste (25 to 30 t/ha), sap (17,000 to 22,000 l/ha) and central core (8 to 10 t/ha) are also obtained simultaneously. The banana pseudostem has also been considered for use as pulp and paper raw material, fibre for textiles, and filler or structural reinforcement in composites materials.

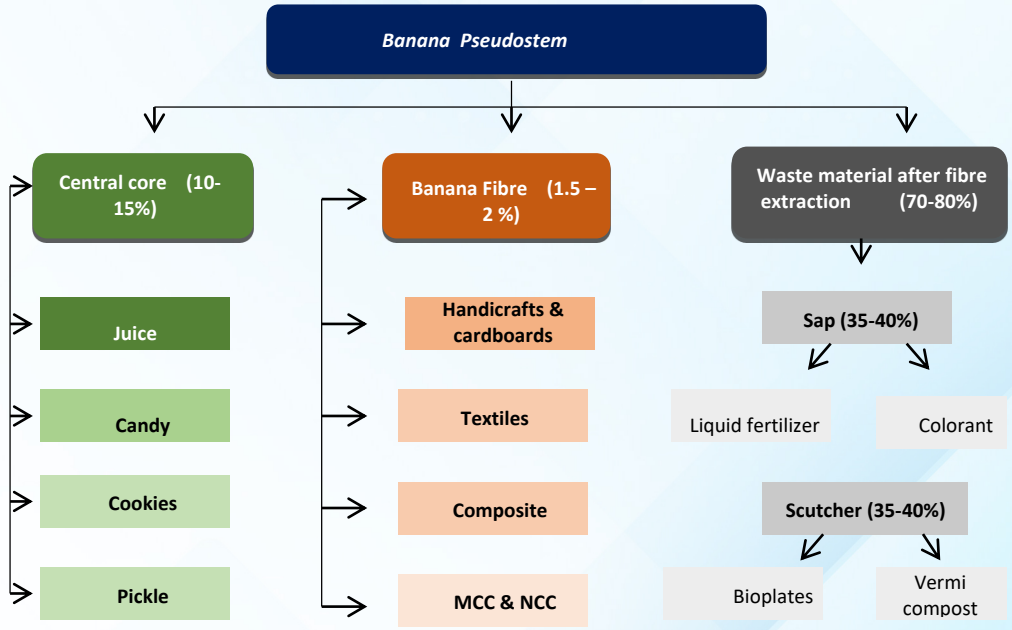


Four different components obtained while fibre extraction: use all for the sustainability and profitability

Application of plant fibres as one of the component in polymeric materials such as reinforcement in composites have attracted greater attention due to their added advantages. Natural fibres and its composites is environment friendly as these are derived from renewable sources, and at the end of life cycle either they can be composed or calorific value can be recovered. In Costa Rica, Industrial production of paper from banana pseudostem is going on and a whole range of products labelled Earth which includes paper, cardboard, notepads, letter paper, envelopes, post card, packaging material and notebooks have been launched. The banana fibre paper is reported to be of high strength and it is used to make tea bags and currency notes. Due to its being lightweight and comfortable to wear, it is still preferred by people there as summer wear.

With increasing demand on eco-friendly materials, banana fibres are now used to make garments, ropes, mats, carpets, cushions, cushion covers, bags, baskets, table cloths, curtains, rugs, matresses, pillows, wallets, wallets, yoga mats, sausage casings, tea bags, vacuum bags, cigarette papers, fishing nets, packaging sheets, base material for growing of mushrooms, cardboards, string threads, socks etc. Rugs made from banana silk yarn fibres are also very popular world over. With the increasing environmental awareness and growing importance of unfriendly fabrics, banana fibre

has also been recognized for all its good qualities and now its application is increasing in other fields too such as apparel garments and home furnishing. The expansion of bio-composites has amplified industrial usage that would release the possibilities to minimize the wastage of renewable materials. It promotes a non-food- based market for agricultural industry. In this review, we attempted to give comprehensive overall picture about the utilization of banana pseudostem methodologies for the extraction, versatile use of the fibre in composites, textiles, paper and pulp industry, usage of other ancillary products like banana sap, scutcher and central core stem for different applications.



Scope and potential of banana fibre industry

Worldwide, nearly over 1.2 billion tons/year of banana stems are left to rot. Bananas and plantains are the fourth most important global food commodity of the developing countries after rice, wheat and maize in terms of gross value of production. It is one of the most popular fruits in the world in terms of per capita consumption besides the most widely traded fruit. India is the top most banana cultivator and it has about 0.83 million ha under banana cultivation. About 50–60 kg of waste needs to be get rid off, for every 30–40 kg of banana bunch. With the extractable pseudostem fibre yield of 400 kg fibres per hectare, Rs.3000–4000 crores ($500 million) of fibre in India and 3-4 USD billion worldwide could be extracted which is otherwise dumped as a waste after harvesting the bunches.

The trunk of banana plant that is pseudostem is thrown as a major agro-waste, which can be effectively utilized in bulk production of banana fibre. Banana fibre, a ligno-cellulosic fibre belongs to stems/bast fibre. The outer sheaths of pseudostem produce the coarsest fibre which are very brittle and can break at the slightest jerk, so practically two or three of the outer sheaths are rejected. The innermost sheaths contain pulpy matter and these are not utilized for fibre production. Only the intermediate sheaths have been exploited for obtaining fibres.

Natural fibres like banana fibre has various applications in the field of textile, handicrafts, composite boards and paper industry, other than structural reinforcement in composites materials and a source of cellulose fibre. Banana fibres can be used as natural absorbent, bio – remediation agent for bacteria in natural water purifier, mushroom production, tea bags, string thread, and high quality fabric material, paper for currency notes and good rope for tying purpose. The banana fibre has important advantages such as low density, appropriate stiffness and mechanical properties and high disposability and renewability. Moreover, they are recyclable and biodegradable. Very recently, banana fibre and other plants fibres have attracted much interest in polymer composite materials as it has a potential to use as an effective reinforcing component.

Many applications of banana pseudostem fibre have been enlisted as follows:

- As an eco-friendly substitute in textile industry in place of the environmentally hazardous synthetic fibres.
- Being completely biodegradable and naturally occurring, the fibre products are expected to be in great demand in the international markets as they pose no toxic effects to man and environment.
- To make value added products, which would enhance the profitability of banana farming.
- To minimize deforestation due to various wood/cellulose processing industries, thus protecting our ecology and environment.
- Boxes made from these boards can be used for transport of fruits and other materials and coarse fibre can be used for making files, covers and packing materials
- Banana fibre is the natural fibre and the appearance is similar to that bamboo and remie fibre however has better spinnability than other fibres.
- It has a smaller elongation and is strong, has the shininess with strong moisture absorption capacity and also releases the moisture very fast.
- It is an eco-friendly fibre and can be spun through all kind of spinning including ring spinning, open end spinning, bast fibre spinning and semi-worsted spinning

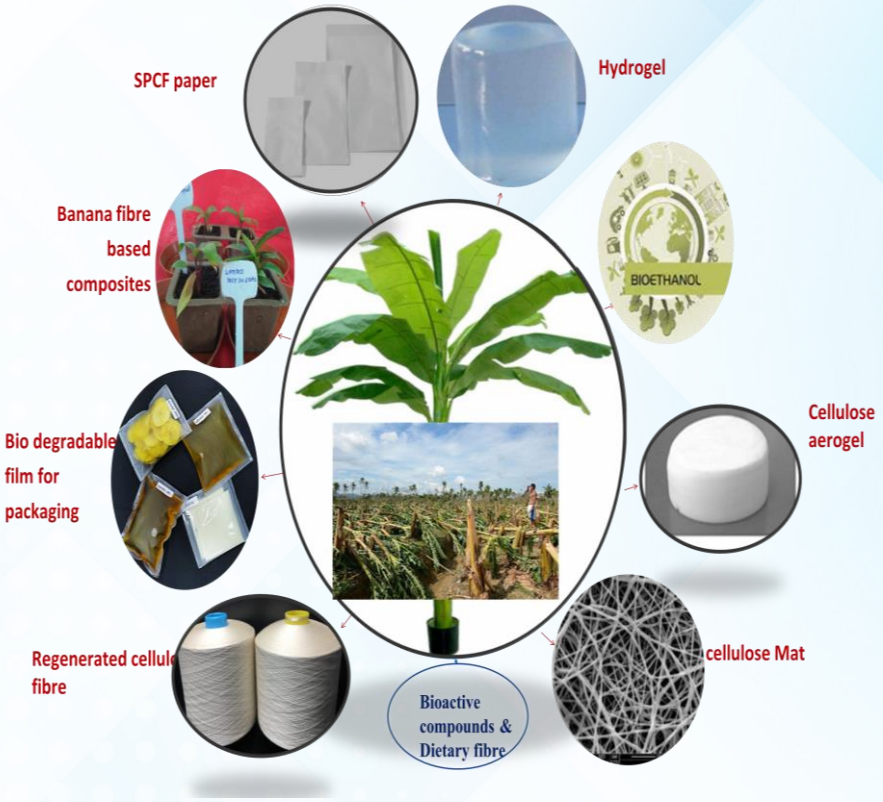
- To provide livelihood to the rural poor through generation of employment in the fibre producing and processing industry.

Stem fibres as natural craft materials

Due to the relatively high cost of synthetic fibers and health hazards, it becomes necessary to explore natural fibers. The banana fiber is composed of cellulose – 62%, lignin - 29%, hemicellulose - 3%, pectin - 2%, miscellaneous - 4%. By-products of the fiber are: fabrics, bags, various types of mats, interior decoration items, window blinds, cushion covers, bolster covers, table lamps, home decorative, door mats, table mats, meditation mats and folders, to name a few. Banana fiber has got very wide usage in the units like: 100% chemical free tissue paper, filter paper, paper bags, craft papers, greeting cards, wedding cards, carry bags, nursery pouches, art papers, decorative papers, tissue papers, bond papers, paper products like pen stands, table decorative, land shades etc. Banana fiber is grease proof, water and fire resistant and totally bio-degradable. Paper made out of banana fiber is having very good export potential including European countries.

Problems, challenges and solutions

- In banana growing regions hardly 5% of the banana waste is used for extracting the fibre and the rest is wasted. There is no standard way to extract the banana fibres in any country resulting in irregular demand supply situation, which finally leads to higher price of banana fibres against other natural fibres for end users. The main reason behind the under-utilization of banana fibre is the lack of sufficient scientific data on this fibre, except information regarding its chemical constituents.



Future products using banana wastes

- Banana fibre at present is a waste product of banana cultivation and either not properly utilized or partially done so. The extraction of fibre from the pseudostem is not a common practice and much of the stem is not used for the production of fibres. The buyers for banana fibres are erratic and there is no systematic way to extract the fibres regularly. Useful applications of such fibres would regularize the demand which would be reflected in a fall in the prices.
- Mechanization, continuous operation, higher fibre efficiency, use of ancillary products, identifying right blending for textiles and improving the durability of fibre composites are major problem in the utilization of banana pseudostem fibre.
- There are some logistical problems in banana fibre production in a bulk scale. The extent of fibre realization from banana stem is only of the order of about 1%. Since the area of banana plant cultivation is widely scattered, banana stems are to be transported (from the place of cultivation to the place of fibre extraction). The transportation involved in this connection will make the whole process economically unviable. Therefore, development of a mobile fibre extraction unit (which can be taken to the place of banana plant cultivation) is the first vital step in making the process of banana fibre extraction an acceptable proposition.
- Since banana fibres are much coarser (15 to 20 times coarser) than cotton, spinning of banana fibres with cotton would be very difficult. At present the banana blend ratio cannot be increased more than 30% with cotton fibres.
- Yarn from banana traditionally is a time-consuming and costly process where banana stems were first boiled in lye to soften them and then prepared from shredding to extract yarn. They produced banana fibres of varying degrees of softness, yielding yarns and textiles with differing qualities for specific uses.
- Until recently, there was no fast and efficient method of extracting the fibres. There's another big reason that banana fibres have not yet seen any large-scale application in the international textile industry: the ready availability of cheap, mass-produced cotton. Banana fibre textiles can definitely lessen the demand for cotton to a large extent. However, banana-fibre textiles are not able to completely replace cotton without creating severe environmental problems.

Action plan to enhance the fibre market

- A few manufacturers in India and China now incorporate banana fibre into cotton blend fabrics. The blending of cotton and banana fibre could lessen the demand for cotton cultivation. The process of turning banana stalks into textiles is the much easier than the relatively slow and labour - intensive process of turning woody stalks of bamboo, hemp, or flax into fibres suitable for textiles.
- Banana fibre can easily be sorted as per their thickness. The innermost stalk fibres are the softest and most pliable; the outer fibres are the thickest and strongest. Segregation of inner and outer layers of banana stem fibres is to be extracted and a special attention is required to spin yarns with inner and outer layers of banana fibres. Technology for yarning is available nonetheless of its high cost. Procurement and availability of large quantity of banana fibre is the impedance in growth of the industry.

- Efforts should be made to form the clusters in the banana growing area, Farmers groups may be promoted to have sufficient number of fibre extraction machines to extract fibre from the banana pseudostem and to utilize the scutcher waste and sap for other purposes.
- Unlike cotton and jute where the primary output for income is fibre, the pseudostem in banana is the waste material being generated after harvesting the bunches. Efforts should be therefore made to bring down the cost of banana fibre and thereby making the business more remunerative and viable. Banana fibre association or central buying agency is to be formed and a minimum support price from the government for the extracted fibre with the assured market must be created.
- Successful, sustainable, creative business models with cluster development should be developed and it should align well with the existing businesses of natural fibres.
- Development of better throughput fibre extraction machines with higher efficiency coupled with modern features and affordable cost is pre-requisite coupled with fibre testing methodologies and technologies for spinning of banana yarn blended with other natural and manmade fibres.
- A complete setup for producing banana /cotton or banana/ viscose or bamboo blended yarn spinning techniques and machineries are to be developed from fibre cutting – fibre opening – fibre softening – fibre blending – carding- drawing- flyer spinning – splitting- winding operations
- Maximizing fibre output, softening of banana fibre using greener technologies, blend ratio evaluation are some of the key areas where research thrust should be given to find a viable technologies.
- For sustainability and for large scale production and cost reduction, the fibre should be accommodated with the power loom industry from the present status of weaving only through manually.
- Development of composite boards, acoustic components are possible with the utilization of banana fibre. Technologies must be standardized and up scaled for producing nano-fibres from banana and its uses in multiple applications.
- Should be made to tap the potential to use the fibre of coarse part to make panel boards for interiors; fibre of soft part to produce the medicine plastering cloth for the dressing for wound; produce non-woven mats to cover workshop sheds to reduce the heat of the metal sheet covered room and use the coarse fibre to reinforce natural fibres in place of using the glass wall fibres.
- Browning is the common cause of quality deterioration of banana fibres. Standardization of solar drying of extracted banana fibre, use of banana fibre in bedding materials, banana fibre for flower garland needs to be standardized.
- Plastic crates are normally used for the transport of various agricultural commodities. For the greener environment, in lieu, banana fibre based disposable crates for transport of fresh banana was emphasized and technologies may be commercialized for large scale production of reinforced materials.
- Fibre thread making unit/Rope making units can be developed with the help of Jute/Coir bonds.
- Shade nets being used in nurseries can be replaced with banana fibres of different percentage shade and research and development could be taken up to standardize the shade requirement of various crops under banana blend nets.

Conclusion

In earlier days, natural fibres served a crucial role to mitigate the everyday needs. But the arrival of synthetic product is dominating over the natural fibre due to low cost. The synthetic fibres are non- degradable and cause serious pollution problems. Systematic insights to enhance the utilization of banana waste in different value added products could increase the profitability of banana farming while gaining environmental and economic benefits to both agriculture and related industries, marinating sustainability and to reduce the carbon foot print. The development of new applications for these agricultural residues could be an interesting income for banana producers and for an economy. The most important property of natural fibre is biodegradability and non-carcinogenic which bring it back into fashion, with an advantage of being cost-effective. The versatile nature of it makes it suitable for automobiles, railway coach, building construction, partition wall cabinets, or furniture for machinery uses and packaging.

With new innovations consumers can expect new things in the textile industry like fabrics and textiles woven from fine quality banana fibre. Rugs made from banana silk yarn fibres are also very popular world over. The development of commercially viable "green products" based on natural resources for both matrices and reinforcements for a wide range of applications is on the rise. This effort includes new pathways to produce natural polymers with better mechanical properties and thermal stability using nanotechnology and use of natural polymers to make biodegradable plastics and their composites with lingo cellulosic fibres. Use of lignocellulosic to produce ethanol and other sugars can possible by fermentation. Biomasses can also be converted into carbon, hydrogen and oxygen to produce various chemicals, enzymes and proteins. It is reasonable to expect that agricultural by-products will be a major source of industrial products and chemicals in the near future. However, there are a few limitations associated with agro-based fibres that should be considered when designing products using bio-fibres. The primary limitation is the relatively higher moisture absorption of natural fibres, making it difficult for the hydrophobic fibres and hydrophilic polymers to bond together. Entrepreneurship development in farm sector will be a key driver for promoting and sustaining the momentum of growth. Non availability of skilled people on knowing the technical knowhow and absence of incubation centres handicapped the spread of banana fibre based industry and one of the reasons for such a huge waste in banana and non-utilization of its parts. With the huge potential of availability of fibre it is pre-requisite for the development of integrated package for promoting handcraft from fibre and supporting MSME enterprises. Developing replicable models across regions, having diverse and convergence of ideas, design and technology development workshops, promoting farmer producer organizations (FPOs) and business friendly atmosphere are essential for promoting and utilization of fibre. Therefore, systematic and persistent research in the future will increase the scope and better utilization of banana fibre and its products.

The scope and merits of Banana fibres and its current trends in textile and non - textile applications- Challenges in blending and spinning with silk & other fibers

Mathiazhagan P[1##], Atharvan Deshpande[1], Radhalakshmi Y.C[1], Suresh Kumar P[2], Nilesh Waghmare[3], Rupesh Khare[3], Chinnarj S[4], Seenivasan R[4], Yerraiah D[5], Anandi Balagurunathan[6], Anandkumar[6] and Priyadharshini A[7]

1. Central Silk Technological Research Institute, Bangalore.
2. National Research Centre for Banana, ICAR, Tiruchirappalli, Tamil Nadu.
3. Pulp& Fibre Innovation Centre, Grasim Industries Ltd. Mumbai
4. Tamilnadu Newsprint & Papers Ltd. Pugalur, Tamil Nadu..
5. Maruthi Spun Silk Mills, Channapatna, Karnataka.
6. Anandi Texstyles (P) Ltd. Tirupur, Tamil Nadu,
7. Imayam Institute of Agriculture & Technology, Thuraiyur, Tamil Nadu.
Corresponding author: mathicstri@gmail.com; Contact Number: 9480673650

Introduction

Banana fibre is obtained from superimposed leaves forming the pseudostem of the plants, which are traditionally used in cooking, cattle feed etc. Otherwise, it goes as agriculture waste, manures/bio fertilizers / bio fuel. The textile and handicrafts applications have been amplified by different agencies like NGO's, societies self-help groups apart from Govt institutions like Khadi boards, DCH etc. In the current trend of pro-environment safety measures and its associated works on use of eco-friendly, bio degradable textile fibres and yarns, the banana fibre is inching towards better future as it has significant merits as a cellulosic fibre having rare presence of flavonoids & its effects in non-food applications.

Contrarily, the banana fibres lack certain basic requirements for spinning process. In order to understand these requirements let us discuss threadbare, on the physico mechanical process of *tufting & twisting* of individual fibres in a sequential manner to make the complete process of spinning. This includes following fibre characteristics like

- **Fibre length & uniformity**
- **Fibre strength & elongation**
- **Fibre fineness**
- **Fibres stiffness etc.**
- **Fibre color**
- **Fibres maturity**
- **Fibres cleanness**
- **Fibre Flexibility & Elasticity**

If the above properties are there in any fibre, it is highly suitable for Spinning. Cotton plays most significant role in fitting well in the above characteristics to make best yarns for different apparel uses. While spinning of yarns, we need to know whether we spin individual fibres as an exclusive 100% yarn or its blend with different fibres. Cotton is having natural properties to spin as an individual fibre to make 100% cotton yarn. Similarly, cotton has very good fibre compatibility to blend with many cellulosic protein and synthetic **fibres like viscose, modal, tensel, lyocell, polyester, acrylic, wool, silk etc.** The major advantages, we get while blending of cotton with the synthetic fibres is that they are prepared in such a way which is suitable for spinning. **This is possible due to reverse engineering and polymerization process which can be controlled & adjusted right from fibre denier / fineness, diameter and thickness etc.**

But in case of natural fibres like silk, wool, linen, banana fibres it is not possible to do such preprocess adjustments. We need to accept that according to the fibre characteristics of these natural fibres, we have to go for blending process. Although this is significantly possible & successful in case of cotton blending with wool, silk , linen etc., yet, it was not much possible in case of Banana fibres. **Banana fibres lack certain basic characteristics like fibre fineness, cohesiveness and frictional properties apart from its yield, and spinnability /viability issues.** Hence we need to introduce / use what is possible while blending banana fibre with cotton silk etc. Spinning of finer counts from 60's; 120's Ne is possible in cotton and its blend with Viscose, polyester etc. **This is not possible in case of banana fibres as only coarser counts like 10s to 30s is possible.**

Constraints of Banana fibres in Spinning and blending

Banana fibres are eco-friendly and bio degradable. But its basis requirement for spinning is having some serious challenges. Any fibre to be used in textiles need basic requirements like fibre length, cohesiveness and softness. This decides the spinnability of textiles fibres. As of now, banana is not possible to be spun on its own as a 100% banana spun yarns of finer counts/ thinner count yarns. The inherent characteristics like **flexural rigidity its stiffness, high frictional properties**, etc are not favorable to be used for spinning. Hence, we need to blend only with less blend ratio. However, we can spin thicker/ coarser counts yarns.

Banana fibres can be made to produce twins ropes, handspun yarns etc as a 100% banana material. These items are used in handicrafts furnishing etc. But as far as textile use for fabric weaving for apparel wearing, it is not possible to make 100% banana spun yarn/ fabric. The main bottleneck in spinning finer counts to make popular apparel garments in the GSMs range of 50-150 is yet to be made successful. **Hence it has been forced to make heavier/ thicker GSMs fabrics above 250-350 GSMs which incidentally goes into the non-apparel sector.**

However, considering the Eco friendly and bio degradable nature of banana fibres, it is worth making banana fabrics with at least 50-30% composition / blend ratio with any other fibre like cotton, wool, Silk, viscose, linen etc, if not 100% banana fabrics. Textile engineers/ Scientist may have to take such study and introduce 100% banana fabrics or at least 50-30% composition of banana fabrics. Similarly, when used in blending it was not possible to have more blending composition of banana fibres. As of now only 10-15% banana fibres is possible for blending.

New avenues and CSTRI Bangalore initiations

In this background, CSTRI Bangalore has approved a pilot study to carry out a study on the blending of silk with banana fibres. This initiation includes a new attempt on "**regeneration of banana fibres**" with the help of M/S Grasim industries, Mumbai and Tamil Nadu News prints & Papers Limited, TNPL Pugalur, Karur Tamil Nadu. Regenerated fibres like viscose, model, lyocell, tensel etc are basically cellulosic based and are made using solvents treatment which coagulate with wood pulps and are spin through mechanical and spinneret passage to make required size diameter/ denier of fibres/ filaments.

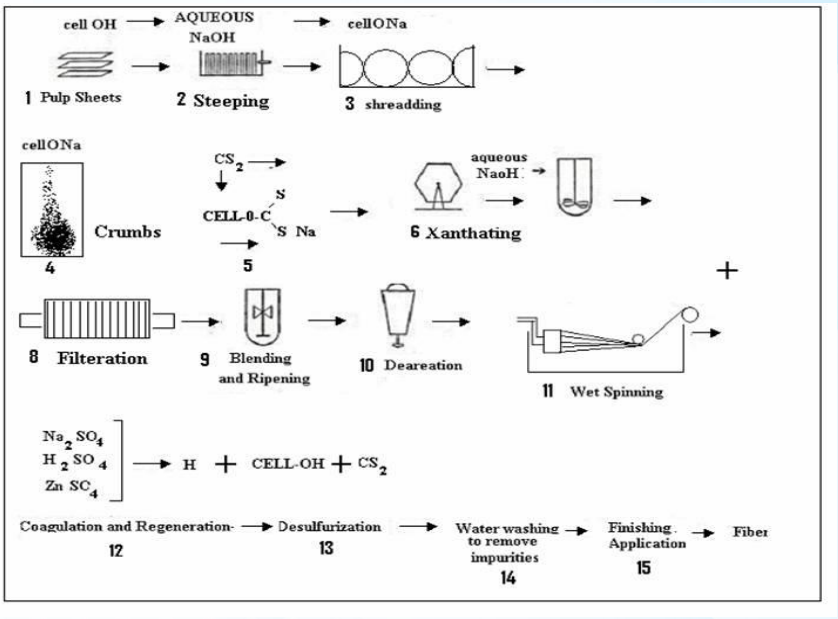
Regeneration of textile fibers

Regenerated fiber are similar to cotton, they were the first of the ***manufactured fiber*** to be developed called as "***Man-made Fibres***. They are made from cellulose based fibers that originate from plants such as wood pulp where some chemicals are treated to make pure cellulose fibres.

Rayon is known as regenerated fiber because it is manufactured from natural resource like cellulose present in wood pulp and short fibers. The properties of regenerated fiber is generally having 75-68% degree of crystallinity, 0.82 degree of orientation,1.05-1 cN/tex tensile tenacity in water and 30% volume DMSO coagulation baths respectively

The popular and major regenerated fibers are viscose rayon & lyocell rayon apart from cellulose derived acetate fibers. The regenerated fibers are formed when a natural polymer or its chemical derivative is dissolved and extruded as a continuous filament. While doing so, the chemical nature of the natural polymer is either retained or regenerated after fiber formation as we are not doing any modification/chemical reaction to form a new fiber but use natural polymer and hence it is called regeneration. In case of synthetic fibre like polyester, nylon, acrylic, etc. it's formed due to chemical polymerization and hence it is called synthetic fibers.

Manufacturing process of viscose rayon technology



Theory of fiber/yarn/fabric blending and the challenges in banana fibers

The natural fibers were directly used as 100%spun yarn in the beginning of the textile manufacturing dating back to 20th century. With increase in human population and associated increase in demand and consumption of more fabric globally, the quest for cheaper and large quantity production has ended in invention of new synthetic fiber like polyester, acrylic, lycra etc. This situation also pushed for blending of textile fibers to have more comfort and long life related requirements. In general fibers are blended in the following method like

- Manual blending (compulsory in all blends)

- Willowing machine blending(one of effective method)
- Blow-room blending (Equally effective method)
- Sliver blending (not so effective)
- Simplex/roving blending (in some cases done)
- Yarn blending (doubling & twisting of different fiber yarns)
- Fabric blending (it is union fabric done in warp/weft form and end/picks ,drawing/insertion methods)

Banana fibres blending with cotton and silk: Pilot study

Banana based Products developed marketed by M/S Anandi Texstyles, Tirupur

M/s Anandi Texstyles, Tirupur is one of the leading manufacturers and retailer in Banana fabrics having their outlet showrooms at Tirupur and Pondicherry with manufacturing facilities' at Salam and Rajapalayam. They are being involved as one of the collaborators for this pilot study. The few sample products developed by them may be seen as below.

Conclusion

The Pilot study taken up CSTRI, Bangaluru is in the preliminary stage. Considering the limitations involved in developing more banana composition based apparel fabrics, various Institutions/Factories involved in Banana oriented manufacturing, R & D, marketing/retailing are being involved to promote more products to exploit its natural merits rather than working in isolation. In this perspective, this study is being pursued with above mentioned affiliated Institutions/authors with due acknowledgements.

Product development studies carried out by SITRA using banana / cotton fiber yarn and fabric blends

Rakash Vasudevan P, Panneerselvam G, Nagarajan N K and Vittobaa M.K

SITRA (*South India Textile Research Association*), *Coimbatore, Tamil Nadu*
Corresponding author: vittopa@gmail.com; spg@sitra.org.in; Contact Number: 9865440003

Introduction

Banana belongs to the *monocotyledon* family. It is the most widely grown fruit crop in India and abroad distributed in more than 120 countries and being the food-fruit staple crop for more than 400 million people in the developing countries. Apart from being a food crop, banana plant is very versatile with respect to its utilisation. Nevertheless, banana trunk is still mostly wasted or used uneconomically and a possible outlet is the manufacture of paper for currency, ropes, cordages, handicrafts, and fancy articles etc. In some tropical countries, the pseudo-stem (sheath) of the plant is scraped by a blunt knife or a decorticator to obtain the fibre. The fibre is later washed with water or with a dilute chemical to prevent it from becoming brittle. The shapes of banana fibre cells vary from round to polygonal corners and pointed ends. **The fibre cells have thinner cell walls of 0.25 µm as against coir cells of 8 µm.** The chemical constituents and ultimate cell dimensions of banana fibre resemble that of jute fibre. Although its ash content is high, the somewhat higher alpha-cellulose and lower lignin content indicate the potentialities of banana fiber for textile applications.

Based on a customer request to produce banana/cotton blended fabrics, SITRA has undertaken this study for manufacturing banana / cotton fibre blended yarns. Banana fibre was extracted from the trunk and cut into short staple lengths of 34 mm suitable for processing in the short staple ring spinning system. The extracted banana fibres were blended with the cotton fibres in a **blend proportion of 20:80 Banana / Cotton and spun in to a count Ne 20 (29.5 tex) in cotton spinning machinery. Ne 20 (29.5 tex) 100% cotton yarns were also produced and both the yarn samples were converted in to single jersey knitted fabrics.** Similarly, Ne 23 yarns of 30:70 blend proportion of banana/cotton blended fibres and 100% cotton yarns of the same count were converted in to plain woven fabrics.

Objectives of the study

- Standardization of process techniques to produce banana/ cotton blended yarns in short staple cotton ring spinning system.
- Quality evaluation of banana / cotton blends and 100% cotton yarns and fabrics.
- Manufacture of banana/cotton garments

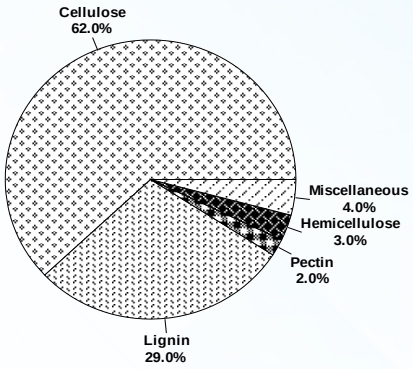
Physical and chemical properties of banana fibre

The physical and chemical properties of the banana fibre collected from the literature and the chemical composition of cotton fibre are shown in Table 1, Figure 2& Figure 3.

Table 1. Physical properties of banana fibres

Physical Characteristics	Banana Fibre (Mean value and Range)
Single fibre tenacity (gf/tex)	50 (17.0 – 78.8)
Single fibre extension at break (%) (After being wet overnight)	50.3 (17.2 – 75.5)
Fibre bundle tenacity (gf/tex)	28.4 (22.0 – 33.4)
Fibre bundle tenacity (gf/tex) (After being wet overnight)	23.4 (17.3 – 31.0)
True density (g/cm^3)	1.31
Apparent density (g/cm^3)	0.62
Fibre porosity (%)	53
Uncombed linear density (tex) of 2 mm cut length	10.5 (3.0 – 12.0)
Flexural rigidity (dyn/cm^2)	33 (20 – 50)
Moisture regain at 65% (RH%)	15.2

Source: Journal of Textile Institute (JTI) Vol.65, No.11 1974



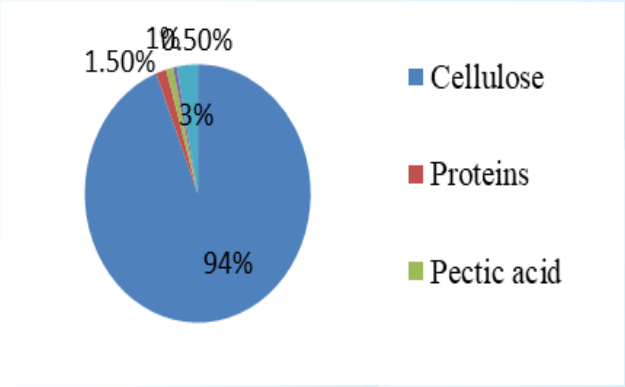


Fig 1. Chemical Composition of Banana Fibre **Fig 2. Chemical composition of cotton fibres**

Methodology

Cotton and Banana fibres used in this study are tested for their fibre properties and the results are shown in Table.2. The banana fibres were pre-treated by a softening treatment to make it pliable for blending with the cotton fibres by spraying softening oil / water in appropriate proportion. Cotton fibres were pre-opened in an opening machine and mixed with banana fibres in the ratio of 20:80 (Banana/cotton).. The blended fibres were then opened and cleaned in blow room and laps were prepared with a linear density of 350 GSM. The lap material was processed through C1/2 carding, LR DO/2S draw frame, LF 1665 Speed frame and LR G5/1ring frame and Ne 20 (29.5 tex) carded banana/cotton blended spun yarns was produced.

Table.2. Quality attributes of Cotton and Banana fibres

Fibre properties	Cotton	Banana fiber
2.5 % span length (mm)	29.0	--
Uniformity ratio (%)	46.5	--
Cut length (mm)	---	38
Fibre fineness (dtex)	1.45 (3.7 µg/inch)	22.22
Bundle fibre strength (g/tex)	22.8	--
Single fibre strength (g/den)	--	5.50
Fibre elongation (%)	5.1	6.14

The yarn samples were tested for their quality attributes like unevenness, imperfections, yarn tenacity, elongation in Uster Tester 4 and Uster Tenso rapid 4 yarn testing instruments. The yarn diameter was measured by using image analyser. The yarn samples were converted in to a single jersey knitted fabric in an 18 gauge machine. Similarly, plain woven fabrics were made using banana/cotton blended and 100% cotton yarns. The fabrics were evaluated for their quality attributes like air permeability, moisture vapour transmission rate (MVTR) and moisture management capability (OMMC). Comparisons of fabric were made with 100% cotton knitted and woven fabrics to evaluate the performance of the banana/cotton blended fabrics.

Results and Discussion

Yarn properties

The yarn quality attributes such as unevenness (U %), imperfections, yarn hairiness are tested by Uster Evenness tester according to standard testing procedure. The yarn irregularity of Ne 20 (29.5 tex) Banana /cotton and 100% cotton yarns tested in Uster Evenness Tester according to ASTM D 1425 / D 1425 M–2014 standard testing procedure and the test results are shown in Table.3.

Table.3. Regularity and hairiness properties of Ne 20 (29.5 tex) Banana/cotton and 100% cotton yarns

S. No.	Material Properties	Banana/cotton blended yarn	100% cotton yarn
1	Unevenness U%	18.10	11.65
2	Thin (-50%)	473	0
3	Thick (+ 50%)	1948	210
4	Neps (+200%)	3098	253
5	Total Normal Imp/km	5519	463
6	Thin (- 40%)	1975	193
7	Thick (+ 35%)	3218	1123
8	Neps (+ 140%)	5443	1418
9	Total Ex. Sens. Imp/km	10636	2734
10	Hairiness index (H)	6.61	8.71

Table 3 shows the yarn results of banana/cotton blended and 100% cotton yarns. It is observed that the 20:80 banana/cotton blended yarns show higher unevenness, imperfections than the 100% cotton yarns. The unevenness, total normal and extra sensitive imperfections are higher by about 35%, 91% and 74% respectively than 100% cotton yarns. The higher yarn imperfections of banana/cotton blended yarn may be attributed to the more variation in the banana fibres. However, the hairiness index of banana/cotton blended yarn is better by about 24% (absolute values). This may be attributed due to the color and shape of the banana fibres which would have caused lower hairiness in optical hairiness measurement.

Yarn tensile properties

The tensile properties of banana/cotton blended and 100% cotton yarns tested by Uster Tenso rapid according to ASTM D 2256/D2256 M -10 (2015) standard testing procedure and the test results are shown in Table 4.

Table. 4. Tensile properties of Ne 20 (29.5 tex) Banana/cotton and 100% cotton yarns

S. No.	Properties	Banana /cotton blended yarn	100% cotton yarn
1	Single yarn tenacity (g/tex)	10.79	14.72
2	CV% of tenacity	16.35	6.64
3	Elongation (%)	5.62	7.15
4	CV% of elongation	14.50	5.14
5	Actual count (Ne)	20.35	20.54
6	CV% of count	1.27	0.55
7	CSP	1648	2418
8	CV% of CSP	5.42	2.51

Single yarn tenacity and elongation % of the banana/cotton blended yarn is substantially lower by about 36 % and 21% (absolute values) than its counterpart 100% cotton yarn. The lower tensile properties of banana/cotton blended yarn may be ascribed to the ineffective contribution of strength, variations in fibre length and also inadequate inter fibre cohesion of banana fibres.

Fabric properties

The fabric properties such as air permeability, moisture vapour transmission rate (MVTR) and moisture management capability were evaluated for knitted and woven fabrics according to standard testing procedure**.** The knitted fabric specifications of banana/cotton and 100% cotton are shown in Table 5.

Table.5. Knitted fabric specifications of banana/cotton and 100% cotton

Fabric type	Banana/Cotton	100% Cotton
Fabric weight (GSM)	194.14	156.13
Thickness (mm)	47.25	45.6
Yarn diameter (mm)	0.2298	0.2522

Air permeability

Air permeability tests was carried out using Textest FX equipment according to ASTM D737 (2016) standard testing procedures. The air permeability test results of the banana/cotton and 100% cotton knitted fabrics are shown in Table.6.

Table.6. Air permeability of banana/cotton and 100% cotton knitted fabrics

Property	Banana/cotton blended fabrics	100% cotton fabrics
Air permeability ($cm^3/cm^2/sec$)	225	152

Table 6 shows the air permeability results of the banana/cotton and 100% cotton single jersey knitted fabrics. The test results reveal that the air permeability of banana/cotton fabrics is higher by about 32% than that of the 100% cotton fabrics. The higher permeability of the banana/cotton knitted fabrics may be attributed to its lower yarn hairiness and smaller yarn diameter of the banana/cotton blended yarn which has resulted in more inter yarn spacing between the loops during knitting even with higher GSM.

Studies on woven fabric

In order to analyse the performance of banana/cotton blended yarns in woven fabrics,, a study has been carried out using banana/cotton blended yarns and 100% cotton yarns in weaving. Ne 23 banana / cotton blended yarns in the blend ratio of (30:70) yarns and 100% cotton yarns of the same linear density were used for developing plain woven fabric samples. The specifications of the plain-woven fabrics is shown in Table 7.

Table.7. Specifications of banana /cotton blended plain woven fabrics

S.No	Fabric specifications	Banana/cotton (30:70)	100% cotton
1	Ends per inch (EPI)	54	54
2	Picks per inch (PPI)	40	40
3	GSM	172	164
4	Thickness (mm)	0.57	0.35
5	Warp yarn diameter (mm)	0.391	0.417
6	Weft yarn diameter (mm)	0.253	0.224
5	Weave construction	Plain	Plain
6	Warp yarn count (Ne)	2/23.29	2/23.36
7	Weft yarn count (Ne)	22.76	22.60
8	Fabric cover factor	24.21	24.25

Fabric properties

The fabric properties such as air permeability, moisture vapour transmission rate and overall moisture management capability of banana/cotton woven fabrics were evaluated using standard test equipment according to ASTM and AATCC standard testing procedures.

Air permeability

The air permeability test results of the banana/cotton blended and 100% cotton woven fabrics (cm3/cm2/sec) are shown in Table.8.

Table.8.Air permeability of Banana/cotton and 100% cotton plain woven fabrics

Property	Banana/cotton (30:70) blended fabrics	100% cotton fabrics
Air permeability ($cm^3/cm^2/sec$)	55.2	33.1

From the test results, it is observed that the banana/cotton blended woven fabric has higher air permeability by 66% than that of the 100% cotton fabrics**.** It may be due to the lower yarn diameter and more air spaces between the yarns in the banana/cotton blended fabrics which allow more air to penetrate through the fabrics.

Conclusions

Based on the banana fibre provided by a customer to develop banana/cotton blended fabrics, SITRA has developed banana/cotton blended yarns, knitted and woven fabrics. The teat data of yarns indicate that the yarn quality attributes of banana/cotton blended yarns is found to be inferior to 100% cotton yarns such as imperfections, tenacity etc. In both the knitted and woven fabrics, the banana/cotton blends have shown higher air permeability, better moisture management capability and moisture vapor transmission than its counterpart 100% cotton fabrics. Hence**,** the

banana/cotton blended yarns may be suitable for making fancy garments and bed linen material as it provides comfort to the user.

Banana fibre

Before softening

After softening

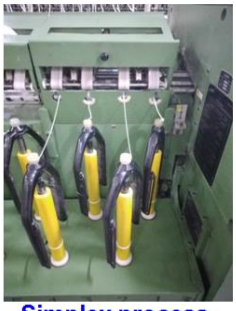
Manufacturing unit photos

Cotton / Banana softening process

Yarn samples

Carding process

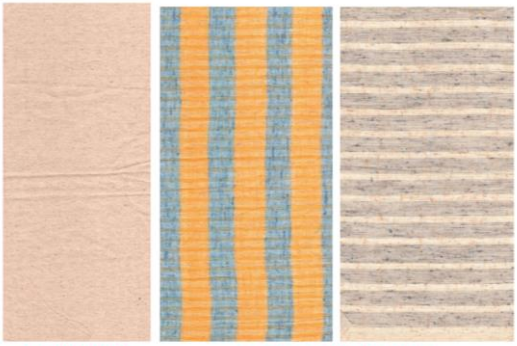
Drawing process



Simplex process

Spinning process

BANANA / COTTON FABRICS



GREY FABRIC **PROCESSED FABRIC**

Profitable entrepreneurship from banana fibre: A case study of SS natural fibre unit, Mohanur, Namakkal Tami Nadu

P. Suganthi

Development Officer (Namakkal Cluster)
SS Natural Fibre Unit, Rasipalayam - Mohanur, Namakkal district- 637015
Corresponding author: suganthi.p@icicifoundation.org: 9894629344/7010852960/ 9894060161/7639270240

Introduction

Banana cultivation is widespread throughout Tamil Nadu, particularly in Namakkal district, where banana cultivation alone covers approximately 2500 hectares (6250 acres). The district grows Poovan, Karpooravalli, Numaran, Rasthali, and Red Banana varieties of bananas. Bananas are primarily grown in Mohanur, Kolli Hills, Namagiripettai, Paramathi, and Kabilarmalai.

Banana stem, which is more often considers as a waste material by local farmers can be converted into a useful raw material for the production of eco - friendly banana fibre products. The characteristics of banana fibre which qualifies it as the best ecofriendly fibre is its moisture absorption, robust strength, smaller elongation, higher biodegradability etc, .In addition with this, the export and sales of these products can provide livelihood opportunities for women
The major steps in banana fibre production includes;

a) Collection of banana stems

Banana stems are collected directly from local farmers at a fair price, which benefits them. An average of 50 to 100 banana stems are collected from the different farmers across Mohanur block of Namakkal district. The harvested stems are then manually cleaned of impurities and dirt. The healthy banana stems that are about to be processed to extract fibers are carefully cleaned and sliced from the inner banana barks.

b) Extraction of banana fibres

The banana fiber extraction is performed with the help of an automated machine. The fibre extraction could be accomplished simply by placing a cleaned section of banana stems on the machine's fixed platform. In a single day, an average of 40 banana stems can be processed and their fibers extracted.

c) Cleaning and drying of extracted fibres

The extracted banana fibers are then carefully washed with water and dried for 3 hours in direct sunlight to remove excess moisture.

After that, the fibers are tied into a number of bundles that are later incorporated into the weaving process. The dried banana fibers, which are also sold in bundles for other purposes, can actually be viewed as the main raw material.

d) Mat weaving

Banana fibers are then inserted into the handloom weaving machine, and the weaving process includes embedding strands of banana fibres with fine cotton threads resulting in banana fibre mats.

f) Manufacturing of banana fibre products

The banana mats are used to produce numerous s products such as mats (yoga mats, dining mats), ladies bags, school bags, mobile pouch, pencil pouch, lunch bag, shopper bag, office folding files, wall pouch etc.

Uses of banana fibre

- Textiles, Papers, Sanitary Napkins Fibre products such as eco- friendly bags, Ropes

Banana pseudostem based handmade products

Baskets, bowls, lamps and other eco- friendly products from banana pseudostem

Model of women empowerment

Banana fiber products' manufacturing has generated a vast array of inclusive employment opportunities. Women perform every step of the process, from the initial separation of the banana husks from the banana bark to the final mat weaving or production of products made from banana fiber. Thus, the unit not only promotes a sustainable lifestyle among people by producing eco-friendly fiber products, but it also offers employment opportunities for five different women from various backgrounds. Thus the fibre unit stands as a model for women employment.

SS Natural Fibre unit is one of the most zestful and youthful initiative incorporated in the center of *"Transport Hub of South India"* Namakkal. We are manufacturing and marketing wide range of bag and floor furnishing products made of natural banana fibre and jute. All our products are hand crafted and of premium quality. We are catering to the needs of domestic market with a wide range of product such as handbags, shopper bags, wall hanging pouch, pencil pouches, baskets, mats etc.

III
Government's role in boosting banana trade

Marketing strategies and support for boosting Banana trade: Standards for commercial, GI and traditional banana- placing Indian banana in offshore markets

Madhur P Verma* and Ravindra Chavan**

**Senior Marketing Officer, **Marketing Officer*
Directorate of Marketing & Inspection, Ministry of Agriculture and Farmers Welfare, Government of India, Sub Office, Bengaluru, Karnataka
Corresponding author: dmilkk04@nic.in; madhur524@gmail.com
Contact Number: 9549382070

Introduction

India ranks first in terms of area and production, sharing about 17 % of global production. Banana fruit has a high nutritive value, it is rich source of carbohydrate and is rich in vitamins particularly vitamin B complex. It is also a good source of potassium, phosphorus, calcium and magnesium. The fruit is easy to digest, free from fat and cholesterol and available to consumers at lower price. It is consumed in ripe and raw fruit or fresh and cooked form. Processed products, such as chips, banana puree, jam, jelly, juice, jiggery-dip banana candy, wine and Halwa can be made from the fruit. The tender stem, which bears the inflorescence is extracted by removing the leaf sheaths of the harvested pseudostem can be used as vegetable. Plantains or cooking bananas are rich in starch and have a chemical composition similar to that of potato. The medicinal value of banana is reducing risk of suffering from high blood pressure, gastroenteritis, kidney disorders, heart diseases, arthritis and ulcer.

Though Cavendish bananas are ruling the banana export in the world trade, traditional bananas like Nendran, Ney Poovan and Red Banana find the place in the hyper malls especially in West Asia and South East Asia markets due to the settlement of ethnic population from India. Nendran the commercial plantain variety in Kerala, Tamil Nadu and parts of Karnataka occupies 50 % of the total area in these states and maximum quantity of the fruit is sold locally. Banana is a very perishable fruit, hence its marketing faces many problems such as chain of middlemen, transport, storage, *etc.*

Directorate of Marketing and Inspection (DMI) and its role in marketing of banana for domestic trade as well as for export

The Directorate of Marketing and Inspection (DMI), an attached Office of the Department of Agriculture and Farmers Welfare under Ministry of Agriculture & Farmers Welfare, is helping farming community by assisting Central Govt. in formulation and implementation of agricultural marketing policies and programmes for the integrated development of marketing of agricultural and other allied produce in the country with a view to safeguard the interests of farmers as well as the consumers. It maintains a close liaison between the Central and the State Governments.

The Directorate of Marketing and Inspection (DMI), popularly known as AGMARK is having grade standards of almost 231 commodities which covers agricultural and allied commodities including fruits and vegetables for which Agmark certification facility for domestic trade as well for export is available. European Union has made Agmark certification compulsory for export of fruits and vegetables from India.

Agmark grading charges for export

(A) For export under consignment-wise inspection, for commodities which require elaborate testing in Agmark laboratories, a fee @ 0.4% of freight on board (FOB) value, subject to a minimum of Rs. 500 per consignment. For commodities which do not require elaborate testing in Agmark laboratories, a fee @ 0.2% of freight on board (FOB) value, subject to a minimum of Rs. 200 per consignment.

(B) For export under in-process quality control system, a fee @ 0.2% of freight on board (FOB) value, subject to a minimum of Rs. 500 per consignment.

(C) For export under self-certification system, a fee @ 0.1% of freight on board (FOB) value, subject to a minimum of Rs. 10,000 and maximum of Rs. 1,00, 000 in a financial year.

Note: 1. The Agmark grading charges shall be calculated at the specified rates for the total weight/volume or total number of packages in a lot of the commodity graded under Agmark and not for the weight or volume of individual package in the lot.2. The charges so calculated shall be rounded off to the nearest rupee i.e. less than 50 paise shall be ignored and 50 or more paise shall be rounded to one rupee

Grade designation and quality of bananas as per AGMARK standards

1. Bananas shall be obtained from Varieties (cultivars) of Musa. spp. of the Musaceae family.

2. Minimum requirements

(i) Bananas shall be:

(a) whole (taking the finger as the reference), (b) firm, (c) sound, (d) clean, free of any visible foreign matter, (e) free of bruisings, (f) free of pests affecting the general appearance of produce, (g) with the stalk intact, without bending, fungal damage or desiccation, (h) with pistils removed, (i) free of malformation or abnormal curvature of the fingers, (j) free of damage caused by low temperature, (k) free of abnormal external moisture excluding condensation following removal from cold storage and bananas packed under modified atmosphere condition, (l) free of any foreign smell and/or taste.

(ii) In addition, hands and clusters must include:

- A sufficient portion of the crown of normal colouring, sound and free of fungal contamination,

- A cleanly cut crown, not bevelled or torn, with no stalk fragments.

(iii) Bananas shall comply with the residue levels of heavy metals, Pesticides and other food safety parameters as laid down by the Codex Alimentarius Commission for exports

Criteria for grade designation

Grade designation	Grade Requirements	Grade tolerances
1	2	3
Extra class	Bananas shall be of superior quality. They must be characteristics of the variety and/or commercial type. The fingers must be free of defects, with the exception of very slight superficial defects, provided these do not affect the general appearance of the produce, quality, the keeping quality and presentation in the package.	5% by number or weight of bananas not satisfying the requirements of the grade, but meeting those of for Class I grade or, exceptionally, coming within the tolerances for that class.
Class I	Bananas shall be of good quality. They must be characteristics of the variety and/or commercial type. The following slight defects of the fingers, however, may be allowed, provided these do not affect the general appearance of the produce, quality, the keeping quality and presentation in the package. - Slight defects in shape and colour. - Slight defects due to rubbing and other superficial defects not exceeding 2 sq.cm. of the total surface area. The defects must not affect the flesh of the fruit.	10% number or weight of bananas not satisfying the requirements of the grade class, but meeting those of Class II or, exceptionally, coming within the tolerances of that grade.
Class II	This includes bananas which do not qualify for inclusion in the higher classes, but satisfy the minimum requirements. The following defects may be there, provided the bananas retain their essential characteristics as regards the quality, the keeping quality and presentation. - Defects in shape and colour provided the product remains the normal characteristics of bananas; - Skin defects due to scrapping, scabs, rubbing, blemishes or other causes not exceeding 4 sq.cm. of the total surface area; The defects must not affect the flesh of the fruit.	10% by number or weight of bananas not satisfying the requirements of the grade, but meeting the minimum requirements.

Other requirements

(i) The development and condition of the bananas must be such as to enable them

- ✓ To reach the appropriate stage of physiological maturity corresponding to the particular characteristics of the variety,
- ✓ To withstand transport and handling, and
- ✓ To arrive in satisfactory condition at the place of destination in order to ripen satisfactorily.

(ii) Bananas must be presented in hands and clusters (parts of hands) of at least four fingers. Bananas may also be presented as single finger

- ✓ Clusters with no more than two missing fingers are allowed, provided the stalk is not torn but clearly cut, without damage to the neighbouring fingers.
- ✓ Not more than one cluster of three fingers with the same characteristics as the other fruit in the package may be present per row.

Provisions concerning sizing

(i) For the purposes of sizing bananas, the length of the fingers is determined along the outside curve from the blossom end to the base of the pedicel where the edible pulp ends and the diameter is defined as the thickness of a transverse section between the lateral faces. The reference fruit for measurement of the length and grade is: for hands, the median finger on the outer row of the hand, for clusters, the finger next to the cut section of the hand, on the outer row of the cluster.

(ii) The minimum length should not be less than 14.0 cm & the minimum grade not less than 2.7 cm.

(iii) For all classes, 10% by number or weight of bananas not satisfying the sizing characteristics, up to a limit of 1 cm for the minimum length of 14 cm.

In addition to the above, the department is implementing scheme related to dissemination of arrival, wholesale prices of all agricultural commodities for helping the farming community in getting remunerative price of their produce;

Market Research Information Network (MRIN)

Marketing information helps the farmers in taking decisions in marketing their produce. The farmers are not able to know about the prices prevailing in the markets, as the market committees are able to disseminate information only in respect of their own markets. Therefore, farmers are left with no alternative but to dispose their produce in the nearest market, even at uneconomic prices. Market information is equally needed by other market participants in arriving at optimal trading decisions.

In order to improve the present agricultural marketing information system in the country, Directorate of Marketing & Inspection (DMI), Ministry of Agriculture and Farmers Welfare is implementing Market Research Information Network (MRIN) scheme to link important agricultural produce markets (APMCs) spread all over the country and the State Agriculture Marketing Boards and Directorates under which 3241 agricultural mandis have been connected online for dissemination of data related to arrival, wholesale price of all the commodities on daily basis.

The data is available on **www.agmarknet.nic.in.** AGMARKNET envisages linking all important agricultural produce markets in the country, the State Agricultural Marketing Boards & Directorates and DMI for effective information exchange. AGMARKNET has led to a national-wide information network for speedy collection and diffusion of market information, computerization of market related information such as market fees, market charges, etc., ensuring regularity and reliability of data and increasing the efficiency in agricultural markets.

e - National Agriculture Market (eNAM)

To promote uniformity in agriculture marketing by streamlining of procedures across the integrated markets, removing information asymmetry/ gap between buyers and sellers with promoting real time price discovery based on actual demand and supply, e-National Agriculture Market (eNAM) scheme is being implemented as pan-India electronic trading portal which networks the existing APMC mandis to create a unified national market for agricultural commodities. The vary purpose of this scheme is integration of APMCs across the country through a common online market platform to facilitate pan-India trade in agriculture commodities, providing better price discovery through transparent auction process based on quality of produce along with timely online payment.

At present tradable parameter of 203 agricultural commodities have been prepared by the Directorate for trading these commodities in e-NAM markets. In the line of same, this Directorate has received request from various State Agricultural Marketing agencies to formulate tradable parameters for Banana as it has huge potential for trading in e-NAM markets. The formulation of parameters/ specification for Banana for trading at e-NAM platform are as under:

A. Commodity Parameter - Banana raw

Common Name:

Hindi	English Name	Botanical Name
कच्चा केला	Banana (Raw)	*Musa acuminate*

1. Green Banana shall be-

i. green, firm, white flesh, colour characteristics to the variety.

ii. Reasonably free from visible and other visible defects, foreign smell, mould/pest infestation.\

iii. With calyx, short green un-withered stalk attached and should be in bunches.

2. The stalk is not torn but clearly cut, without damage to the neighbouring fingers.

3. Variety…….. (to be filled by assayer)

4. Actual Picture of the lot…… (to be uploaded by assayer)

5. Criteria for Range designation

S.No.	Tradable parameters	Range- 1	Range - 2	Range - 3
A	**Essential**			
i	Defects(% by count) (i) Cuts/Bruising/black spots(up to 20 mm on surface)	Upto 10%	Upto 15%	Above 15%
ii	Range Acceptance	95 %	90 %	85 %
B	**Optional (Industrial/Processors)**			
iii	Diameter(mm)	30.00 and above		Below 30
iv	Length (mm)	110 and above		Below 110

5. Sampling:

i. 5 % or minimum one container shall be randomly selected for sampling.

ii. 5 Nos shall be drawn from each selected container and shall be mixed homogenously, Called as primary sample.

iii. 5 nos. shall be drawn from primary sample called as Laboratory sample.

Optional parameters are voluntary and may be analyzed as per buyer-seller agreement.

B. Commodity Parameter - Banana Stem

Common Name: Banana Stem

1. Banana stem shall be-

i. Intact, fresh, firm, clean;

ii. Shining white to light yellow in color and characteristic to the variety;

iii. Free from insect infestation, cuts, mechanical injury;

2. Variety…….. (to be filled by assayer)

3. Actual Picture of the lot…… (to be uploaded by assayer)

4. Criteria for Range designation

S.No.	Tradable parameters	Range - 1	Range - 2	Range - 3
A	Essential			
i	Length (in ft.)	Between 6 to 7	Above 5 to 6	Less than 5
ii	Thickness of sheath (in inch)	Between 3 to 5	Less than 3 and more than 5	Less than 3 and more than 5
iii	Defects (in %) Bruising	Less than 2	Between 2 to 5	More than 5

5. Sampling: 5% or 5 No (whichever is less) of the Lot shall be randomly selected and that will be called as Laboratory Sample.

C. Commodity Parameter - Baji Banana

Hindi	English Name	Botanical Name
Monthan	Baji Banana	*Musa spp.*

Common Name: Baji Banana

1. Baji banana shall be-

i. Firm, whole, sound, clean, of reasonably uniform size and color;

ii. practically free of pests and damage caused by pests;

iii. free of any foreign smell and/or taste;
iv. practically free of bruises;
v. free from malformation or abnormal curvature of the fingers;
vi. With the stalk intact, without bending, fungal damage or desiccation.

2. Variety…….. (to be filled by assayer)
3. Actual Picture of the lot…… (to be uploaded by assayer)
4. Criteria for Range designation

S.No.	Tradable parameters	Range - 1	Range - 2	Range - 3
A	**Primary**			
i	Weight of Bunch (kg)	More than 15	Between 11 to 15	Less than 11
ii	Weight of Banana finger (grams)	More than 180	Between 160 to 180	Less than 160
iii	No. of Hands in the Bunch	More than 10	Between 9 to 10	Less than 9
iv	Length of Banana Finger (cm.)	More than 15	Between 10 to 15	Less than 10
v	Diameter of banana finger (cm)	More than 5	Between 3 to 5	Less than 3
vi	Defects (knife wounds, cracks, bruising, black spot etc.,) % of total surface area	Less than 5	Between 5 to10	More than 10
B	**Optional (Industrial/Processors)**			
i	Colour(Characteristic true to variety)Scale (1 to 100) Visual 100% is true to variety colour	More than 70	40-70	Less than 40

5. Sampling:
i. 5 % or minimum one container shall be randomly selected for sampling.
ii. 5 Lungars shall be drawn from each selected container and shall be mixed Homogenously, called as primary sample
iii. 03 bunches shall be drawn from primary sample called as Laboratory sample.
Optional parameters are voluntary and may be analyzed as per buyer-seller agreement.

D. Banana

Hindi	English Name	Botanical Name	Varieties Name
केला	Banana	*Musa spp*	Dwarf Cavendish, Robusta, Rasthali, Safed Velchi Musa, Karpuravalli, Monthan etc.

1. Banana shall be-
i. Intact, firm, clean, firmly attached to the stalk of reasonably uniform size, color (Green/Yellow/Golden Yellow) characteristics to the variety
ii. Free from chitti, insect infestation, cuts, mechanical injury ,
iii. Bananas shall not be over ripened /under ripened

2. Variety……..(to be filled by assayer)
3. Actual Picture of the lot……(to be uploaded by assayer)
4. Criteria for Range designation

S.No.	Tradable parameters	Range-1	Range-2	Range-3
A	Essential			
i	Defects(% by count) (Max) (i) Cut/ Bruising(10 to 20mm of total surface area)	5	10	Above 10
	(ii) Chitti(5-10mm of surface area)	5.0	8.0	Above 8.0
	(iii) Black spot(5-10mm of surface area)	2.0	4.0	Above 4.0
iii	Range Acceptance	95%	90%	85%
B	Optional (Industrial/Processors)			
i	Sizing characteristics	The minimum length should not be less than 14.0 cm and the minimum grade not less than 2.7 cm		

5. Sampling:
i. 5 % or minimum one container shall be randomly selected for sampling
ii. 5 Lungars shall be drawn from each selected container and shall be mixed Homogenously, called as primary sample
iii. 03 bunches shall be drawn from primary sample called as Laboratory sample
Optional parameters are voluntary and may be analyzed as per buyer-seller agreement

E. Commodity Parameter - Lady Finger Banana

Hindi	English Name	Botanical Name
--	*Lady finger banana*	*Musa acuminata*

Common Name: Yelakki banana, Elaichi banana, Lady finger banana, Sugar banana, Fig banana, Date banana, Baby banana, Ney Poovan

1. Lady Finger Banana shall be-

i. firm, whole, sound, clean, of reasonably uniform size and color;

ii. practically free of pests and damage caused by pests;

iii. free of any foreign smell and/or taste;

iv. practically free of bruises;

v. free from malformation or abnormal curvature of the fingers;

vi. with the stalk intact, without bending, fungal damage or desiccation.

2. Variety…….. (to be filled by assayer)
3. Actual Picture of the lot…… (to be uploaded by assayer)

4. Criteria for Range designation

S.No.	Tradable parameters	Range - 1	Range - 2	Range - 3
A	**Primary**			
i	Weight of Bunch (kg)	More than 12	Between 10 to 12	Less than 10
ii	No. of Hands in the Bunch	More than 10	Between 9 to 10	Less than 9
iii	Length of Fruit (cm.)	More than 10	Between 8 to 10	Less than 8
iv	Diameter of banana finger (cm)	More than 4	Between 3 to 4	Less than 3
v	Defects (knife wounds, cracks, bruising, black spot etc.,) (% of total surface area)	Less than 5	Between 5 to 10	More than 10
B	**Optional (Industrial/Processors)**			
i	Colour(Characteristic true to variety)Scale (1 to 100) Visual 100% is true to variety colour	More than 70	Between 40 to 70	Less than 40

5. Sampling:

i. 5 % or minimum one container shall be randomly selected for sampling.

ii. 5 Lungars shall be drawn from each selected container and shall be mixed homogenously , called as primary sample

iii. 03 bunches shall be drawn from primary sample called as Laboratory sample.

Optional parameters are voluntary and may be analyzed as per buyer-seller agreement

F. Commodity parameter - Mysore Banana

Hindi	English Name	Botanical Name
मैसूर केला	Berry banana	*Musa spp.*

Common Name: Mysore Banana (Poovan)

1. Mysore Banana shall be-

i. firm, whole, sound, clean, of reasonably uniform size and color

ii. practically free of pests and damage caused by pests;

iii. free of any foreign smell and/or taste;

iv. practically free of bruises;

v. free from malformation or abnormal curvature of the fingers;

vi. with the stalk intact, without bending, fungal damage or desiccation.

2. Variety…….. (to be filled by assayer)

3. Actual Picture of the lot…… (to be uploaded by assayer)

4. Criteria for Range designation

S.No.	Tradable parameters	Range - 1	Range - 2	Range - 3
A	**Primary**			
i	Weight of Bunch (kg)	More than 12	Between 8 to12	Less than 8
ii	No. of Hands in the Bunch	More than 10	Between 7 to 10	Less than 7
iii	Length of Banana Finger (cm.)	More than 11	Between 8 to 11	Less than 8
iv	Defects (Bruised /Chitti/ black spot etc.,) % of total surface area	Less than 2	Less than 5	Less than 10
B	**Optional (Industrial/Processors)**			
i	Colour(Characteristic true to variety)Scale (1 to 100) Visual 100% is true to variety colour	More than 70	Betweeen 40 to 70	Less than 40

5. Sampling

i. 5 % or minimum one container shall be randomly selected for sampling.
ii. 5 Lungars shall be drawn from each selected container and shall be mixed homogenously, called as primary sample
iii. 3 bunches shall be drawn from primary sample called as Laboratory sample.
Optional parameters are voluntary and may be analyzed as per buyer-seller agreement

G. Commodity parameter - Red banana

Hindi	English Name	Botanical Name
लाल केला	Red Dacca	*Musa acuminata*

Common Name: Kappa Pazham, Chenkadali, Chovvazhapazham (Malayalam), Red Dacca

1. Mysore Banana shall be-

i. firm, whole, sound, clean, of reasonably uniform size and color;
ii. have a deep red or maroon rind when ripe;
iii. practically free of pests and damage caused by pests;
iv. free of any foreign smell and/or taste;
v. practically free of bruises;
vi. free from malformation or abnormal curvature of the fingers;
vii. with the stalk intact, without bending, fungal damage or desiccation.

2. Variety…….. (to be filled by assayer)
3. Actual Picture of the lot…… (to be uploaded by assayer)
4. Criteria for Range designation

S.No.	Tradable parameters	Range - 1	Range - 2	Range - 3
A	**Primary**			
i	Weight of Bunch (kg)	More than 10	Between 9 to 10	Less than 8
ii	No. of Hands in the Bunch	More than 12	Between 10 to 12	Less than 10
iii	Length of Fruit (cm.)	More than 17	Between 14 to 17	Less than 14
iv	Diameter of banana finger (cm)	More than 4.4	Between 3 to 4.4	Less than 3
v	Defects (knife wounds, cracks, bruising, black spot etc.,) (% of total surface area)	Less than 5	Between 5 to 10	More than 10
B	**Optional (Industrial/Processors)**			
i	Colour(Characteristic true to variety)Scale (1 to 100) Visual 100% is true to variety colour	More than 70	Between 40 to 70	Less than 40

5. Sampling:

i. 5 % or minimum one container shall be randomly selected for sampling.

ii. 5 Lungars shall be drawn from each selected container and shall be mixed homogenously, called as primary sample

iii. 03 bunches shall be drawn from primary sample called as Laboratory sample.

Optional parameters are voluntary and may be analyzed as per buyer-seller agreement.

Now the tradable parameters for trading of Banana is included in e-NAM portal and farmer can sell their banana produce to any buyer across the country through this electronic platform.

e - NAM Platform of Platforms (PoP)

e - NAM Platform of Platforms (PoP) Launched by Honourable Union Agriculture Minister on 14th July'2022 at National Conference of Agriculture & Horticulture Ministers in Bangalore. The e-NAM Mobile app can be downloaded through Google Play Store.

Agricultural Marketing Infrastructure (AMI) scheme

To minimize the farm loss and value addition of all agricultural commodities for enhancement of farmer's income, Agricultural Marketing Infrastructure (AMI) for creation of storage infrastructure and infrastructure for value addition is also being implemented by the Directorate of Marketing and Inspection (DMI), Ministry of Agriculture & Farmers Welfare, Govt. of India. The scheme is a back ended subsidy scheme and financial assistance with loan facility is available for farmers, individual, firms end other various type of promoters. The detail guideline of the scheme is available on **www.dmi.gov.in.**

Role of quarantine and phytosanitary measures on boosting export in Banana

Sivarama Krishnan S, Govindaraj R and Elangovan C

Central Integrated Pest Management Centre, Directorate of Plant Protection Quarantine & Storage, Department of Agriculture & Farmers Welfare
No. 16, Abdul Salam Street, Khaja Nagar, Tiruchirappalli, Tamil Nadu
Corresponding author: ipmtn16@nic.in; Contact Number: 0431-2420190

Introduction

Banana is an important fruit crop of many tropical and subtropical regions in India and in the world in terms of acreage and production. Being a tropical fruit with its origin in Asia, banana is a convenient fruit for people across the world as it is affordable, nutritious and available everywhere throughout the year. Bananas are eaten in ripened form as a fruit or dessert and raw form (known as plantains) as a vegetable is used for cooking. India is the world's largest producer of bananas, accounting for 21 per cent of the global output. However, its share in the export market is less than 0.1 per cent, due to the large domestic market. Despite being the largest producer of bananas, India's position in the trade this fruit is unremarkable.

The role of the Plant Quarantine is to prevent the introduction of destructive plant pests, soil and diseases of plants from other countries. The term 'Quarantine' as French word literally means 40- day period. Quarantine can be defined "as a legal restriction to prevent the entrance and establishment of a plant disease or insect pest in an area where the pest or disease does not exist" (Reddy, 2010).

Plant Quarantine rules are promulgated by governments to prevent the introduction and spread of harmful pests and pathogens. Protection of the plant and plant products by quarantine but only become the government at the turn of this century, following a series of catastrophic pest and diseases epidemics in different parts of the world (Rai, *et al.*, 2014). **Plant quarantine is a government endeavor enforced through legislative measures to regulate the introduction of planting material, plant products, soil and living organisms, etc. in order to prevent inadvertent introduction of pests (including fungi, bacteria, viruses, nematodes, insects and weeds) harmful to the agriculture of a country/state/region, and if introduced, prevent their establishment and further spread (Kahn *et al.*, 2017).**

Phytosanitary measure is defined as any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests **(ISPM No. 5).** In that regard, the IPPC has the responsibility to protect plant resources while facilitating safe movement of plants and plant products internationally. Implementation of measures to prevent the introduction and spread of plant pests is critical to ensuring the development of a viable and sustainable global seed market. The **International Standards for Phytosanitary Measures (ISPMs)** provide useful guidance on the application of Phytosanitary measures to the international trade.

Global overview of Banana

Globally, around 5.5 million hectares was under banana crop, with India alone accounting for 15% of the total area. Other top countries with high banana acreage include Brazil, Tanzania and

Philippines. In terms of production, India is the largest producer of bananas contributing to more than a quarter of global production of 119 Million tonnes during 2020. While average world productivity of banana was 21 tonnes per hectare (tonnes/ha), India (35 tonnes /ha) recorded a higher yield than most of the countries including Brazil (14 tonnes /ha), USA (15 tonnes /ha), China (28 tonnes /ha) and Mexico (29 tonnes /ha).

Domestic overview of Banana

Domestic production of banana in India is dominated by Andhra Pradesh (17.99%), Maharashtra (14.26%), Gujarat (12.04%), Tamil Nadu (12%) and Karnataka (11. 44%) (2021-22). Banana acreage is dominated by Karnataka (13.93%), Kerala (12.03%), Tamil Nadu (10.56%), Andhra Pradesh (10.52%) and Maharashtra (9.11%) (2020-21) (National Horticulture Board).

Banana trade pattern

Banana is the largest trading fruit crop in the world with global demand of 23.3MMT in 2018. However, the four largest banana-producing countries do not even feature in the top ten banana exporting countries list. **Ecuador, the fifth largest banana producer, is the world leader in banana exports and accounts for 28% of global exports. India which produces more than a quarter of world banana production, exports a meagre 0.5% and ranks twentieth. Philippines, Guatemala and Costa Rica are other important banana exporting countries.** USA is the largest banana importing nation in the world with almost 41 lakhs MT of bananas imported during 2021, which is almost 22% of world banana imports. Other countries that import considerable quantities of banana include Germany, Russia, Belgium, UK, China and Japan, each importing (7–5%) of total banana imports.

India exported **376,000 MT of bananas during 2021–22**. Indian bananas are mostly exported to Middle Eastern countries and neighboring countries. Iran (34.43%) is the largest importer of Indian bananas, followed by UAE (20.38%), Oman (10.82%), Saudi Arabia (6.43%), Iraq (4.93) and Qatar (4.5) in 2021-22.

Top countries which imported Banana from India in 2021-22 (April - November)

Country	Value (USD Millions)	Share %
Iran	19.82	34.43
UAE	11.73	20.38
Oman	6.23	10.82
Saudi Arabia	3.7	6.43
Iraq	2.84	4.93
Qatar	2.59	4.5

Export of Banana during last 7 years from India (Fresh Banana or Dried)

Year	Quantity (in Thousands)	Value (in Rs. Lakhs)	% Share
2016-17	110750.58	39,117.50	0.0212
2017-18	102521.88	35,216.62	0.0180
2018-19	134632.88	41,507.19	0.0180
2019-20	195750.36	66,094.10	0.0298
2020-21	232648.77	77,719.65	0.0346
2021-22	376961.09	1,18,848.55	0.0378
2022-23 (April-Aug)	122347.93	38,732.76	0.0252

Source: Ministry of Commerce and Industry

National plant quarantine

The Directorate of Plant Protection, Quarantine and Storage (DPPQS) of Ministry of Agriculture and Farmers Welfare is the apex body for implementation of plant quarantine regulation and the PQ order forms the basis of the functioning of the Directorate. It has a nationwide **187 entry points at different Airports (25), Seaports (47), Land Frontier Stations (24), Inland Container Depots and Container Freight Stations (80) and Foreign Post Offices (11).** The development of the Plant Quarantine (Regulation of Import into India) Order, 2003 reflects the primary plant quarantine concerns of the Government of India. The main aims are:

1. Prevent the introduction and spread of exotic pests that are destructive to the country by regulating the import of plants and plant products through adequate policy and statutory measures.
2. Support India's agricultural exports through credible export certification.
3. Facilitate safe global trade in agriculture by assisting producers, exporters and importers and by providing technically comprehensive and credible Phytosanitary Certification.

In all, three categories of materials are being imported: (a) bulk consignments of grains/ pulses for consumption, (b) bulk consignments of seeds/ planting materials for sowing/ planting, and (c) samples of germplasm in small quantities for research purposes. The PQ Stations under the DPPQS undertake quarantine processing and clearance of consignments of the first two categories. However, ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR) undertakes the quarantine processing of all plant germplasm and transgenic planting material under exchange. It has developed well- equipped laboratories and green house complex (Bhalla *et al.*, 2018).

Importance of plant quarantine in export promotion

- To prevent the introduction and spread of exotic pests that are destructive to crops by regulating/restricting the import of plants/plant products
- To facilitate safe global trade in agriculture by assisting the producers and exporters by providing a technically competent and reliable Phytosanitary Certificate System to meet the requirements of trading partners.
- To inspect goods (the plant products) coming from other country and to check for exotic, pests, diseases and weeds.
- Inspection of imported agricultural commodities for preventing entry of exotic pests and diseases
- Inspection of agricultural commodities meant for export as per requirements of importing countries under International Plant Protection Convention (IPPC)
- Detection of exotic pests and diseases already introduced for controlling/ containing them by adopting Domestic Quarantine regulations
- Undertaking Post Entry Quarantine Inspection (PEQ) in respect of identified Planting materials.
- Conducting the Pest Risk Analysis (PRA) to finalize Phytosanitary requirements for import of plant/plant materials.

Domestic quarantine

Domestic Quarantine may be defined as the restriction imposed by Plant Quarantine authorities in association with State machinery on the production, movement and existence of plants and planting material and is brought under regulation in order to prevent the introduction or spread

of a pest. It is importance to maintain **"Pest Free Area" (PFA)** to gain export market access in different countries without the need for application of additional Phytosanitary measures.

Domestic quarantine regulations are imposed to curtail the movement of introduced pests from the area of introduction to newer, non-infested or non-infected areas through Domestic Quarantine Regulations imposed by Government of India through Gazette notifications, issued under the DIP Act. It is the responsibility of the State / Union Territory to restrict the movement of commodities from those areas to prevent establishment and spread of introduced pests.

Domestic quarantine regulations

Section 4A of Destructive Insects and Pests Act, 1914 (DIP Act) empowers Central Government to implement Domestic quarantine regulations. The Domestic quarantine regulations are implemented by State / Union Territory (UT) governments to prevent the spread of introduced pests from place of introduction to other States or UT.

Two Domestic Quarantine Regulations have been notified to regulate movement of banana planting materials from state to state within India.

1. Complete prohibition of transport of banana planting material for Banana Bunchy Top Virus from Assam, Kerala, Orissa, Tamil Nadu, West Bengal to any parts of India.
2. Complete prohibition of transport of banana plants and packing materials for Banana Mosaic Virus from Maharashtra & Gujrat to any part of India (Sathyanarayana *et.al.* 2006)

International agencies involved in plant quarantine

- WTO (World Trade Organization)
- IPPC (International Plant Protection Convention)
- RPPO (Regional Plant Protection Organization)
- APPPC (Asia and Pacific Plant Protection Commission)

World Trade Organization (WTO)

An organization which was established to set and enforce rules for international trade and to provide a forum for negotiating and monitoring further trade liberalization. The headquarter of WTO is at Geneva, Switzerland. SPS (Sanitary and Phytosanitary agreement) agreement comes into force with establishment of WTO on 1st January, 1995. The main objective of SPS (Sanitary and Phytosanitary agreement) agreement are: (1) Protect human, animal or plant life or health in the territories of the Parties while facilitating and expanding trade by utilizing a variety of means to address and seek to resolve Sanitary and Phytosanitary issues, (2) Reinforce and build on the SPS Agreement, (3) Strengthen communication, consultation and cooperation between the Parties, and particularly between the Parties' competent authorities and primary representatives, (4) Ensure that Sanitary or Phytosanitary measures implemented by a Party do not create unjustified obstacles to trade, (5) Enhance transparency in and understanding of the application of each Party's sanitary and Phytosanitary measures, (6) Encourage the development and adoption of international standards, guidelines and recommendations, and promote their implementation by the Parties (Ebbels, 2003).

International Plant Protection Convention (IPPC)

It is the Phytosanitary standard setting organization named in WTO- SPS Agreements and implemented by the FAO in 1952. The IPPC was created by member countries of the Food and

Agriculture Organization of the United Nations. The IPPC places emphasis on three core areas: international standard setting, information exchange and capacity development for the implementation of the IPPC and associated international Phytosanitary standards. The Secretariat of the IPPC is housed at FAO headquarters in Rome, Italy, and is responsible for the coordination of core activities under the IPPC work program. In recent years the Commission of Phytosanitary Measures of the IPPC has developed a strategic framework with the objectives of: 1. Protecting sustainable agriculture and enhancing global food security through the prevention of pest spread, 2. Protecting the environment, forests and biodiversity from plant pests, 3. Facilitating economic and trade development through the promotion of harmonized scientifically based Phytosanitary measures (Ebbels, 2003).

Important Export related Phytosanitary Standards

ISPM - 1: Principle of plant Quarantine related to international trade
ISPM - 2: Guidelines for PRA
ISPM - 5: Glossary of Phytosanitary terms
ISPM - 7: Phytosanitary certification system
ISPM - 12: Phytosanitary certificates
ISPM - 20: Guidelines for a Phytosanitary import regulatory system
ISPM - 46: Commodity-specific standards for Phytosanitary measures

Regional Plant Protection Organization (RPPO)

The RPPOs are required to cooperate with the IPPC Secretariat to achieve the objectives of the IPPC and, in turn, the CPM Secretary must convene regular technical consultations for RPPOs, promote ISPMs and encourage inter-regional cooperation. RPPOs now cover most areas of the world and all countries have the opportunity to become members of an RPPO. The main functions of RPPOs are to act as Phytosanitary coordinators for their respective regions, to gather and disseminate information, to promote harmonization of Phytosanitary regulations, to encourage the adoption of sound Phytosanitary policies, and to promote the objectives of the IPPC. However, RPPOs have no legal force and have advisory powers only, although these can be strong (Ebbels, 2003).

Asia and Pacific Plant Protection Commission (APPPC)

The Asia-Pacific Plant Protection Commission convened for the first time in 1956. The Commission administers the Regional Plant Protection Agreement for Asia and the Pacific. It reviews the plant protection situation at the national level in member countries, and also at the regional level. Coordinating and promoting development of regional plant protection systems, assisting member countries to develop effective plant protection regimes, setting standards for Phytosanitary measures, and facilitating information sharing are among its key objectives. A total of 25 countries are members and the APPPC meets at least once every two years. APPPC helps member countries analyze risks to their national plant resources and use science-based measures to safeguard their cultivated and wild plants. The Commission helps member countries improve their capacity for pest surveillance, pest risk analysis, pest risk management through systems approaches, and implementation of regional and international standards for Phytosanitary measures. It helps with the management of outbreaks of invasive species to promote safe agricultural trade (Ebbels, 2003)

National Agencies involved in Plant Quarantine and Trade Promotion

- Directorate of Plant Protection, Quarantine and Storage, Faridabad (NPPO)

- National Bureau of Plant Genetic Resources (NBPGR), New Delhi
- Indian Council of Agricultural Research (ICAR) Institutes
- Agricultural and Processed Food Products Export Development Authority (APEDA)
- Head of Plant Pathology Division of State Agricultural Universities (SAU)
- State Agricultural and Horticultural Departments

Phytosanitary Certification for Export from India

Export Phytosanitary Certification (PSC) of plant and plant materials is carried by Public Officers notified by NPPO from time to time *viz*., Officers of DPPQS, Scientists of NBPGR, ICAR Institutes, State Agriculture/Horticulture Universities and Officers of State Department of Agriculture/Horticulture. PSC should be in conformity with Plant Quarantine Regulations of importing country.

Phytosanitary condition for export of Banana from India

Most of the countries has not required any additional declaration for export of banana fruits for consumption purpose except Iran and UAE. The list Phytosanitary conditions which required by different countries is furnished in the table.

Phytosanitary condition for export of banana from India to other countries

S. No.	Name of Commodity	Name of country	Additional declaration & treatment conditions
1.	Banana (*Musa* spp.) Fruit for consumption	Iran	The consignment is free from *Fromaleurodicus disperus, Parasaissetia nigra, Pentalonia nigronervosa, Spodoptera litura, Bactrocera dorsalis, Eudocima fullonia, Dysmicoccus brevipes, Colletotrichum musae, Guignardia musae, Ralstonia solanacearum race1, 2.*
		Kuwait	Nil
		Oman	Nil
		Qatar	Nil
		Saudi Arabia	Nil
		Bahrain	Nil
		UAE	The consignment is free from fall armyworm (*Spodoptera frugiperda*) on the basis of visual inspection
		EU	Nil
2.	Banana (*Musa* spp.) Tissue culture plants	Angola	Import Permit: Certified that plantlets were raised through sterile tissue culture procedure and free of virus including Banana Bunchy Top Virus, Cucumber Mosaic virus, Banana Mosaic Virus, banana Bract Mosaic Virus, *Xanthomonas* (Banana Wilt) using ELISA/PCR test, *Erwinia chrysathemi*, *Pseudomonas syringae* pv. *Syringae* (Bacterial Canker)
	Grand Naine Bananas (*Musa acuminata*) (Tissue Culture)	Australia	"Prior to the removal of the plant tissue from media, the tissue cultures were inspected and found to be free of contamination. The plant tissue was aseptically transferred under supervision to sterile containers which were then sealed and not

			subsequently re-opened". & All tissue cultures in this consignment were derived from mother tissue cultures that were tested by PCR and found free of *Xylella fastidiosa* as indicated in laboratory test report number (TCPT14-2018). These plants are produced at their AQIS accredited lab at No.....

Measures for boosting the banana exports

Countries like the Philippines in South East Asia and Ecuador and Costa Rica in Central America are better organized and have large sized banana plantations owned by International companies. Therefore, to enhance competitiveness, the following measures need to be taken for making available quality banana of International Standard:

- Geographically, India is better placed compared to South East Asian, Central and South American countries for exports to Gulf countries.
- Production technology on modern lines needs to be demonstrated to the growers on a massive scale.
- Farmers need to be educated about export requirements and International Quality Standards.
- Protocol for post-harvest handling of Grand Naine, Nendran and Red banana need to be perfected/ standardized for shipping to Gulf/other countries by sea.
- Most modern pack house facilities need to be created in major banana producing States.
- Banana holdings in India are very small and it is not possible to install cable ways for transporting bunches from field to pack houses to avoid bruises. Under these circumstances, groups of farmers need to be encouraged to have system of make shift pack houses, to cut hands from bunches in the field itself and send these hands to central pack houses for further processing /treatment and packing.
- It will be advisable to have some working arrangements for ripening of our banana arrivals in importing countries on a regular basis. In the long run, India needs to have its own ripening facilities in one or two countries to begin with.
- It is suggested that training to pack house workers about post-harvest handling technology and also about international quality standards must be imparted.

Marketing strategies and support from government in Banana business

Saravanan G

Deputy Director of Agriculture, Department of Agricultural Marketing & Agri Business, Tiruchirappalli

Marketing of Banana

Banana is called as the "fruit of the wise men" is an important fruit crop cultivated large area in India, it's per hectare yield is also the highest (30 - 35 MT/ha) of all the fruits. Therefore, its production is large and the prices are within the reach of common people.

Tamil Nadu is one of the largest producers of banana in India. In Tamil Nadu, Theni District holds first position in area under cultivation of banana followed by Coimbatore, Erode and Tuticorin districts. Tiruchirappalli district has banana crop area of 6166 Hectares. Ney Poovan, Nendran, Poovan, Rasthali and Karpooravalli are the main varieties cultivated by farmers in Trichy. Banana, the intensely satisfying and energizing fruit, is commonly available across the globe. A powerhouse of nutrition, it is a rich source of vitamins, minerals, potassium, magnesium and much more. Banana has fantastic health benefits which make it a favorite fruit to include in the everyday diet. Banana farming delivers a comparatively quick return on investment and provides consistent income throughout the year.

The Evolving Food Processing Industry

With changing times, the consumer is looking at more innovative ways to consume banana while retaining its nutritional and health benefits. This has resulted in the production of a variety of processed banana products.**Processed banana products like banana puree, chips, powder** and many more are being produced to simplify and enhance the lives of the consumer.

The use of modern and technologically driven food processing techniques results in better quality and longer shelf life of the agricultural produce like banana. This also ensures an increase in revenue for the farmers.Indian food processing industry is going through a facelift and is on the brink of a revolution. The cold storage facilities and the infrastructure are getting more high-tech.

Marketing Strategies for a Business

4 P's of Marketing

The "4 P's of Marketing" refer to the four key elements comprising the process of marketing a product or service. They involve the marketing mix, which is a set of tools that a company uses to influence consumers into buying its product.

Marketing Mix

1. Product

A product is any good or service that fulfills consumer needs or desires. It can also be defined as a bundle of utilities that comes with physical aspects such as design, volume, brand

name, etc. Companies can change the packaging, after-sales service, warranties, and price range, or expand to new markets to meet their objectives

2. Price

The price of a product directly influences sales volume and, consequently, business profits. Demand, cost, pricing trends among competitors, and government regulations are crucial factors that determine pricing.

3. Promotion

Promotion involves decisions related to advertising, salesforce, direct marketing, public relations, advertising budgets, etc.

4. Place (or Distribution)

Place involves choosing the place where products are to be made available for sale.

Marketing Strategies for Business

1. **Get organized.**
2. **Develop a strong online presence.**
3. **Offer valuable content.**
4. **Take advantage of search engine optimization (SEO).**

Elements of a Marketing Strategy

When it comes to marketing for small businesses, there are a few key elements that should be included in any strategy. The following is a non-exhaustive list of what should be considered when creating a marketing plan for your small business:

1. Target Market

We should know our target market, their demographic information, their interests and needs. Once you know this, it is easier to craft a marketing message that will resonate with them.

2. Goals

Once you know what we're after, it's easier to determine which marketing strategies will work best for achieving those goals.

3. Strategy

Once you have an understanding of your target market, your goals, and the strategy you'll use to achieve them, it's time to develop the actual plan of attack.

Types of Marketing

There are many different marketing strategies that a small business can use. Here are some of the most common:

1. Traditional Marketing

2. CRM Marketing: CRM marketing is a type of marketing that uses customer relationship management software (CRM) to manage and track customer data.

3. Social Media Marketing
4. Search Engine Marketing
5. PR/Publicity Campaigns

The Importance of a Good Marketing Strategy

Marketing is one of the most important aspects of small business, and without a good strategy, it can be difficult to attract customers and make money

1. Know Your Target Audience
2. Create Effective Communications Plans
3. Use Marketing Tools Wisely

Support from central and state government schemes

Primary Processing Centers

There are **Eight numbers** of Primary Processing Centers established for Banana primary processing under **Tamil Nadu supply Chain Management Project** in Tamil Nadu. Viz four in Trichy (Manachanallur - II, Lalgudi, Pidaramangalam and M. Puthur), two in The Nilgris, one in Coimbatore and one in Theni .APEDA certification done for PPC at M. Pudur ,Trichy Dt

Prime Ministers Formalization of Micro processing Enterprises

Ministry of Food Processing Industries (MoFPI), has launched an all India Centrally Sponsored PM Formalization of Micro food processing Enterprises Scheme (PM FME Scheme) for providing financial, technical and business support for upgradation of existing micro food processing enterprises.

- **Food processing unit assistance:** Unorganized micro food processing facilities are eligible for a credit-linked capital grant of 35% of the project cost, with a maximum limit of Rs. 10 lakhs per unit for upgradation under the plan. Members involved in micro food processing are also eligible for a seed financing of Rs. 40,000 for operating capital and the acquisition of small instruments.
- **Marketing and branding assistance**: The State Nodal Agency may grant up to Rs. 5 lakhs to FPOs, co-operatives, and SHGs for the preparation of a Detailed Project Report (DPR) for marketing and branding proposals
- **Support for the development of common infrastructure:** Under the plan financial assistance given to create common infrastructure. There are credit-linked grants available for up to 35% of the overall project cost.
- **Research and capacity building:** Training is a critical component in the transformation of unorganized micro food processing units into organized units.

Subsidy schemes available on setting up a Banana Ripening Chamber

Financial Assistance/Subsidy on Banana Ripening Chamber

1. Agricultural Marketing Infrastructure under NABARD (Central Government Scheme)

The scheme provide following benefits for creation of Banana Ripening Chamber with capacity of 50 MT maximum 5,000 MT:

i. 33.33 % of project cost subject to maximum of Rs 30 Lakhs for the Registered FPO, Panchayati Raj Institutions, Women farmers/entrepreneurs, SC/ST entrepreneurs and their cooperatives.

ii. 25% of project cost subject to maximum of Rs 25 lakhs for all other categories of beneficiaries.

2. Agriculture Infrastructure Fund Scheme (Central Government Scheme)

The scheme provides financial assistance on setting up business of Banana Ripening Chamber in form of Interest Subvention of 3% per annum for 7 years and credit guarantee coverage fees as facilitated by CGTMSE (Credit Guarantee Funds Trust for Micro and Small Enterprises) available on loan up to a limit of ₹ 2 crores.

3. Assistance for the establishment of processing and supply chain infrastructure

Beneficiaries: APEDA registered Exporters are eligible to apply for assistance under Central, State government institutions and public sector enterprises are eligible to apply for assistance.

a) **Integrated Pack House and processing facilities** for Facilities include equipment for collection, cleaning, washing, sorting/ grading, pre- cooling, packing, cold storage, Hand held Near-infrared Spectroscopy (NIR) instrument, Hot water dip treatment etc. **Pattern of Assistance** will be up to 40 % subject to a ceiling of Rs. 200 lakhs.

b) Purchase of insulated, reefer transport /mobile pre-cooling units

The assistance will be up to 40% of the total cost subject to a ceiling of Rs. 200 lakhs.

c) Cable handling system for banana and other crops

The assistance will be up to 40% of the total cost subject to a ceiling of Rs. 200 lakhs

- **Food processing facilities for addressing missing gaps** required for value added products. The assistance shall be up to 40% of the total cost subject to a ceiling of Rs. 200 lakhs ,detector, sensors, vibrators or any new technology or equipment for food safety and quality requirement
- **Common infrastructure facilities** such as Integrated Pack houses, Processing Units, Laboratories etc. to be set up by Central and State government institutions. The assistance will be up to 90% of the approved cost subject to a ceiling of Rs. 600 lakhs.

Related Schemes of other Agencies

National Horticulture Board (NHB)

Setting up of cold storage (of capacity above 5000 MT and up to 10000 MT) and their modernization are eligible for assistance under the NHB Scheme of **Capital Investment subsidy for construction/ expansion/ modernization of cold storage for Horticulture Products**. It is open ended credit linked scheme with scale of assistance @ 40% of capital cost of project limited Rs 30.00 lakhs per project in general area and 50% limited to Rs 37.50 lakhs per project in case of NE, Hilly & amp

National Horticulture Mission (NHM)

Cold storage up to 5000 MT capacity are eligible for assistance under the open ended scheme of NHM/ HMNEH. The assistance is extended as subsidies to credit linked projects @ 35% of capital cost of project in general area and 50% in case of Hilly & Scheduled area.

Small Farmer Agri-Business Consortium (SFAC) assistance to cold storage

Setting up of cold storage as a part of a integrated value chain project are eligible for subsidy provided the cold storage component is not more than 75% of TFO (Total Financial Outlay). The scale of assistance as subsidy to projects is @ 25% of capital cost and maximum ceiling to Rs 2.25 crores in general area.

Agricultural and Processed Food Products Export Development Authority (APEDA)

Setting up of cold chain are assisted by APEDA as a part of strategy to develop the industries relating to the scheduled products for export. The Scale of assistance as 40% subsidy subject to a limit of Rs 75 lakhs for cold chain projects with mechanized handling system.

Development Commissioner Micro, Small and Medium Enterprises (MSME)

This is the scheme for promotion and technology up gradation of Small Scale Industries (SSI). . Under the scheme **Credit Linked Capital Subsidy Scheme (CLCSS)** DC MSME provides subsidy at the rate of 15% of the investment in plant and machine to micro and small manufacturing enterprises (MSEs). Maximum amount of subsidy is Rs 15 lakhs and maximum ceiling of investment in plant and machinery is Rs 1 crore.

Venture Capital by Small Farmer Agri-Business Consortium (SFAC)

SFAC extents venture capital assistance in form of equity to agribusiness projects. The quantum of SFAC support is 26% of promoter's equity or amount of Rs 50 lakhs whichever is lower in general area. This venture capital is repayable to SFAC after the repayment of term loan.

Venture Capital by SIDBI Venture Capital Ltd. (SVLC) Funds Details of SVLC

Extents support to MSME through one of its scheme Smaridi Fund with a corpus of Rs 450 crores invested by Department for International Development (DIFD) UK and SIDBI. The scale of support is between Rs 5 to Rs 25 Crores in form of equity and convertible instrument payable after 7 years.

Ministry of Micro, Small and Medium Enterprise

To promote innovation and entrepreneurship culture at grassroots level, Ministry of MSME under its scheme for Promotion of Innovation, Entrepreneurship and Agro Industry have been allotted budget of 210 crores.

Strategy for enhancing export of bananas

Unnikrishnan K

Joint Director General, Southern Region,
Federation of Indian Export Organisations (FIEO) Chennai, Tamil Nadu
Corresponding author: unni@fieo.org; Contact Number: 9500120259.

India's Banana Exports and major markets

India is the world's leading producer of bananas with a share of around 25 % in total global output. More than 70 % of the country's banana production takes place in Andhra Pradesh, Gujarat, Tamil Nadu, Maharashtra, Kerala, Uttar Pradesh, Bihar and Madhya Pradesh. Irrespective of the fact that India is the largest producer in the world, **India exported Banana worth of USD 160.52 million only out of global export of $14.5 Billion during the year 2021-22 and ranked 20th position in exports with just 0.6% share in global trade.** However, India's banana exports experienced quantum jump of 44.62 % increase during the year 2021-22 comparted 2020-21 where our export was to the tune of 101.53 Million.

During the year 2021-22, our top export destinations were Iran ($ 54.55 M, 68% growth) UAE ($ 27.98 M, 30.61% growth) Oman $14.44 M, 34.15% growth), Iraq ($20.40 M, 120.95% growth).These four markets contributed 73% of our total exports. But none of these countries ranked amongst the top 10 ten importing countries, thereby limiting India's potential to gain more share in this product category.

Even though India is having the capacity to become top exporter in the world with world's largest output with wide range of verities, India not able to influence banana markets even in our favourable import depend markets like UAE, Saudi Arabia, Iran, etc.

Competing countries in India's Top 3 Banana export Markets-2021 - 22

Countries	UAE	Iran	Saudi Arabia
Total Imports - USD Mn.	100.71	401.99	181.91
Imported form			
Ecuador	55.11	1.98	102.78
India	27.27	92.88	8.85
Philippines	12.89	33.33	52.68
Costa Rica	2.67		8.08
Sri Lanka	2.36		7.87
Pakistan		27.26	
Turkey		256.25	
Total from top 5 suppliers	**100.31**	**401.7**	**180.26**

UAE, Iran and Saudi Arabia together contributed 80% of our banana exports during the year 2021-22. While India is the second largest supplier of banana in UAE and Iran, our share in Saudi Arabia's Banana import is negligible.

Global Trends in Banana exports

The Global Banana Market is segmented by Geography North America, Europe, Asia-Pacific, South America, and Africa. **Equador, world's 5th largest producer of Banana is the world's top exporter of Banana with $ 3.5 Billion exports and a share of 24% in global trade in Banana. Other major players are Cost Rica (13%), Philippines (7.8%) Colombia (7%), Guatemala (6.5%) and Netherlands (5.2%)** During the year 2021 there was stagnation in production and export from Ecuador mainly due to bad weather, which helped many smaller players including India to increase their exports. The fastest growing markets for Banana is Middle East, US, EU and Turkey during last two years. It is projected that for next 5 years world Banana Market will grow at CAGR of 4.5%. If India takes necessary steps to upgrade infrastructure, logistic, quality and production, India can become one of the major player in Banana exports.

The Pandemic had hit agro system across the world very hard. This has resulted in price crash in few markets while in other places there was increase in prices. Due to this experience, future objective of major brands are focused on developing sustainable marketing and processing lines for bananas across the world and India is way behind in this regard.

During the year 2021, global export for Banana declined by 7.8% in quantity terms due to constraints aroused from the continuing COVID-19 pandemic, higher costs for inputs such as fertilizers as well as for packaging materials, increase in logistic costs, refrigerated container Shortages, adverse weather conditions, more stringent rules in EU related to MPR levels, etc., which exerted pressure on prices and margins along the value chain and affected the ability of producers and exporters to supply bananas in adequate quantities and meet the quality standards and prices expected in export markets.

One of the major characteristics of Banana trade globally is the historic presence of big companies (E.g.: Chiquita, Fyffes, Fresh Del Monte Produce, Dole Food Company, Compagnie fruitière). These 5 companies together controls more than 50% of Banana market globally and always strongly organise structured supply to the world market, and are present in all the links of the industry including production, sea-freight, import, ripening and distribution to international purchasing centres. These companies possess their own procurement offices in major producing countries and also invest and involve in pre- and post-harvest process. **After pandemic, there is a shift in Banana marketing and many of these importing firms started closing their procurement offices and started signing contracts with producers or producers' associations leaving all responsibilities to the producers, thereby reducing their overhead costs of maintaining own channels**. A major initiative from the Govt, along with all stake holders is required to bring major banana trading companies to tie-up for picking and promoting Indian Bananas.

Indian banana sector needs product specific policies & support measures

For development of Banana farming, procurement and distribution, it is necessary **that our domestic market should upscale, invest in technology, packaging and handling, not only for exports, but also for domestic consumers who are also need to get the experience of consuming quality bananas.** This will help the country in improving overall quality and branding of Indian Bananas. The present system of separate production exclusively for export market need to be replaced with the aim to produce, processed, packed, stored and distribute banana for domestic as well as for export market using same process and channels. This will help the country to offer better price to farmers, better choice to Indian consumers and importantly help in expanding our global market.

India is a unique country which produces more than 100 varieties for bananas with all of them known for unique taste and nutrition. Many of these varieties are not exportable as well as incur huge wastages before reaching to the domestic consumers due to the inherent nature of the product, farming practises and post-harvest management. **Our research institutions and other stake holders together should come forward for providing solutions to increase shelf-life, reduce skin damages, providing technology and infrastructure for pre and post-harvest process, etc.,** so that these verities known locally can be promoted through and made available to Indian diaspora across the globe. There are several verities of bananas being produced in India which need to be promoted across the globe through our ethnic population. The United States and GCC can be focused for this, as both are free markets, with no Customs duty. In principle, it is simply sanitary regulations to be taken care of, unlike in Europe where the import regulation system is stringent and seen significant changes very frequently.

Governments of many banana exporting countries established guaranteed minimum price for Banana farmers and it is necessary that Govt. of India as well as the State Govts should take initiative to introduce Minimum support price for Banana by setting up district-wise Banana procurement and processing centres in major production areas and create pool for Banana exporters who can be encouraged to sign long term contracts with producers /FPOs. MSP program adopted by Govt. of Kerala for Vegetables including Bananas is a right direction in this regard.

In many of the major banana exporting countries including Ecuador, Costa Rica, Colombia, Philippines, etc., it is estimated that less than 20 per cent of volumes are traded based on the **spot market footing, i.e. the prices governed by market fundamentals–supply and demand, whereas 80 per cent of export volumes are under long term contracts with producers and exporters.** Hence it is necessary to promote contract farming on banana cultivation.

Government also should come forward to encourage major retailers and department stores in India to **invest in post-harvest channels** to procure banana and sell through stores with specified standards, branding and packaging. This can bring in revolution in Indian Banana marketing and can substantially reduce wastages, value addition, and post-harvest and implement block chain

technologies, logistic and better price to farmers. Bringing in proper system with quality produce for domestic market will lead to expansion of our export capacity.

We need to create Branding of Banana and the state government should come forward for creating and promoting State specific brands and its promotion in major markets. The supports provided by the State Govt. in creating procurement, sorting, packing, processing centres, etc. are much below the desired level. There is a need for co-ordination with all stake holders including research institutions, packaging, technology providers, APEDA, FIEO, certification agencies, etc., and address all challenges including traceability.

There are several country specific standards and regulations prohibit export of Indian banana which includes marketing standards, quality (minimum characteristics, classification into categories), sizing (minimum length and grade), quality tolerances, presentation (uniformity, packaging, presentation), marking (product identification, nature, origin, commercial specifications, brand). Towards this objective, a separate division may be created by the State Govts to set out and help in implementation of all the internationally accredited production, processing, distribution, inspection, labelling, organic product certifications, traceability phytosanitary standards, etc.

In Banana export marketing, Private standards plays a major role and incentives may be provided to the producers and exporters to develop, buyers' specifications or process, Fairtrade, use of approved pesticides or waste management, social issues, etc.

India also needs to develop a good agricultural practices code aimed at conservation of biodiversity, farm conservation and environmental management. **Similar to the GLOBAL GAP code, an Indian benchmark for Banana to be developed for creating confidence on Indian produce by overseas consumers.**

Organic banana is a niche, top-end market, with distribution in networks of specialist shops is an important area of huge market potential. Many of the supermarkets in EU, US and GCC having separate shelf for Organic Banana where presence of Indian product almost nil. There are specialised Organic Banana importers who makes systematic benchmark for the supermarkets and driving substantial development in the sector. Hence an initiative may be launched by the Govt. and involve major buyers is need of the hour for ensuring good remuneration to the producers.

India also having several varieties of GI tagged bananas produced in different states. There is a need for market these varieties by branding and promoting. In this regard, a separate category provided in '**indianbusinessportal.in**' a B2B and B2C portal maintained by FIEO for GI certified agri and other sectors is commendable. During last year one consignment of GI tagged Jalgaon Banana has been shipped to UAE with APEDA support. However, continuous and larger quantity shipments not yet happened.

A **State-wise Banana development program** is needed with adequate funding from the Govt. to improve the competitiveness of the banana industry, the working conditions of plantation

labourers as well as the environmental impacts. There is a need for variety of actions, relating to availability of credit, housing, competitiveness, training, certification, packing houses, phytosanitary requirements, transportation, limited usage of pesticides, etc. needed in this sector for its growth and acceptability in global market.

Globe over, Bananas are exported entirely by sea-freight between the production zones and destination markets. However, in India, more than 60% is exported through Air, there by incurring additional expenses which restricts marketability of Indian Bananas. **There is a need for closer association with major shipping lines towards creating proper banana export infrastructure.** Globally, Bananas reaches major markets when still in green after 15-20 days of voyage due to temperature control and post-harvest care and the ripening process is done at consumption markets and gets10 to 15 days for colouring, distribution and shelf life. India needs to focus more on this and promote few dedicated logistics facilities and ports for Banana exports, along with taking initiatives for availability of direct sailing from Indian ports to major destinations in EU and US.

India also need to undertake domestic consumer awareness campaigns to appreciate the quality produce, branding and packaging for better price realisation in banana.

The initiatives taken by Govt. of Tamil Nadu to brand 'Tamil Nadu Bananas' is a good step towards this objective and if above suggestions are implemented, Tamil Nadu alone can export banana worth of $50 million from present $ 22 Million exports within three years. There is a need for greater involvement of producers by providing them training, pre and post-harvest technology and supports, setting up modern infrastructure, testing facilities, etc.

Banana exports require major investments along the supply chain, facilities for banana specific contract farming, critical upgradation on post-harvest process, cold chain and dedicated infrastructure, availability of permitted pesticides, testing and certification facilities at farm level, etc. Hence common facilities needed to create to attend all infrastructure and technology related issues.

Export Strategy

The banana market is consolidated with few major players dominating the import markets. Partnership and expansion are the prime strategies being followed by these companies to increase their market share and improve production capabilities using modern technologies. The stake holders including the State and Central Govt. departments may initiate dialogue and tie-ups with major buyers, understand their specific requirements and should support the producers in implementing it.

The best opportunity for Indian banana exports is with **differentiated products**. For this purpose, bananas require a significant point of difference built around and branding it. This can be done only with public and private participation.

We need to create **niche markets with ultra-premium products like Hill Banana, Rad Banana, Nendran**, etc., by highlighting the quality flavour and nutritional claims. There are large segments of extremely affluent consumers who will pay a premium for better tasting or safer fruit of

a very high-quality appearance. Research institutes may come up with modifications in traditional verities making it suitable for export markets including long shelf-life. More focus also should be in Organic, Eco-friendly, New varieties, etc. to compete with branded bananas.

Relative to other mature horticultural industries such as Apple, grapes, etc., the banana industry's export supply chain is undeveloped because, the industry has been fully focused on the domestic market. **Banana exports in India have been handled by exporter/agents. Growers do not appear to be export-focussed.** The banana industry needs focused export market development program in place. Such programs should engage with all stake holders starting from farmers to exporters to gain knowledge on how the supply chains function and what the desired product specifications of consumer markets to be produced, etc. with focus on tie-ups and collaboration.

The most exported variety in global trade is the Cavendish type banana, which accounts for around 47 percent of global production and more than 70% of global imports. Hence apart from promoting niche local verities, special focus needs to be given for promoting cultivation of exportable verities by identifying the areas where suitable soil is available.

Banana production costs include labour costs, fertilizer expenses, and costs for phytosanitary control and pesticide use and unscientific use of all these inputs increase cost of production and make our banana uncompetitive in international market. **Presently, labour costs incurred is around 50%, Agro Chemicals and other inputs 35% and transportation around 13%, etc. To become competitive, there is urgent need for reducing expenses on all above heads.**

Lack of supporting trade policies, proliferation of preferential agreements and lack of competitiveness, lack of awareness on permitted fertilisers and pesticides, its limits, phytosanitary requirements of importing countries, etc. hindering Indian produce form entering into the potential markets. Special mission may set up to help our produce to reach destinations including US, Germany, Russia, Belgium, Japan, China, Netherland, France, UK and Italy which totally accounts for 68% of global import of bananas during the year 2021. The individual exporters cannot handle various non-tariff barriers and need proactive supports form the Govt. including having active role by Indian Missions for gaining market access. Africa, Caribbean and Pacific countries enjoy duty free and quota free access in these markets and hence contribute major share.

More focus needs to be given for promoting value addition in Banana by providing technology and financial supports to Micro and small industries, which will help further development of Banana sector and ensure stability in prices across all seasons.

*** Data Source: Trade Map; UNCTAD, MOC, FAO**
****views expressed are personal**

Hurdles and Solutions in banana trade: Customs affair in export logistics

Pradeep N

IRS Joint Commissioner
Office of the Chief Commissioner of Customs (Preventive)
Cantonment, Tiruchirappalli, Tamil Nadu
Corresponding author: commrprev-custrichy@nic.in; 04312417466

Introduction

The Tiruchirappalli Customs (Preventive) Zone is a part of the Central Board of Indirect Taxes & Customs under the Department of Revenue, Ministry of Finance, Government of India. The field offices of this Zone deal with the administration and enforcement of the Customs Act, 1962, the Rules and Regulations made thereunder and other allied Acts in the matter of collection of Customs duty and Prevention of Smuggling. In the performance of export related administrative and executive functions, the Directorate of Export Promotion, Directorate of Logistics, Directorate of Data Management are few such attached/subordinate offices assisting the Board.

Details of class of cases which shall be considered by member Exports

1. T. C., ETC and other prohibition or restriction on imports and exports.
2. Cesses on imports and exports.
3. Customs Valuation.
4. Tariff classifications, tariff advises.
5. Customs procedures, customs house agent's regulations.
6. Warehousing, inland bondage warehouses.
7. FTZs., EPZs, 100% EOU, E H T P's STP's and other special export schemes.
8. World Customs Organization, World Trade Organisation, ESCAP and International talks and agreements with organisation concerning customs. 11.
9. Matters relating to drawback. 12.
10. Matters relating to export promotions in Exim Policy.
11. Revenue Intelligence.
12. Safe-guards.
13. Customs & Central Excise procedures relating to above subjects.
14. Supervision and Control over Customs & Central Excise formations relating to above items of work and Directorate of Drawback.
15. Coordination with other ministries relating to export promotion and related issues.
16. Valuation
17. Supervision and control over:- (a) Chief Commissioners, Delhi, Meerut, Ahmedabad, Nagpur, Bhopal and Vadodara. (b) Directors General of Revenue Intelligence, Export Promotion, Safeguards, Valuation. (c) Directorate of Logistics. (d) Central Revenue Control Laboratory (CRCL)

Export scenario: Tamil Nadu state

The Tamil Nadu state boasts a diversified export basket in various sectors such as automobile and components, machinery and instruments, electronic hardware, software, readymade garments and accessories, yarns, fabrics, and leather products. Besides manufactured goods, the State has demonstrated competence in traditional products exports such as handicrafts, handloom fabrics, and plantation products that contribute to the State's outbound shipments. In alignment with the Government of India initiative to develop **Districts as Export Hubs**, Tamil Nadu offers a multi-product potential to export from each district.

The value of merchandise exports from Tamil Nadu stood at Rs. 11.55 lakh crore (USD 168.5 billion) between 2015-16 and 2020-21. The export basket predominantly comprises **manufactured goods, followed by agricultural and allied products, and a small share of minerals, petroleum products, and other commodities**. Tamil Nadu accounted for 9% of the national exports in FY2020 - 21, with a major contribution from automobiles, textile, machinery, etc. Among marine and agriculture exports, marine products shrimps, sugar and molasses, and spices dominated the share between 2015-16 and 2019-20. Oil seeds, processed fruits and vegetables, tea, rice, and cashew nut are the other significant export items from the State. During this period, agricultural and allied products accounted for Rs. 0.73 lakh crore (USD 10 Bn) exports. Twenty-three commodity clusters from agriculture, horticulture, animal husbandry, and fisheries sector along with potential districts have been identified for promotion of Agri exports in the State in which Commodity: Banana is in special focus at Tiruchirappalli District.

Banana exports

Banana exports have been taken place from several clusters for the first time. Despite the pandemic, export of fresh horticulture produces took place by multimodal mode and consignments were shipped by air and sea to Dubai, London and other destinations from these areas. Handholding by the Department for market linkages, post-harvest value chain development and the institutional structure such as FPOs, enabled farmers to send their commodity: Banana beyond the Indian borders.

- **Ananthpur Cluster (Banana):** During the recent season (Jan-April 2021), 30,291 MT of banana have been dispatched from Ananthpur in Andhra Pradesh through 9 reefer rail movements and exported to Middle East.
- **Theni cluster (Banana):** During the last one year till date, 2400 MT of Cavendish and 1560 MT of Nendran banana have been exported from the cluster.
- **Banana Cluster, Gujarat:** From April 2020 till date, 6198.26 MT of fresh banana has been exported to Middle East countries-. Bahrain, Dubai, Georgia, Iran, Oman, Saudi Arabia, Turkey, UAE, Iraq etc. from the cluster comprising Surat, Narmada & Bharuch.
- **Banana Cluster, Maharashtra**: During 2020-21, 3278, 280 & 90 containers of Banana have been exported from Solapur, Jalgaon & Kolhapur respectively.

Custom requirements for export of Banana (with respect to Tuticorin Port)

- Customs Tariff Code(CTH) : : 08039010

- No Hybrid variety exported from Tuticorin
- Varieties exported: Karpuravalli, Red Banana, Poovan, Nendran, Cooking banana etc.
- Export to Maldives, Middle East and Far East countries.
- Procedure to be followed For exports (Essential Document):
  Export documents: IEC Code (Given by DGFT)
    - Invoice,
    - Packing list,
    - Phytosanitary certificate,
    - APEDA RCMC (**A**griculture and **P**roceed Food Products **E**xport Development **A**uthority - Registration **C**um **M**embership **C**ertificate)
- Export to some countries, Eg. OMAN (Gulf Countries) :
    - Phytosanitary certificate is must
    - Health Certificate by Municipal Health officer or port Health officer as cargo fit for human consumption is also must.
    - Original certificates to be produced at port of import.
    - In some countries, certificates with digital signature in phytosanitary and health certificates are verified online and imports allowed.
- Export incentive available under RoDTEP Scheme given by Customs.
- Incentive also available under (TMA) Scheme from DGFT & (MAI) Scheme from Ministry of Commerce.
- Tuticorin is small port. Only feeder vessel movement. Mother vessel for the feeder vessel export at Colombo only.
- Export Planning should be done according to connecting mother vessel at Colombo.
- Only Mixed Vegetables is going through Air cargo of Madurai, Trichy & Coimbatore.

Need for interaction with banana stakeholders

- A comprehensive **need-gap analysis** of existing export-oriented infrastructure across the value chain is to be undertaken for promotion of banana export.
- Ports are a vehicle for economic development. Yet, while port development will indeed improve exports it will not provide an exceptional boost to agri trade until supply, quality, handling and hinterland connectivity is enhanced.
- Identifying strategically important clusters, creating inland transportation links alongside dedicated agri infrastructure at ports with 24x7 customs clearance for perishables will therefore go a long way in boosting trade exponentially. The focus therefore shall be to:

1. Identify major ports where current/projected bulk and container agri traffic demands infrastructure and modernization initiatives.
2. Sea Port - development of dedicated perishable berths, agricultural jetties;
3. Airport -Identify the challenges of operationalizing existing defunct infrastructure at ports such as the **Centre for Perishable Cargo (CPC)** and requirement of new CPCs, loaders, designated and sufficient quarantine areas, better Hinterland Connectivity

Sample data sheet of all India export data for Banana

Customs Site (Indicates the export site: India)	Item Code	Item Description 1	FOB Amount (INR)	SB Date	Quantity	Report UQC Quantity	Country Of Destination Name
INTRZ4	8039010	KARPOORAVALLI, NENDHIRAM BANANA	21810.83	13-11-2022 00:00	280	0.28	SINGAPORE
INTRV4	8039010	EDIBLE FRUITS(BANANA)-(WE INTEND TO CLAI	8627.23	13-11-2022 00:00	90	0.09	BAHRAIN
INTRV4	8039010	BANANA	149855.66	13-11-2022 00:00	1271	1.271	UNITED ARAB EMIRATES
INCOK4	8039010	BANANA	20005.54	13-11-2022 00:00	315	0.315	KUWAIT
INCOK4	8039010	RASAKADHALI(BANANA)	23940.36	13-11-2022 00:00	336	0.336	UNITED ARAB EMIRATES
INCCJ4	8039010	FRESH BANANA	90731.97	13-11-2022 00:00	1525	1.525	UNITED ARAB EMIRATES
INCCJ4	8039010	BANANA	119211.89	13-11-2022 00:00	1240.5	1.2405	OMAN
INCOK4	8039010	BANANA	234964.76	13-11-2022 00:00	3360	3.36	UNITED ARAB EMIRATES
INCOK4	8039010	BANANA	27175.98	13-11-2022 00:00	354	0.354	BAHRAIN
INBLR4	8039090	FRESH ASSORTED FRUITS & VEGETABLES, DETA	51183.35	13-11-2022 00:00	456.5	0.4565	QATAR
INCCJ4	8039010	FRESH BANANA	63716.3	13-11-2022 00:00	714	0.714	QATAR
INNSA1	8039010	INDIAN FRESH GREEN CAVENDISH BANANA 1000	187404.3	13-11-2022 00:00	4500	4.5	OMAN
INTRV4	8039010	BANANA(WE INTEND TO CLAIM REWARDS UNDER	82173.89	13-11-2022 00:00	1325	1.325	UNITED ARAB EMIRATES
INCCJ4	8039010	BANANA FRESH	10900.2	13-11-2022 00:00	148	0.148	UNITED ARAB EMIRATES
INCOK4	8039010	BANANA (WE INDENT TO CLAIM UNDER REWARDS	78422.72	13-11-2022 00:00	1057	1.057	UNITED ARAB EMIRATES
INCCJ4	8039010	BANANA	15683.57	13-11-2022 00:00	199	0.199	QATAR
INBOM4	8039010	BANANA LEAF	1668.79	13-11-2022 00:00	7	0.007	CANADA

INCCJ4	8039010	FRESH BANANA	62024.76	13-11-2022 00:00	679.5	0.6795	BAHRAIN
INTRV4	8039010	BANANA	76029.72	13-11-2022 00:00	315	0.315	QATAR
INCOK4	8039010	YELLOW BANANA	35910.54	13-11-2022 00:00	504	0.504	UNITED ARAB EMIRATES
INSNLB	8039010	BANANA	93000	13-11-2022 00:00	15500	15.5	NEPAL
INNSA1	8039010	INDIAN FRESH GREEN CAVENDISH BANANA 1928	521900.29	13-11-2022 00:00	12532	12.532	OMAN
INIXE4	8039010	FRESH BANANA	33972.21	13-11-2022 00:00	272	0.272	QATAR
INTRV4	8039010	BANANA	118142.4	13-11-2022 00:00	787.5	0.7875	OMAN
INCOK4	8039010	BANANA	78463.91	13-11-2022 00:00	955	0.955	QATAR
INCOK4	8039010	BANANA FRUITS	126721.35	13-11-2022 00:00	1505	1.505	QATAR
INTRV4	8039010	BANANA (WE INTEND TO CLAIM REWARDS UNDER	252046.91	13-11-2022 00:00	3710	3.71	KUWAIT
INIXE4	8039010	FRESH BANANA	33636.82	13-11-2022 00:00	428	0.428	UNITED ARAB EMIRATES

Banana export operations at pack house

Reaching the new milestones - Logistics in banana at air cargo complex

Subramani P

Airport Director
Airports Authority of India, Tiruchirappalli International Airport, Tiruchirappalli, Tamil Nadu
Corresponding author: apdtrichy@aai.aero; tm_trichy@aai.aero; 9443590599

Introduction

Trichy district is one among the 75 districts in India to be developed as an export hub. It has been estimated that the value of banana export from Trichy is 65 crore (Courtesy: DEPC District Export promotion Committee). Trichy being located at the geographical centre of the State makes it convenient as a platform for trade and export. The flourishing banana ecosystem existing in the district gives scope for the need to develop the export platform of the district. Thus banana and its products are being identified as products with special focus for expanding the export corridor in Tiruchirappalli district. Based on this the cargo handling capacity of the Trichy airport terminal has been developed year wise encasing the capacity for shipment of large quantities of banana. Varieties such as Grand Naine, sometimes Red Banana and Yelakki banana varieties are being exported. The potential export market existing for banana in and around the district is to be explored by the banana stakeholders for a voluminous and continuous export of the commodity.

Procedure for Cargo acceptance and case study

Facilities available in the cargo complex for import & export

1. Truck dock facility is available. At the same time six trucks can be operated.
2. Ramp facility is available for offloading the cargo
3. 49 numbers of four wheel trolleys and 04 numbers of hydraulic trolleys are available to facilitate the trade.
4. Weighing scale:
    a. 5 Ton weighing scale is available for weighing the export cargo
    b. 2 Ton weighing scale is available for weighing the import cargo
    c. Two numbers of 150 Kgs weighing scale is available in the examination area for weighment.
5. Two numbers of X-ray machines (Scanning Machine) available for scanning
6. Dangerous goods storage shed is available to store the DG shipments
7. Radioactive material storage shed is available to store the radioactive shipments
8. Strong room facility is available to store the Valuable shipments.
9. Cold storage facility is available to store the perishable
10. Transhipment shed is available to store the TP cargo.
11. Provision (Space) is available to store the customs detained cargo with lock and key.
12. Domestic Cargo Operations have not yet started and courier operations are under process.

Details of upliftment of cargo from Trichy international airport

- All types of fruits including Banana are being exported from our Cargo

- No hurdles faced so far. After Customs approval Cargo will be uplifted
- Procedure: Export Cargo will arrive from various places to our Cargo Complex.
- After arrival of Cargo, same will be offloaded and physical verification will be carried out. (No. of pkgs and weight verification)

Procedure for cargo acceptance and case study

Step - 1. Carting order issued by the respective Airlines will be verified.
Step - 2. Collection of terminal storage and processing charges (TSP) from the respective CHA/IATA agents (Customers) through PDA (Pre-Deposit account).
Step - 3. Cargo will be arriving to our cargo complex.
Step - 4. After arrival, the cargo will be offloaded at the ramp. No of pkgs and weight will be physically verified for further process.
Step - 5. Truck doc acceptance will be done in the custodian system (ICMS) and the same will be sent to the customs - EDI system. (Custodian is communicating the arrival of cargo to the officials of customs)
Step - 6. Cargo examination will be done by the customs and the Let Export Order (LEO) given by the customs to custodian system (ICMS).
Step - 7. After LEO bond will be closed in the ICMS (Custodian System),
Step - 8. Cargo will be scanned by the RA (Regulated Agent) Screener.
Step - 9. Security cleared Cargo will be loaded in the Trolleys (Bulk loading)
Step - 10. Release permit (Gate pass) will be issued by Custodian for Upliftment of cargo.

Note on Banana export

1. There is no separate cold storage facility for banana (export), due to less volume.
2. Banana are being exported to following countries: Dubai, Sharjah, Kuwait and Doha
3. Varieties of banana exported from Trichy other than Grand Naine: Poovan, Karpooravalli, Nendran, Red Banana, Pachanadan (Green Banana), Rasthali, Robusta, Monthan, Elakki, Banana Flower, Banana Stem and Raw Banana
4. Bananas are being brought to cargo complex from nearby Trichy Areas. (All bananas are collected from nearby Trichy surroundings and gathered in Banana Mandy – Trichy).
    a. Presently banana are being exported with very less quantity
    b. Per day 5 to 10 Kgs banana are exported.
    c. Already we have sufficient cold storage facility (APEDA – 10 Ton capacity) at our cargo complex, Trichy to promote the banana business.
5. Suggestion for Improvement of cold chain facility:-
    a. Once in three month, we have to conduct the meeting with Importer, Exporter, CHA, IATA agents & customs to promote the perishable cargo including banana.

Air Cargo Complex, Trichy International Airport, Tiruchirappalli		
Details of Export Cargo Commodity & Tonnage Report (In Metric Ton)		
Period	**Commodity**	**Tonnage(In MT)**
2018-2019	-	-

2019-2020	-	-
2020-2021	Vegetables, Fruits, Flowers, Leaves, Panner, Chilled Fish	393.57
2021-2022	Vegetables, Fruits, Flowers, Leaves, Panner, Chilled Fish	4680.66
01.04.2022 - 10.11.2022	Vegetables, Fruits, Flowers, Leaves, Panner, Chilled Fish, Garments, Fabrics, Food Stuffs	4010.42
Total		**9084.65**
Per Day Average: 20-25 Tons		

Air Cargo Complex, Trichy International Airport, Tiruchirappalli		
Details of Import Cargo Commodity & Tonnage Report (In Metric Ton)		
Period	**Commodity**	**Tonnage(In MT)**
2018-2019	-	-
2019-2020	-	-
2020-2021	General Cargo	0.1
2021-2022	General Cargo	4.33
01.04.2022 - 10.11.2022	General Cargo	1.72
Total		**6.15**

Role of cargo terminals

Acts as custodian of import cargo under section 45 of Customs Act 1962. The terminals are developed as a Common User facility to avoid duplication. All agencies such as Customs, Airlines, Agents and regulatory and facilitating agencies under one roof and **provides 3-tier services viz.**

(I) Custodian of import cargo appointed u/s 45 of Customs Act 1962.

(II) Ground Handling Agent (through SGHA appointed) on behalf of the Airlines in accordance with the Govt. of India Gazette Notification No.4272/GI/2007, Dated 18th October, 2007.

(III) Facilitator

Functions

1. Discharge corporate functions
2. Framing corporate policies on cargo handling at international as well as domestic airports
3. Implementation of IATA rules, ICAO recommendations, Implementation of BCAS, CBEC objectives and regulations, pertaining to cargo handling
4. Liaison at apex level with the regulatory Ministries, and other bodies, as well as user agencies such as Central Board of Excise and Customs, DGCA, Ministry of Commerce
5. Tapping hitherto untapped areas of operation for harnessing additional revenue from cargo handling, including Express and Courier Operations
6. Overseeing cargo operations at the two metro airports and other domestic airports

7. Representing in the various trade bodies like SCOPE-Air, sectoral meeting on EC/EDI Taskforce Meeting, Conventions and high level meetings arranged by BAR India (Cargo), CII, Federation of Freight Forwarder's Association of India (FFFAI), Air Cargo Agents Association of India (ACAAI), Federation of Indian Exporter's Organization (FIEO), Chambers of Commerce, etc.
8. Setting up of cargo terminals and managing them by providing services comparable to international standards
9. Modernization of cargo handling system, re-engineering systems and procedures for hassle free terminal operations resulting reduction in dwell time
10. Make proposals on various policy and operating matter to the AAI board; implementation of the policy decisions taken by the Board/Government of India

Business objectives

1. To promote, represent, organize, undertake, establish, conduct, handle, arrange, own, operate, participate, facilitate, sponsor, encourage and provide the business as Cargo Terminal Operators, Free Trade Zone, Air Freight Station and Inland Container Depot for Cargo and Passenger.
2. To provide services related to passenger handling, ramp handling, cargo handling, palletisation, customs clearances, document handling, storage and warehousing of cargo including bonded storage for all types of cargo therein.
3. To provide transport services/logistics for carriage of bonded and non-bonded cargo from and to the Freight Station/Inland Container Depot and Airports/Seaports including door-to-door delivery/courier goods.
4. To provide security services for securing of Cargo including Screening of Cargo/pax baggage by X-ray or physical examination and escort of cargo.
5. And to provide such facilities, by whatsoever means, in all parts of the world including India and to make incidental or necessary arrangements for the accomplishment of above objects including design and built cargo terminals, free trade zone, freight stations and or Inland container depots.
6. Any other aviation related activities/operations and allied services including movement of cargo/courier goods through multi-model avenues.

Scope of Services to be undertaken and provided

To provide Air Cargo handling and warehousing service to airlines and freight forwarders at all airports under the control to include but not limited to

a. Physical handling

1. Acceptance of export/ outbound domestic cargo on behalf of the airlines and carry ready for carriage process
2. Ensure that export cargo is placed before customs for examination
3. To carry out security examination of export/outbound domestic cargo in terms of BCAS/ICAO guideline
4. To process, palletize, store, hold export/outbound cargo until ready for departure
5. Breakdown import cargo/inbound domestic cargo and make it available for custom examination in case of import cargo and make it ready for delivery in case of domestic cargo.

b. Document handling and supervisory services

1. To provide document handling, data entry and other supervisory services to airlines
2. To provide EDI connectivity to transfer and receive messages and data between various trade partners and more particularly customs and airline
3. Maintain and store records pertaining to cargo handling on behalf of airlines and customs and make them available as and when needed.

c. Custodian services

1. To act in all respect as Custodian of international cargo for customs Administration and felicitation service:
2. Provide storage and examination facility for custom to carry out their activities and\
3. To provide facilities for customs in terms of office and other requirement to facilitate their activities under the Custom's Act

d. Administrative services

1. To provide facilities for handling of different types of cargo including temperature control storage, dangerous goods storage, live animal storage etc
2. To design and develop air cargo terminals at various airports for handling of international and domestic air cargo in line with best international practices for all types of cargo including but not limited to temperature sensitive and perishable cargo, dangerous goods, live animal, office for airlines, customs, trade participants etc
3. To design and install IT system to provide EDI connectivity to trade partners
4. To install X-ray machines and bomb detectors and other security devices at all terminals in accordance with the guidelines of BCAS/ICAO

e. Facilities services

1. To provide value added services to airlines, shipper/consignees such at temperature controlled reefer dolly services at airports with extreme climatic conditions; road feeder services to inland manufacturing clusters; bonded trucking services etc
2. To design and develop free trade zone including free trade warehousing zone wherever feasible
3. To provide ground handling services including ramp and passenger handling to foreign and domestic carriers at various airports
4. To develop and operate air freight stations and provide cargo handling service therein and related bonded trucking services.
5. AAI has created infrastructure / facilities Viz. State of the art centre for perishable cargo, live animal shed, strong room, hazardous cargo shed, wire mesh for vulnerable cargo, etc. to take care of special cargo.

Any exporter/importer/Customs House Agents/Airlines etc. who wish to transact electronically with AAI, would be mandatory required to get register with AAI at aaiclas-ecom.org Registration is mandatory for Message Exchange activities also.

(Ref: https://aaiclas-ecom.org/Live/DefaultCMS.aspx?LinkID=mnuFAQs)

Registration Process

User has to fill up the physical registration form along with relevant documents and submit to Airports Authority of India (AAI). AAI would ascertain the correctness of the details submitted. Users are requested to fill valid E-Mail address and phone Number (s) in registration form to enable AAI to perform further communications regarding User ID and password allocation. Users are requested to immediately change the password(s) assigned by AAI.

Non registered users are not restricted from functionalities pertaining to consignment status, charges calculation estimate sheet and cargo procedures. Same features are available for registered users. In addition, registered users enjoy the privilege of accessing functionalities related to printing of charge related documents, payment transactions and pre- deposit account related statements.

Role of Vegetable and Fruit Promotion Council Keralam (VFPCK) increation of banana based business platforms

Shanthi Anna Kurian

Deputy Manager, Vegetable and Fruit Promotion Council Keralam
Mythri Bhavan, Near Doordarshan Kendra, Kakkanad, Kochi, Kerala
Corresponding author: vfpckorg@gmail.com; Contact Number: 0484 - 2881333

Introduction

Vegetable and Fruit Promotion Council Keralam (VFPCK) is an organization under aegis of Department of Agriculture, Govt. of Kerala. VFPCK is a company registered under section 25 of Indian Companies Act 1856 and has been established to bring about overall development of fruit and vegetable sector in Kerala. Established in 2001 as the successor organization of Kerala Horticulture Development Programme (KHDP), which is managed by a team of result oriented multidisciplinary professionals. We have long- established links with farmers and have set a bench mark for sustainable and socially responsible inclusive farming, offering a win-win solution for the farming community.

The Council works through the principle of **"Self-help, Participation and Prosperity".** The vision foreseen is "**Empowered farmer groups leading the nation in reaping the fruits of self-help."**

Boosting production and export: creation of SHGs

The Council has organized **10211 Self Help groups** comprising around **208194 farmers** who have been organized, trained, facilitated and empowered to undertake all activities in respect of vegetable and fruit sector ranging from cultivation to value addition and final marketing of produce to exports. We have a well-established mechanism to implement and monitor the activities in the field. The extension methodology of office less extension followed by the Council is a good example of transferring the technology from lab to land.

The Self-Help Groups (SHGs) conceptualized by the Council form the base units for all the interventions like Extension, Rural Credit, Group Marketing, Participatory Technology Development (PTD), Value Additions and Exports. The groups comprising of 15-20 farmers inducted based on neighborhood principle enabling better resource group and management system.

Participatory credit involving the system of providing crop loans to farmers cultivating even on leased lands without any registered tenancy agreement was the first of its kind in the country. The self-help groups determine the credit requirement and credit worthiness of the member farmers. Timely credit in adequate amounts in a farmer friendly package through nationalizedbanks is the special feature of the credit policy of the Council. The technological gaps are addressed through Trainings, Participatory technology development etc. using the technical expertise of professionals engaged with the farming community. Through the concept of participatory technology development (PTD) farmers are equipped to find solutions for agricultural problems making use of farmer knowledge and latest technologies rather than thrusting institutional research findings on them.

Banana: crop to reckon with

Being the only Government organization in the state with focus on overall development of thefruit sector, VFPCK has come a long way. In Kerala banana is the most widely cultivated fruit in the state. The humid tropical climate and the rainfall distribution of Kerala make it ideal for banana cultivation. More than 50 banana varieties are grown in the state and a lot of genetic diversity of the crop is observed in the state. Though vast number of varieties is found in Kerala,not more than 10 varieties are cultivated on a commercial scale. They include Nendran, Njalippoovan, Palayamkodan, Karppooravally, Robusta, Kadali, Chenkadali, Poovan, Dwarf Cavandish, Charapoovan, Padathy, Batheesa etc. The area under banana cultivation in Kerala is increasing over the years. Banana cultivation provides employment round the year. Much ofour requirement of banana is coming from outside states. So by increasing the area under banana and also by following scientific and sustainable crop production packages, the gap between demand and supply can be filled.

The per capita land availability is only 0.2 ha. Majority of the farmers involved in banana cultivation are marginal and small farmers who take land for lease on annual or seasonal basis. There are wide varieties of banana and other plantains cultivated in Kerala. Among all the varieties Nendran stands first in area and production and is one of the few crops grown as purecrop in the state. This variety is grown in almost all the districts of the state. In addition to thisthe red banana is also cultivated extensively in the southern districts of Kerala. Banana is cultivated in two seasons, namely Dec-Jan (rain fed banana cultivation) and August -September (irrigated banana cultivation). The bananas are grown as pure crop, as inter crop, as mixed cropand as relay crop in crop rotation with other annuals. The french plantain/ Nendran banana which is the major commercial variety in Kerala is grown as pure crop and no ratooning is practiced in Nendran. Also Nendran bananas are rotated with annuals like paddy, vegetables andtapioca.

Soil Testing Labs (2 nos) with modern facilities are made available for ensuring expected growth potential in the direction of soil health improvement specially in the post flood scenarioin the state.

Helping in inputs supply and formation of clusters

Good planting material is one of the basic requirement for the establishment of a good crop. Tissue culture plant and Bio-control lab are Councils initiatives for providing quality inputs forplanting. The modern tissue culture laboratory has a capacity to produce around 5 lakh plants per year. Most popular varieties in the state like Nendran, Red banana, Grand Naine etc are raised here. The Tissue Culture Lab began its commercial operations in the year 2009. Suckersare collected from disease free high yielding varieties of banana. Explants initiation, multiplication and rooting stages in culturing are carried out in the lab. After primary and secondary hardening, the plants are offered for distribution. The tissue culture lab is equippedto produce around 5 lakh tissue culture plantlets annually. Quality planting materials, seeds andseedlings, organic manures, growth regulators, Bio control agents, grow bags, farm equipment etc. are timely provided for ensuring better yield through Krishi Business Kendra's functioningin Ernakulam, Kasaragod and Trivandrum.

The farmer markets of VFPCK are a unique marketing **system developed and established to ensure the farmers an enhanced and sustained income at farm gate**. The Swasraya Karshaka Samithis (SKS) are farmer markets for the farmers, by the farmers and of the farmers. The focus of VFPCK is to empower and facilitate the farmers to take more effective decisions with regard to the marketing of their produce. To facilitate marketing 289 **Swasraya Karshaka Samitis** are established and they trade around one lakh MT annually. At SKS, the produce is aggregated and traded through auctioning/price fixation through bargaining. Thus avoiding otherwise incurred distress sale, huge marketing costs, non-awareness of the marketing avenuesand market prices and the non-recoverable outstanding with the traders that crippled the farmers. To strengthen the supply chain trader meets are organized by the SKS. As part of expanding the platform and to increase the reach out online portal has been established providing inputs, seeds, value added products, organic farming / bioorganic products etc. For adding value for banana, a value addition unit for dehydrated ripened banana is operating in Kottayam district.

PPCs for better handling

Primary Processing centers (PPCs) 10 nos established in the Swasraya Karshaka Samithis in various districts helps to reduce the loss at farm gate. Activities like cleaning, sorting, grading, packing etc are done here.

VFPCK has been designated by the Government as the Nodal Agency for Agriculture Export promotion from the state in accordance with the institutional framework of the National Agriculture Export Policy formulated by Government of India. Several initiatives catalytic for providing an impetus in agri exports are undertaken by the Council. The activities focus on a cluster centric approach aiming at a paradigm shift from surplus oriented export to export oriented production.

Banana clusters: Case study

A comprehensive study on current technical gaps and specific infrastructure requirement for promoting exports form the state was undertaken. Banana cluster has been identified and approved under Agriculture Export Policy and the samehas been initiated in Thiruvananthapuram Thrissur and Wayanad. Farmer Producer Organizations (FPOs) and Farmer Interest Groups (FIGs) are formed in the cluster convergingthe schemes of SFAC, Agriculture Department, and NABARD etc. The farmers and officials are trained on export production protocols and year round availability of produce assured through staggered planting. Pre harvest practices like bunch covering, potassium sulphate application etc are practiced for producing better quality produce. VFPCK has established infrastructures to facilitate proper post-harvest handling activities including two pack houses, ripening chambers, cold storages, reefer vans etc. This is helpful in reducing wastages at farm gate and improves shelf life of produce as the cold chain can be maintained along the supply chain. Exit point infrastructures like Center for Perishable Cargo are promoted.

Novel export initiative of traditional bananas: Success story

A novel initiative was undertaken by VFPCK in developing a sea protocol for export of

Nendranbanana to Europe. Presently the fruits are being exported through air cargo which incurs much higher expenses and the scope for sustainability and profitability of the business is getting diminished. The sea shipment could reduce the freight cost drastically when compared with air shipments. The project was implemented with National Research Institute for Banana(NRCB) as technical partner and Krishna Traders as exporter. For the first of its kind in the state, Block chain powered Traceability was integrated in perishables through this project. A Bangalore based startup firm Trace X provided the required guidance in this regard. The data was captured using a mobile app **FOODSIGN and translated through a QR code**. The project was carried out in Thrissur district in Kerala. Activities aimed at bringing more number of banana farmers under the ambit of traceability is under progress.

The process of exporting quality Nendran banana to London port began with the identification of suitable orchards for the selection of export quality bunches. **The expert team from ICAR- NRCB, Trichy** visited the Nendran fields at various sites and identified the plots. After the identification of field, the pre-harvest bunch care management actions were provided to the farmers. Time to time plant and bunch care practices were advised like growth regulator application, using bunch sleeves, micro nutrient application and pesticide applications Both onsite and offsite trainings were given to the field officials and the farmers on the scientific handling of the banana including cultivation and bunch care management. Two off site trainingwas given to the officials on scientific cultivation and postharvest handling of the produce. Besides training was also given about the block chain development, input applications, online monitoring by the experts from TraceX. Harvest was conducted following scientific practices involving skilled labourers from Theni. Post-harvest activities were carried out at the pack house at Nadukkara under VAFPCL. All these activities were carried out under the strict monitoring of NRCB.

A consignment of 5460kg, was shipped on a 20' reefer container from Cochin port to London Gateway port on a direct vessel X-PRESS ANNAPURNA 2103W on 10th March 2021. The scheduled travel days to destination were 25 days, but due to congestion in the port due to theunexpected blockage in the Suez Canal have delayed the travel days by another l0 days. The trial was successfully completed which has boosted the confidence of other exporters to come forward for export by sea and thereby enhancing the self-confidence of lots of farmers to comeforward for large scale farming.

VFPCK interventions from seed to marketing and exports facilitates the farming community engaged in fruit and vegetable sector to attain sustainability through better incomes and improved standards of living.

IV
Policies and schemes in Government sector to promote trade

Policies and schemes for improved production and post-harvest handling of Banana - The National Horticulture Board (NHB)

Raja B

National Horticulture Board
Ministry of Agriculture & Farmers Welfare, Govt. of India
Plot no; 85, Sector - 18, Institutional Area, Gurugram, Haryana
Corresponding author: jd.south.nhb@gov.in; 0124 - 2342992

Introduction

The National Horticulture Board (NHB) was set up by the Government of India in 1984 as an Autonomous organization under the administrative control of Ministry of Agriculture and Farmers Welfare and registered as a society under Societies Registration Act with its headquarters at Gurugram. Presently, NHB has 29 field offices located all over the country. The broad aims and objectives of the Board are to develop production clusters/hubs for integrated Hi-tech commercial horticulture, development of Post-harvest and cold chain infrastructure, ensuring availability of quality planting material and to promote adoption of new technologies/tools/ techniques for Hi-tech commercial horticulture etc.

Aims & objectives of NHB schemes

The main objectives of the NHB are to improve integrated development of Horticulture industry and to help in coordinating, sustaining the production and processing of fruits and vegetables. Detailed objectives of the Board are as under:-

1. Development of hi-tech commercial horticulture in identified belts and make such areas vibrant with horticultural activity, which in turn will act as hubs for development of horticulture.
2. Development of modern post-harvest management infrastructure as an integral part of area expansion projects or as common facility for cluster of projects.
3. Development of integrated, energy efficient cold chain infrastructure for fresh horticulture produce.
4. Popularization of identified new technologies / tools / techniques for commercialization / adoption, after carrying out technology and need assessment.
5. Assistance in securing availability of quality planting material by promoting setting up of scion and root stock banks / mother plant nurseries and carrying out accreditation / rating of horticulture nurseries and need based imports of planting material.
6. Promotion and market development of fresh horticulture produce.
7. Promotion of field trials of newly developed/imported planting materials and other farm inputs; production technology; PHM protocols, INM and IPM protocols and promotion of applied R&D programmes for commercialization of proven technology.
8. Promotion of Farm Mechanization in Horticulture through demonstration and its uses at farmers field level to reduce labour cost and increase the productivity of Horticulture crops.

9. Promotion of applied R & D for standardizing PHM protocols, prescribing critical storage conditions for fresh horticulture produce, bench marking of technical standards for cold chain infrastructure etc.
10. Transfer of technology to producers/farmers and service providers such as gardeners, nurserymen, farm level skilled workers, operators in cold storages, work force carrying out post-harvest management including processing of fresh horticulture produce and to the master trainers.
11. Promotion of consumption of horticulture produce and products.
12. Promoting long distance transport solution for bulk movement of horticulture produce through rail etc.
13. Carrying out studies and surveys to identify constraints and develop short and long term strategies for systematic development of horticulture and providing technical services including advisory and consultancy services.

Scheme No: I Development of commercial horticulture through production and post-harvest management of horticulture crops

1.1 Commercial Horticulture Development in open field conditions on project mode

Activities: open field conditions on project mode, including components viz., planting material, plantation, 2irrigation, fertigation, mechanization, precision farming, GAP, land development, store room and labour quarters etc., for projects covering area above 2.00 ha. (5 Acres).

Pattern of assistance: Credit linked back-ended subsidy @ 40% of the total project cost limited to Rs 30.00 lakh per project in general areas.

Eligible Crops: Aonla, Almond, Apple, Apricot, Banana, Ber, Lime, Lemon, Mandarin orange, Sweet orange, Custard apple, Fig,Grapes, Guava, Kiwi, Mango, Papaya, Passion Fruit, Peach, Pear, Pineapple, Plum, Pomegranate, Sapota, Strawberry, Walnut, Jack fruit, Cashewnut, Coconut, Olive, Datepalm, Black pepper, Cardamom, Citronella, Giranium, Stevia, Palmorasa, Mint, Celery and Tamarind.

1.2 Commercial Horticulture Development in protected cover on project mode (Poly House and Net House)

Activities: Projects under protected cover on project mode including components viz planting material, plantation, irrigation, fertigation, mechanization, etc for projects having area over 2500 sq metre.

Crops eligible: a. **Flowers**: Anthurium, Orchids, Rose, Lilium, Chrysanthemum, Carnation and Gerbera. b. **Vegetables**: High value vegetables: Capsicum, Cucumber, Tomato.

Pattern of assistance: Credit linked back-ended subsidy @ 50% of the total project cost limited to Rs 56.00 lakh per project as per admissible cost norms for green houses, shade net house, plastic tunnel, anti-bird /hail nets & cost of planting material etc.

1.3 Integrated Post Harvest Management projects

Activities: Projects relating to Pack House, Ripening Chamber, Refer Van, Retail Outlets, Pre-cooling unit, Primary processing etc.

Pattern of assistance: Credit linked back-ended subsidy @ 35% of the total project cost limited to Rs 50.75 lakh per project in general area.

Cost Norm:- Pack House Rs 4 Lakh/unit with 9MX6M @ 50% subsidy, Integrated pack house Rs 50 Lakh/unit with 9MX18M @ 35% subsidy Ripening Chamber- Rs 1 Lakh/MT @ 35% subsidy, Refer Van- Rs 25 Lakh @ 35% subsidy, Retail Outlets - Rs 15 Lakh/unit @ 35% subsidy, Pre-cooling unit - Rs 25 Lakh/6MT @ 35% subsidy, Cold room- Rs 15 Lakh/30MT @ 35% subsidy primary processing- Rs 25 Lakh/unit @ 35% subsidy

Scheme No: II Capital Investment subsidy scheme for construction/expansion/ modernization of cold storage facilities for Horticulture Produce.

Components & Capacity: Credit linked projects relating to Cold Storages including Controlled Atmosphere (CA) and their modernization are eligible for assistance under this component and storage capacity above 5001 MT up to 10000 MT.

Pattern of Assistance: The assistance will be given as subsidy @ 35% of the capital cost of project in general areas.

Cost Norms:

S. No	Description	Cost Norms
1.	Cold storage units Type 1 - basic mezzanine structure with large chamber of > 250 MT) type with single temperature zone	• @ Rs. 8000/ MT for capacity upto 5000 MT. • @ Rs. 7600/ MT for capacity between 5001 to 6500 MT. • @ Rs. 7200/MT for capacity between 6501 to 8000 MT. • @ Rs. 6800/MT for capacity between 8001 to 10000 MT.
2.	Cold storage units Type 2 - Pre Engineering Building (PEB) Type for multiple temperature and product use , more than 6 chambers of less than 250 MT and basic material handling equipment	• @ Rs. 10000/ MT for capacity upto 5000 MT. • @ Rs. 9500/ MT for capacity between 5001 to 6500 MT. • @ Rs.9000/MT for capacity between 6501 to 8000 MT. • @ Rs.8500/MT for capacity between 8001 to 10000 MT.

Subject: Revision in the scheme guidelines of NHB, including its implementation design, documentation and sanctioning process

This is in continuation to the previous Circulars/Orders issued by NHB from time to time with regard to amendments in the Scheme Guidelines of NHB. The scheme guidelines of NHB including its implementation design, documentation and sanctioning process etc. have further been reviewed and with the approval of competent authority, it has been decided to effect following changes w.e.f. 01.01.2023:-

1. NHB will do away with two stage system of IPA and GoC. Now IPA will not be needed for availing benefit under the Scheme of NHB and applicant will apply straightaway for Grant of Clearance (GoC) to NHB after sanction of term loan by bank. The term loan sanctioned within 3 months from the date of online GoC application to NHB shall be treated valid, however, disbursement of term loan and start of project will be allowed only after issuance of GoC by NHB. GoC will be valid for 3 months for getting disbursement of first installment of term loan and start of project. Accordingly, the applications in NHB will be dealt in the following manner:

a. IPA system will be discontinued from 01.01.2023 and thereafter NHB shall accept applications only for Grant of Clearance with required documents.
b. IPA/GoC applications received prior to 1.1.2023 will be considered as per existing system.

2. The processing of GoC application will be completely digital, including examination and sanction of GoC application. The platform will be augmented with the timeline monitoring systems so that every step can be monitored as per the pre-set target timelines and alerts can be sent to the processing officer/applicant at regular intervals and escalation matrix can be put in place based on ageing analysis of pendency at officer level.
3. Before making a new GoC Application online on the Web-Portal of NHB, the applicant will have to register after Aadhar authentication through OTP verification. Applicant will be given an option at NHB portal and in case loan for the proposed project is sanctioned under Agri-Infra Fund (AIF) Scheme, the entire loan data of the applicant will be captured as such from AIF portal through API and only remaining details would be required to be filled in by the applicant online and saved at NHB Portal to complete the GoC application of NHB. In case loan is not sanctioned under AIF, the complete application form will have to filled up by the applicant.
4. NHB has prescribed a new short template for DPR and Bank appraisal note (Annexure-I). The template is indicative and applicant/bank must ensure that the components mentioned in the template are invariably included in DPR or appraisal note, as the case may be.
5. The applicant will have to submit following documents along with the application for grant of clearance: - a. Details Project Report (DPR) and the information suggested in the NHB's prescribed template will only be mandatory. b. Project Land Document along with non-encumbrance certificate c. Bank Sanction letter d. Bank Appraisal Note e. Undertaking (will be part of Application Form in the prescribed format)
6. After application is submitted, an email will be sent to the applicant along with a reply/confirmation link to the financing bank. Concerned bank need to confirm the authenticity of documents online. Based on the confirmation of documents by the bank e.g. bank sanction letter, appraisal note and land documents etc., NHB will issue GoC.
7. Queries on GoC applications, if any, will be communicated to the applicant Bank automatically by system/email by the concerned division within 15 days from the date of receipt of hard copy of the application/documents/bank documents and get the reply from applicant/bank within 15 days and place the application to the approving authority for decision. GoC will be issued by NHB within a period of two months positively.
8. Subsidy claim documents will also be submitted by bank/applicant online.
9. Technical Data sheet for Cold Storages and Protected Structure will be a part of DPR and instead of their appraisal by NCCD or any other agency, it will be mentioned in the GoC Letter that applicant will construct the cold storage/green house as per extant standards/ specifications prescribed by NHB. Similarly, Registration certificate/Deed in case of legal entity will be a part of DPR.
10. NHB shall rely upon financing banks for the examination of project documents.

For more details visit website: **www.nhb.gov.in**

Role of public sector banks (PSBs) in creation of banana based business platforms

Senthil T

Technical Officer
State Bank of India, Zonal Office, Trichy, Tamil Nadu
Corresponding author: sbi.00930@sbi.co.in; SENTHIL.T@sbi.co.in; 9445866399

Introduction

Indian economy is emerging as one of the fastest growing economy compare to other developing nations. At the same time the growth of economy is largely affected especially more in agriculture sector; the one which contributes more than the other sectors. In order to maintain the steady growth in the economy the performance in the agriculture sector should be catalyzed. **Banks are playing a crucial role in economic development of developing country like India**.

India is an agricultural country. The majority of its population depends upon agriculture. India is one of the world's largest producers of farm commodities, and the second largest producer of fruits and vegetables. Agriculture accounts for about 14.7 percent of the country's total export earnings. It contributes 34.2 percent of the National income. The Government encourages cultivation of horticultural crops like banana, mango, flowers, vegetables etc., so as to increase the contribution of agriculture to the National Income and to augment the farmers' own income.

The contribution of banking and financial sector to the agriculture and rural development is very significant. Profile of rural areas indicates that major source of credit id from informal sector like money lenders with high rates of interest. So, to avoid such an adverse effect to the farmers several reforms in the commercial banking system made in **procedural and transactional bottlenecks including elimination of service area approach**, **reducing margins, redefining overdue to coincide with crop cycles, new debt restructuring policies**, one time settlement and relief measures. In the agricultural sector is an important source of income to small/ marginal farmers and agriculture laborer's. Thus, there is a great scope for increasing the agriculture and rural development growth by providing the banking services.

Agricultural credit

Agricultural credit clearly started to grow after banks nationalization and it has been grown continuously since then. Bank credit is available to the farmers in the form of short term credit for working capital for agri activities and in the form of medium / long term credit for financing capital investment in agri activities like crop cultivation and maintenance, organic farming, horticultural farming, farm mechanization, cold storage and Farmer Producers Company etc. **Loans are available for storage, processing and marketing of value added products. The credit is disbursed through a multiagency network of Commercial Banks (CBs) Regional Rural Banks (RRBs) and Cooperatives.**

There is a need to increase the average ticket size of the **Agri advance**, for which the only way is to source high value investment credit proposals. Indian agriculture is at an inflection point. The $ 370 billion sector is set to undergo a complete "**uberisation**" thanks to the disruptive technology, agri reforms and changing production/consumption patterns. With the advent of the

three agriculture focused Reform Bills in September'20 and generous external funding, India received about $1 billion in Agri-tech funding between 2017 to 2020 - major disruptions across the agricultural value chain are the natural fall-out. While the response of the investor community to many agri fine techs has been very encouraging, further investment is required to popularize the use of latest technologies in agriculture, like precision farming, AI, etc. Allied agriculture activities also require huge investments for creation of infrastructure and establishment of both backward and forward linkages.

Commercial bank norms for agricultural credits

Eligibility

All Farmers - Individuals / Joint borrowers who are owner cultivators, tenant farmers, oral lessees (Rights on land belonging to other) & sharecroppers. The farmers in such cases, should furnish to the Bank satisfactory evidence to the effect having cultivated the land), SHGs or Joint Liability Groups of Farmers including tenant farmers, sharecroppers etc. also eligible.

Type of Credits

(1) Short Term Loan / Working Capital Advance / Credit

To meet short term credit requirements for cultivation of crops, post-harvest expenses, consumption requirements of farmer household, working capital for maintenance of farm assets and activities allied to Agriculture, like dairy animals, inland fishery etc

(2) Medium Term Loan

To meet out the expenses for investment / Fixed Capital purposes like purchase of farm machineries, processing of agri and by products and should be repaid in 2-5 years.

(3) Long Term Loan

To meet out the long term investment purposes like horticultural farming, cold storage, rural godown and to start the farming at large size. Repayable for more than 5 years.

Applying for Loan

The farmers should apply to the nearest branch of a commercial bank, regional rural bank or co-operative bank in their area of operation with the prescribed application form at the branch level.

Experience of the Beneficiaries

The beneficiaries should have adequate experience on the activity that they proposed to undertake and if possible banks are advising the beneficiaries to visit progressive Livestock / poultry farms either private / govt. farms. A good practical training and experience in livestock activity will be desirable.

Ambience of the proposed activity

The application should include information on land, crop and availability of water, marketing aspects and training facilities, experience of the farmer and the type of assistance available from state govt. or any other society should be noted in the application itself.

Project report

It is mandatory to have a project report if the activity is to be newly started at a large scale with the main facts like total cost of the project, margin money to be provided by the beneficiary, required amount of loan, Income and expense statement, Profit and Loss statement, repayment schedule etc.,

Assessment of loan limit by bank

The prepared project report should be submitted to the nearest branch of the bank. The bank officials will assess the vitality of the proposed project report by studying the technical feasibility and by economic viability

Sanction of bank loan and its disbursement

After ensuring the technical and economic viability, the scheme is sanctioned by the bank. The loan is disbursed in kind in 2 to 3 stages against creation of specific assets such as construction of sheds, purchase of equipment and machineries, purchase of animals and recurring cost on purchase of feed and fodder for the initial period of one / two months. The end use of funds is verified and constant follow up is done by the bank.

Lending terms - General

Outlay

Outlay of the project depends on the local conditions, unit size and the components included in the project. Prevailing market prices may be considered to arrive at the outlay.

Margin Money

Margin money depends on the category of the borrowers and range from 5 to 25%.

Interest Rate

Banks are free to decide the rates of interest within the overall guidelines. However, for working out the financial viability and bankability of the model projects taking the current interest rates of the banks would be necessary.

Security

Security may be obtained like primary security /charges over the assets which are created. Collateral in the form of movable or immovable or combination thereof. In some necessary cases, third party guarantee also required.

Repayment period of loan

Repayment period depends upon the gross surplus in the scheme. The loan will be repaid in suitable monthly/quarterly installments usually within a period of five to seven years.

Insurance

The crop and capital assets may be insured annually or on long term master policy, where ever is applicable.

Project approach and financial analysis

Project

Project in general is a plan of action, having specific objective(s), systematically worked out to achieve the objectives within a specified time frame. From the angle of lending, project is defined as: - Project is an investment activity, where money would be spent either for acquiring or for creation of assets so as to perform economic activities in order to derive benefits for several years.

It is clear from the definition that the projects derive benefit for several years which means that an investment which derives benefit in short span only, like meeting the cultivation expenses of crops or working capital requirement of an activity, is not a covered under project financing.

Examples of project in agricultural and rural sectors:

- Minor Irrigation
- Dairy
- Farm mechanization
- Horticulture
- Handloom Weavers etc.,

Each and every project may have its own unique profile, in terms of their:

- Objective
- Investment involved or outlay of funds
- The capital assets acquired or created
- Geographical area where it is proposed to be implemented
- Clientele which it is intended to reach
- The point of time the investment is made
- The point of time the benefits accrue: How much and when? etc.

Project approach

It is an integrated approach f or lending, taking into careful consideration, all the aspects of the project. Projects are carefully prepared and reviewed as well, before parting with the funds, so as to avoid wasteful expenditure.

The steps to be followed in lending by project approach are as under:

1. Identification of the project
2. Preparation of project report
3. Appraisal of the project report
4. Implementation
5. Periodical evaluation

Schemes available for banana based business

Kisan credit card

To meet short term credit requirements for cultivation of banana, post-harvest expenses, consumption requirements of farmer household, working capital for maintenance of farm assets.

Farm mechanization

To meet the cost of farm machineries used for banana cultivation/Tractor, accessories and implements including registration and insurance charges.

Financing cold storage

In order to minimize the postharvest losses and arrest wide scale price fluctuations in prices of banana/horticultural produce, National Horticulture Board (NHB) had introduced a capital investment subsidy scheme for construction of cold storage for storing of horticultural crops. This Capital Investment Subsidy Scheme is being implemented only in those states / union territories / areas which do not administer or control rental of cold storages. This scheme covers Controlled Atmosphere (CA) storages also.

Organic banana farming

While Green Revolution has helped the country to overcome food shortages, chemical based farm packages left behind ecological and environmental problems in the form of degradation of soil, declining bio-diversity, polluted water bodies, and harmful effects on bodies of humans, animals and other flora & fauna by way of residues. It is very important for India to initiate long term policy measures for making our farm sector viable and sustainable to face competition from the health and quality conscious international/domestic market. By financing the organic farming, we are helping the country and the farmers to have sustainable agriculture in the long run. Emerging business opportunities in domestic and international markets. Risk mitigation –present farm crops and production practices are cost intensive and associated with high risks. In the event of failure of crop, debt burden will be unbearable for farmers.

Agriculture Infrastructure Fund (AIF) scheme under Atma Nirbhar Bharat Abhiyan

As a part of Prime Minister's Atmanirbhar Bharat Abhiyan and with a view to strengthen the post-harvest management infrastructure through capital investment in agriculture, GoI has announced a stimulus package for setting up an "Agriculture Infrastructure Fund (AIF)" scheme with an outlay of Rs. 1,00,000 Cr. The AIF scheme will be implemented by the Department of Agriculture, Cooperation and Farmers' Welfare (DAC & FW). The scheme will be operational from 2020-21 to 2029-30

- The objectives of AIF scheme are to enhance post-harvest management infrastructure for reduction of food wastage, and to provide impetus to capital investment in Agriculture besides creating employment.

Target groups

Primary Agricultural Credit Societies (PACS), Marketing Cooperative Societies, Farmer Producers Organizations (FPOs), Self Help Group (SHG), Farmers, Joint Liability Groups (JLG), Multipurpose Cooperative Societies, Agri-entrepreneurs, Startups and Central/State agency or Local Body sponsored Public Private Partnership Projects for funding Agriculture Infrastructure Projects at farm-gate & aggregation points.

- The scheme will facilitate setting up and modernization of key elements of the value chain including (A) Post-Harvest Management Projects like: (i) Supply chain services including e-marketing platforms. (ii) Warehouse (iii) Silos (iv) Pack houses (v) Assaying Units (vi) Sorting & Grading Units (vii) Cold Chains (viii) Logistic facilities (ix) Primary processing centers (x) Ripening chambers. (B) Viable projects for building community farming assets including :- (i) Organic Input production (ii) Bio stimulant production units (iii) Projects identified for providing supply chain infrastructure for clusters of crops including export clusters. (iv) Projects promoted by Central / State / Local Governments or their agencies under PPP for building community farming assets or post-harvest management projects.
- There is no minimum or maximum loan limit stipulated under the scheme. However, the maximum loan quantum on which the interest subvention and credit guarantee in eligible cases available up to loan limit of Rs. 2 Cr.

Agri marketing infrastructure

To develop Agricultural Marketing Infrastructure including Storage Infrastructure in agricultural and allied sector; To promote innovative and latest technologies in post-harvest and agricultural marketing infrastructure; To develop alternative & competitive Agri. marketing channels; To benefit the farmers individually and collectively through FPOs through small size processing units; To incentivize developing and upgrading of Gramin Haats as GrAMs to make better farmer-consumer market linkages and also to assist in integration GrAMs with e- NAM portal; To provide infrastructure facilities for grading, standardization and quality certification of agricultural and allied produce; and To promote Integrated Value Chains through minimal processing /value addition

Farmers Producer Companies

Farmer producer company (FPC) is a company incorporated under **section 581** of Indian Company Act formed by ten for more individuals, each of them being a producer, or any two or more producer companies or any other institution having only producers or producer companies as its members or a combination of ten or more individuals and producer institutions.

- Production, harvesting, procurement, grading, pooling, handling, marketing, selling, export of primary produce of members or import of goods for services for their benefit. Processing including preserving, drying, distilling, brewing, venting, canning and packaging of produce of its members and Manufacture, sale or supply of machinery, equipment or consumables mainly to its members
- Every producer company is to have five to 15 directors including a full time non-producer Chief Executive Officer (CEO) appointed by the board to act as ex-officio director who is not liable to retire by rotation. He will be entrusted with substantial power of management as the board may determine. Majority of directors should be from producer members will initially receive only such value for the produce or products pooled and supplied as the directors may determine. The withheld amount may be disbursed later either in cash or in kind or by allotment of equity shares.

- Depending upon cash accruals, members shall be eligible to receive bonus shares. There is also a provision for distribution of patronage bonus i. e payment out of surplus income to member producers in proportion to their respective patronage (not shareholding). Patronage, in turn, is defined as the use of services offered by producer companies to their members by participation in their business activities.

PM Formalization of Micro Food processing Enterprises scheme

As a part of Prime Minister's Atmanirbhar Bharat Abhiyan and with a view to provide credit linked subsidy to upgrade existing food processing enterprises and undertake new units, Ministry of Food Processing Industries (MoFPI) has launched a Centrally Sponsored scheme "PM Formalization of Micro Food Processing Enterprises . The scheme envisages an outlay of Rs 10,000 crores over a period of five years from 2020-21 to 2024 - 25.

- The objectives of scheme are to build capability of micro enterprises to enable: Increased access to credit by existing micro food processing entrepreneurs, FPOs, Self Help Groups and Co-operatives; Integration with organized supply chain by strengthening branding & marketing; Support for transition of existing 2,00,000 enterprises into formal framework; Increased access to common services like common processing facility, laboratories, storage, packaging, marketing and incubation services; Strengthening of institutions, research and training in the food processing sector; and Increased access for the enterprises, to professional and technical support.

Role of public sector banks (PSBs) in creation of Banana based business platforms

Rajasekar N

Assistant General Manager
MSME Department, Indian Overseas Bank, Central office, Chennai, Tamil Nadu
Corresponding author: sekar.narayan@gmail.com; 9626663444

Introduction

Supply of credit is an important factor in agriculture. After nationalisation of major banks, the country followed the policy of social and developmental banking. The role and objective of the public sector banking shall be the social cause and not solely motivated by financial gains and profitability. As a result, public sector banks played a major role as an important source of finance to agriculture. The flow of increased and liberalised credit to agriculture sector by the public sector banks led to agricultural growth in India which was unparalleled till then. Bank credit to agriculture saw a significant increase owing to direct and indirect finance to agriculture.

The spurt in the credit to agriculture is also due to the change in definitions of lending to agricultural sector besides corporatisation and urbanisation of agro credit. The growing shift towards loans with large credit limits are closely related to changes in official policy on agriculture in our country, which increasingly favours the growth of a capital-intensive and export-oriented production pattern in agriculture and corporatization and urbanization of agriculture.

Advances/ credit facilities to food / agro based units

New and existing Food and Agro based processing units can avail the following type of credit facilities to meet their short term and long-term credit requirements. Constituents like Individual, Proprietorship firms, Partnership concerns, Private limited and Public Limited companies, Limited Liability Partnership Concerns, SHGs/ FPOs/ Cooperatives are eligible to avail credit facilities.

Types of credit facilities

- Fund based Working Capital Finance like Overdraft / Cash Credit against stocks
- Non-Fund based Working Capital Finance like Letter of Credit and Bank Guarantee.
- Cash Credit against warehouse Receipts.
- Term loan for purchase of new / second-hand machinery, equipments, expansion of existing unit, establishment of new unit.
- Term loan for construction/renovation of factory building.
- Composite Loan (Combination of Working capital and Term loan)
- Working Capital Term Loan (WCTL) - To provide one-time core working capital assistance to deserving units in the form of working capital term loan
- Export Credit facilities like Packing Credit (Pre-Shipment Credit) and Bill Discounting (Post-Shipment Credit)

Repayment period

Working capital finance - Twelve months subject to annual renewal as per extant guidelines.

Term loans - Based on life cycle of the project, on the cash flows, on ballooning basis, or as bullet payment or in EMI. Maximum period of 120 months allowed

Working capital term loan limits - WCTL to be repaid in maximum 84 monthly instalments inclusive of moratorium period in line with the projected cash flow.

Export credit facilities available to Banana based business

Export Credit is of two types,

1. Pre-Shipment Credit.
2. Post-Shipment Credit.

Pre-shipment export credit

Pre-shipment credit is also known as **'Packing credit'** is a loan granted to an exporter for financing the purchase, processing, manufacturing or packing of goods prior to shipment. Packing credit can also be extended as working capital assistance to meet expenses such as wages, utility payments, travel expenses etc., to companies engaged in export. Packing credit is sanctioned on the basis of letter of credit or a confirmed and irrevocable order for the export of goods from India or any other evidence of an order for export from India.

Purchase of raw materials, processing, packing, transportation and warehousing of goods meant for export has two essential features, i.e., Existence of an export order and/or letter of credit and liquidation of the packing credit by submission of export documents within a stipulated period.

Post-shipment export credit

'Post-shipment Credit' means any loan or advance granted by a bank to an exporter of goods from India from the date of extending credit after shipment of goods to the date of realisation of export proceeds as per the period of realization prescribed by Reserve Bank of India (RBI) and includes any loan or advance granted to an exporter, in consideration of, or on the security of any duty drawback allowed by the Government from time to time. As per extant guidelines of RBI, the period prescribed for realisation of export proceeds is 12 months from the date of shipment.

Types of credit facilities under export credit

- Packing Credit in Rupees.
- Packing Credit in Foreign Currency.
- Letters of credit/Guarantees for procurement of materials for export.
- Purchase of Export Documents under confirmed order.
- Discounting of Export documents under L/C or confirmed order.
- Negotiation of bills under L/C.

- Export Bills purchase / discounting in Foreign Currency.

NABARD's direct term loan to Units located at Designated Food Parks (DFPs)

NABARD is providing direct term loans at affordable rates of interest to Designated Food Parks (DFPs) and food processing units in the identified 296 DFPs to develop the food processing sector on a cluster basis in the country and to reduce wastage of agricultural produce.

NABARD extend loans for:

- Setting up of individual food processing units or any other unit that is established for supporting the operations of the food processing units within the DFPs.
- Modernization of existing processing units in the DFPs resulting in process technology upgradation, automation, increased efficiency, improvement in product quality, reduction in costs, etc.

Role of ECGC in credit insurance

The Export Credit Guarantee Corporation of India Limited (ECGC) is a company wholly owned by the Government of India. It provides export credit insurance support to Indian exporters and is controlled by the Ministry of Commerce.

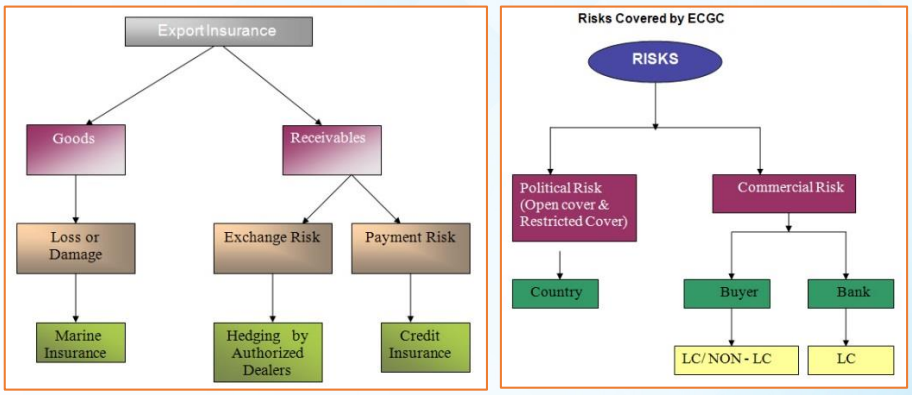
Export credit insurance

Credit Insurance protect exporters against Credit Risk losses in export of goods. ECGC Provides credit risk covers to Exporters against non-payment risks of the overseas buyers / buyer's country in respect of the exports made. It covers non- payment as a result of insolvency of the buyer or non-payment after an agreed number of months after the due date. It may also insure the risk of non – payment following an event outside the control of the buyer or seller (political risk cover), for eg. The risk that money cannot be transferred from one country to another.

Export credit insurance is designed to protect the exporters from the consequences of the payment risks like political risk and commercial risk enabling them to expand their overseas business without fear or loss. It also protects banks against risks of non-payment by exporters. Bank's export credit portfolio is insured under Export Credit Insurance for Banks Guarantee Scheme.

Recently, ECGC has introduced a new scheme to provide enhanced export credit risk insurance cover to the extent of 90% to support small exporters under the Export Credit Insurance for Banks Whole Turnover Packaging Credit and Post Shipment (ECIB- WTPC & PS).

The enhanced cover shall be available for exporters availing fund-based export credit working capital limit up to ₹ 20 crore (i.e., total Pre-shipment and Post-Shipment limit per exporter). The scheme is expected to benefit many small-scale exporters availing export credit with banks which hold the ECGC WT-ECIB covers. This will also enable the small exporters to explore new markets/new buyers and diversify their existing product portfolio competitively.



MSME Sector

The new classification and definition for MSME has come into effect from 1st July, 2020, under Aatma Nirbhar Bharat package. The earlier criteria of classification of MSMEs under MSMED Act, 2006 were based on investment in plant and machinery / equipment. It was different for manufacturing and service units. It was also very low in terms of financial limits. As a result, a new composite classification for manufacturing and service units has been notified on 26.06.2020, to facilitate the present and prospective entrepreneurs. Now, there will be no difference between manufacturing and service sectors. Also, a new criterion of turnover has been added in the previous criterion of classification based only on investment in plant and machinery. The new criteria are expected to bring about many benefits that will aid MSMEs to grow in size. It has also been decided that the turnover with respect to exports will not be counted in the limits of turnover for any category of MSME units whether micro, small or medium. This is yet another step towards ease of doing business. This will help in attracting investments and creating more jobs in the MSME sector. The change in criteria of classifying the MSMEs is set to offer major relief to the exporters.

Credit growth to the Ministry of Micro, Small & Medium Enterprises (MSME) sector has expanded by Rs 52,800 crore in the current financial 2022-23 year against de-growth of Rs 61,000 crore during the similar period of the previous year. Overall credit growth has gained further traction over the previous fiscal and has recorded a three-year high growth of 14 per cent as of mid-July 2022. Retail loans during the period expanded by Rs 1.34 lakh crore against de-growth of Rs 26,500 crore last year (SBI Research, Ecowrap). Supply Chain Finance (SCF) refers to technology-based solutions to lower financing costs and increase business efficiency for buyers and sellers in a sales transaction. It helps them by bridging financial gaps and providing desperately needed liquidity. Banks have limited their exposure to MSMEs due to the high cost of service and the risk of lending without

adequate collateral. Credit risk assessment is complex for lenders due to a lack of structured financial information, historical cash flow position, repayment trends data, etc. For MSMEs, the direct result of this credit gap is a vicious cycle of high costs, low profitability, stunted growth, and an inability to withstand even minor economic shocks. This is where obtaining low-cost financing nature of SCF comes into play in bridging the trust gap by providing lenders additional tools to manage credit risk and expand the scope of financing to include large pools of poorly understood MSMEs.

Conclusion

Thus, credit flow is an important aspect for development of food and processing industries and export. NABARD system is exclusively for agricultural and food processing-based ventures and EXIM system is exclusively for export-based ventures. Ensuring availability of adequate credit to the food processing industries is given utmost importance by the Reserve Bank of India. Accordingly, the Reserve Bank has accorded priority sector status to food processing industry. Loans to food and agro-based processing units and cold chain have been classified under agricultural activities for priority sector lending. Loans for food and agro-processing up to an aggregate sanctioned limit of ₹100 crore per borrower from the banking system is considered as priority sector. Apart from this, credit for developing agricultural infrastructure is also categorised under priority sector lending. Accordingly, loans provided for construction of storage facilities (warehouse, market yards, godowns and silos), including cold storage units / cold storage chains designed to store agricultural produce/ products comes under the priority sector lending, as also loans to MSMEs involved in food processing.

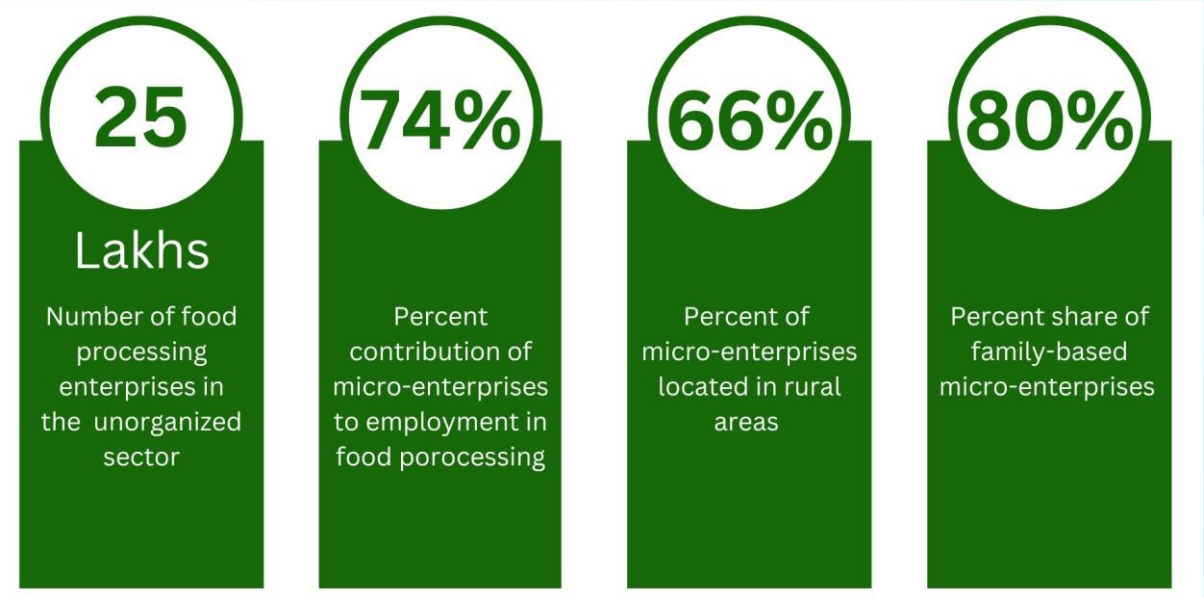
Pradhan Mantri Formalization of Micro Food Processing Enterprises (PMFME) Scheme: Making India "Aatmanirbhar" in food processing

Vibhor Sharma

PMFME Media and PR Division
Ministry of Food Processing Industries, Government of India
Corresponding Author: vibhor.sharma@nic.in; 7011768506

Industry insights

India's food economy, in many respects, mirrors the country's rich regional, cultural, and agricultural diversity. From sweets to cereals, from vegetables to fruits, from pickles to herbs, from traditional confectionaries to local drinks, from meat and poultry to aquatic products, the national food map of India reflects the country's rich civilizational history.

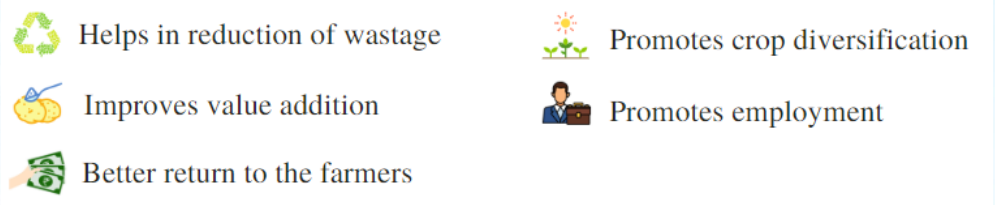


Challenges

The micro food processing sector faces several challenges including the high cost of institutional credit, lack of access to modern technology, and value addition opportunities. Other challenges being faced by this segment are lack of awareness about food safety standards, lack of market knowledge, and lack of branding and marketing for their produce. A large number of unskilled manpower also pose challenges to micro-enterprises.

How can food processing help?

A well-developed food processing sector:



Glimpse of the food processing sector

During the last 5 years ending 2019-20, the Food Processing sector has been growing at an Average Annual Growth Rate (AAGR) of around 11.18 percent. The sector constituted as much as 9.87 percent and 11.38 percent of GVA (Gross Value Added) in the Manufacturing and Agriculture sectors respectively in 2019-20.

A boon for the nation

This sector is also capable of addressing critical issues of food security, food inflation, and providing wholesome, nutritious food to the masses. The food processing sector is one of the important segments of the Indian economy in terms of its contribution to GDP, employment, and investment.

PMFME scheme: The first-ever scheme to upgrade and support the micro-enterprises in the food processing sector

A snapshot

Pradhan Mantri Formalisation of Micro food processing Enterprises (PMFME) Scheme was launched on 29th June, 2020 by the Ministry of Food Processing Industries, Government of India under the Aatmanirbhar Bharat Abhiyan and is to be implemented for a period of five years from 2020-21 to 2024-25 with an outlay of Rs. 10,000 Crore. The PMFME Scheme seeks to support micro food processing enterprises through a package of support and services. These include:

1. Financial support for setting up a new food processing unit or upgradation of an existing unit
2. Subsidy available under the scheme may be clubbed with interest subvention/non-overlapping components of other Government of India schemes or top-up provided by various State Governments
3. Training & capacity building support
4. Support to Farmer Producer Organizations (FPOs), Self Help Groups (SHGs), and Producers Cooperatives along their entire value chain
5. Support for transition of existing enterprises into formal framework for registration under regulatory framework and compliance
6. Marketing support for their integration with the organized supply chain

Scheme benefits for all

1. Disbursement of credit linked subsidy to existing and new micro-enterprises.
2. The transition of existing unorganized enterprises into formal frameworks.
3. Increased access to credit for existing and new micro food processing entrepreneurs, women entrepreneurs, and entrepreneurs in Aspirational Districts.
4. Expected to generate skilled and semi-skilled jobs at the local level.
5. Increased access to common services like food testing, storage facilities, and access to high-end machinery, technologies, and incubation services.
6. Increase in turnover and better integration of existing micro-enterprises with the organized markets.

Support to food processing units

1. Credit linked grant @35% of the project cost with maximum grant up to Rs. 10 lakhs to unorganised food processing units for upgradation or setting up of a new unit
2. Credit linked subsidy @35% of eligible project cost with a maximum ceiling of Rs.3.00 Crore can be availed under Common Infrastructure
3. Seed capital @Rs. 40,000/- per member to those engaged in food processing as working capital and for the purchase of small tools
4. Support for Branding and Marketing to FPO/SHG/cooperative or an SPV, up to 50% of the total expenditure with maximum limit as prescribed for the development of State/regional level brands
5. Training and Capacity Building support to individual micro-food processing entrepreneurs (both new and existing food processing entrepreneurs) & members of SHGs/ FPOs/Cooperatives receiving credit link subsidy under the PMFME Scheme and beneficiaries benefitted under Seed Capital and Marketing & Branding component

Eligible beneficiaries for support

1. Individual Category - (Support for New and Existing Micro Enterprise) Individual/ Proprietorship/Partnership/FPO/NGO/SHG/Co-op/ Pvt. Ltd Companies
2. Seed Capital Support - Self Help Groups
3. Common Infrastructure - FPOs/SHGs/Producer Cooperatives/Government Agencies

To avail the benefits under the PMFME Scheme, visit: **www.pmfme.mofpi.gov.in**
Helpline Number: **9254997101, 9254997102**
E-mail: **pmfme-fpi@gov.in**

सत्यमेव जयते
MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

PMFME
सूक्ष्म उद्यमों का संबल

V
Contribution of Industries in banana business

Banana for food process revolution- Room for small and big players

Tamilselvan P*, Sivananth C and Suresh Kumar P*****

**Consultant and Farmer, Udumalpet Taluk, Tiruppur Dist, Tamil Nadu*
*** Research Associate, ***Principal Scientist, ICAR- NRC Banana, Tiruchirappalli, Tamil Nadu*
Corresponding author: tamilselvan.jain@gmail.com; 9944978355

Banana: The most popular fruit

Banana is a widely cultivated fruit crop in the tropical and subtropical regions of the globe. It is popularly cultivated in Asia (China, India, Pakistan, Philippines,Thailand), Africa (Cameroon, Congo, Ethiopia, Kenya, Mozambique, Nigeria, Tanzania) and Latin America (Argentina, Colombia, Ecuador, Haiti, Dominican Republic, Cuba). The origin of banana cultivation dates back to 10,000 years ago in Southeast Asia.

Banana is believed to have been cultivated in India since 2000 BC. The earliest evidence of banana cultivation in India comes from the Tipu Sultan's palace in Kerala. In the early 18th century, banana was introduced to other parts of the world. During this period, banana was cultivated in the Caribbean Islands and in the Pacific Islands. After the mid-19th century, banana cultivation was introduced to Africa and the Mediterranean regions.

Bananas are among the most produced, traded and consumed fruits globally. More than 1000 varieties of bananas exist in the world, which provide vital nutrients to populations in producing and importing countries. The most traded variety is the Cavendish banana. Bananas are particularly significant in some of the least developed and low-income, food-deficit countries, where they can contribute not only to household food security as a staple but also to income generation as a cash crop. It's hard to overstate the importance of bananas in the developing world. More than 400 million people rely on them for 15 to 27 percent of their daily calories. In Central and East Africa alone, half of permanent cropland is dedicated to growing the fruit.

Banana Global Production - Overview

Available data indicates that between 2000 and 2017, global production of bananas grew at a compound annual rate of 3.2 percent, reaching a record of **114 million tonnes in 2017**, up from around 67 million tonnes in 2000. The global banana market is projected to register a CAGR of 4.5% during the forecast period (2022-2027). In 2020, Asia-Pacific led the market with 55.0% of the global production. India is the world's leading producer of bananas, accounting for nearly 26.3% of the total production in 2020. Bananas are one of the major globally exported fruits and also an important source of livelihood and food.

Indian secenario

India is the largest producer of bananas in the world which accounts production of 33.06 million tons from the area of 9.24 lakh ha as per the Agricultural statistics 2021. Banana in India rapidly grown in terms of area and production in last three decades. **The area increased by 2.5 fold, production increased by 4.30 fold and productivity increased by 1.80 fold,this mainly due**

to adoption and practice of Innovative technologies by the farmers introduced by the ICAR-NRCB over these years.

Area, Production, Productivity of Banana in India from 1991 to 2021			
Year	**Area** 000 Ha	**Production** 000 MT	**Productivity** Tons/ha
1991-92	383.9	7790.0	20.3
2001-02	466.2	14209.9	30.5
2002-05	475.3	13304.4	28.0
2003-04	498.6	13856.6	27 8
2004-05	589.4	16744.5	28.4
2005-06	569.5	18887.8	30.2
2006-07	604.0	20998.0	34.8
2007-08	658.0	23823.0	36.2
2008-09	709.0	26217.0	37.0
2009-10	770.3	26469.5	34.4
2010-11	830.0	29780.0	35.9
2011-12	796.5	28495.1	36.7
2002-13	776.0	26509.1	34.2
2003-14	802.6	29734.6	17.0
2014-15	821.8	29721.4	35.5
2015-16	841.2	29134.8	34.6
2016-17	860.0	30477.2	35.4
2017-18	883.8	30807.5	34.9
2018-19	866.0	30460.0	35.2
2019-20	897.0	32597.0	36.3
2020-21	923.0	33379.0	36.2
(Ref: Horticulture Statistics at a Glance 2018)			

Over 90% of bananas produced in India are consumed domestically as fresh fruit. And it is estimated that processing in banana is only to an extent of **2.5% of which about 1.80% is used to process banana chips**. The rest is processed into banana puree, banana pulp, banana beer, banana powder and etc so on.

The NRCB forecast for banana production is as follows,

Banana Production Forecast		
Particulars	**Present**	**2050**
Population	1350 million	1600 million
Per capita consumption	10.5 kg	30 kg
Production	33 million MT	60 million MT

The country is expected to grow at a CAGR of 7.6% between 2021 and 2031. The rapid growth of the country has led to a need for more lands for its expansion.

Statewise area and production of banana in India

Statewise Area and Production of Banana in India								Area '000Ha Production'000MT	
S.	STATES/Uts	2015-16		2016-17		2017-18		2020-21	
No.		A	P	A	P	A	P	A	P
1	ANDHRA PRADESH	75.72	3570.62	88.17	4672.75	88.96	5003.07	97.25	5834.70
2	ARUNACHAL Pradesh	5.42	31.64	2.45	17.47	2.21	14.08	2.20	14.03
3	ASSAM	51.10	882.71	49.27	854.85	53.08	913.27	48.78	909.83
4	BIHAR	34.80	1535.30	35.07	1527.85	31.07	1396.39	35.32	1612.56
5	CHHATISGARH	25.76	587.42	26.12	609.21	26.57	745.78	24.54	585.71
6	GUJARAT	64.69	4185.52	66.31	4293.23	68.15	4472.32	59.26	3907.21
7	HIMACHAL PRADESH	0.09	0.42	0.08	0.35	0.08	0.35	0.07	0.12
8	JHARKHAND	12.53	33.28	9.06	31.63	9.17	32.06	5.64	32.87
9	KARNATAKA	96.63	2370.95	99.46	2446.03	110.55	2328.90	128.76	3367.67
10	KERALA	84.56	1292.41	84.98	1250.55	109.26	1119.16	111.26	957.05
11	MADHYA PRADESH	28.35	1758.05	26.97	1876.45	26.38	1834.03	29.48	2025.46
12	MAHARASHTRA	69.55	3025.15	81.34	3888.90	80.88	4209.27	84.26	4223.05
13	MANIPUR	6.95	93.95	8.19	109.82	6.93	93.48	6.18	88.50
14	MEGIHALAYA	7.11	88.71	7.24	94.32	7.37	96.90	7.30	95.01
15	MIZORAM	10.91	141.03	11.00	141.04	11.21	143.84	11.43	140.50
16	NAGALAND	7.25	108.51	8.32	116.98	8.34	117.04	6.94	87.28
17	ODISHA	24.47	462.71	24.46	466.44	24.20	449.82	23.61	502.83
18	PUNJAB	0.11	6.43	0.09	5.27	0.09	5.27	0.15	9.05
19	RAJASTHAN	0.03	0.41	0.04	0.35	0.03	0.68	0.04	0.41
20	SIKKIM	1.15	3.56	1.21	3.87	1.28	3.71	1.30	5.53
21	TAMIL NADU	94.61	4331.65	94.98	3499.48	82.63	3205.04	97.64	3895.65
22	TELANGANA	4.65	183.70	2.06	73.00	2.29	90.02	2.19	100.12
23	TRIPURA	14.62	153.62	10.80	115.28	10.29	109.40	10.75	111.11
24	UTTAR PRADESH	67.00	3061.21	69.10	3160.82	69.38	3172.33	73.78	3387.51
25	WEST BENGAL	48.07	1172.34	48.07	1172.34	49.30	1200.00	51.60	1116.41
	OTHERS	5.03	53.55	5.16	48.97	4.07	51.29	4.43	51.63
	TOTAL	**841.19**	**29134.82**	**859.97**	**30477.22**	**883.77**	**30807.50**	**924.16**	**33061.80**
Ref:Horticulture statistics at a Glance 2018 and Agricultural ststistics at a Glance 2021									

Fresh fruit export of banana from India

Export of Banana from India-Countrywise						Qty in MT Value in Rs. Lakhs
Country	**2015-16**		**2016-17**		**2017-18**	
	Qty	Value	Qty	Value	Qty	Value
United Arab Emirates	24971.12	11728.78	24277.42	11862.79	19073.18	9150.29
Oman	8486.03	3199.92	12929.16	4615.69	18158.69	6283.19
Iran	20304.50	6762.92	15710.14	5461.28	14095.43	4938.74
Saudi Arabia	12676.77	6318.26	10262.96	5189.99	7918.01	3814.90
Kuwait	4974.11	2470.35	10441.73	4298.59	6120.95	2653.55
Qatar	2946.66	1780.95	3747.34	2241.93	4601.17	2318.17
Nepal	17122.66	1792.68	27583.43	2707.53	20915.47	1981.26
Iraq	0.00	0.00	593.23	189.40	4985.26	1583.76
Bahrain	1940.23	1053.51	2606.08	1304.62	2067.58	927.17
Maldives	1273.31	450.65	1503.43	466.11	1707.18	600.75
Pakistan	32.43	13.78	0.00	0.00	685.26	241.51
Afghanistan	8.74	3.36	21.98	7.38	309.70	124.24
Korea Republic	0.00	0.00	271.35	100.35	261.81	94.41
Malaysia	110.88	36.51	576.26	182.10	207.51	58.27
Singapore	1.91	0.84	17.66	6.37	86.13	29.67
Ireland	30.47	26.34	30.91	30.30	19.16	15.17
France	0.22	0.15	3.12	1.34	11.57	14.62
United Kingdom	38.04	23.52	24.74	15.44	21.31	13.72
Italy	1.54	1.00	0.00	0.00	19.13	6.78
Canada	0.06	0.03	6.53	3.81	5.65	6.12
Korea DP Republic	0.00	0.00	52.65	20.52	16.90	6.04
Others	302.98	103.65	90.44	54.13	27.32	15.06
Total	**95222.66**	**35767.20**	**110750.56**	**38759.67**	**101314.37**	**34877.39**
Ref:Horticulture statistics at a Glance 2018						

India s fresh banana fruit exports reached 211407 M Tonnes in the year 2020 (FAO -database) but if compare the overall production our export to world market is only 0.63%.

Banana Industry

Banana industry is an important part of the global industrial agro business. Most bananas goes into export and international trade for consumption in Western countries. They are grown on banana plantations primarily in Latin America and the Caribbean as well as Central and South America. In India its estimated that it is 50000 crore business,of which the post harvest losses estimated for 20 to 25% and viz at retailer level 10 to 20%,at wholesalers level 8 to 15% and at farm level 7 to 9%. The banana farmers have incurred losses to the tune of Rs 6000 crores due to steep drop in prices and disruption supply during the Covid 19 impact in recent years. Hence there is need for Banana processing innovations which will help the farmers and stakeholders to befefit from the post harvest losses accounted.

Food processing in India

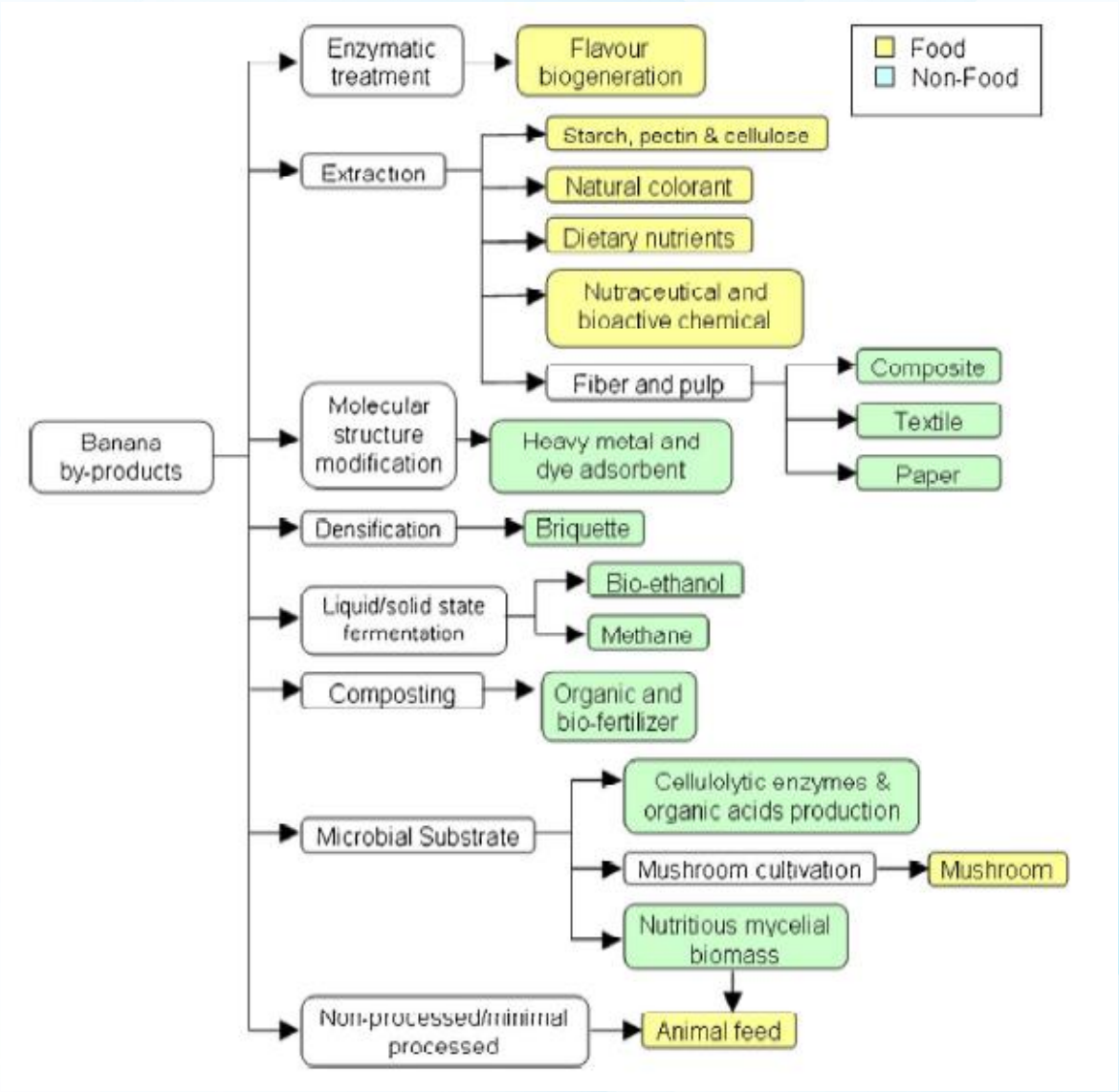
Since liberalization in August 1991 proposals for projects have been proposed in various segments of the food and agro-processing industry. Besides this, Govt. has also approved proposals for joint ventures; foreign collaboration, industrial licenses and 100% export-oriented units envisaging an investment. The foreign direct investment in food processing sector in 2020-21 is estimated to be 2934.12 crores.

India's exports of Processed Food was Rs. 41,460.06 Crores/ 5,559.84 USD Millions in 2021-22, which including the share of products like Mango Pulp (Rs. 924.54 Crores/ 124.11 USD Millions), Processed Vegetables (Rs. 3986.45 Crores/ 534.98 USD Millions), Cucumber and Gherkins(Prepd. & Presvd) (Rs. 1487.30 Crores/ 199.46 USD Millions), Processed Fruits, Juices & Nuts (Rs. 3626.08 Crores/ 486.58 USD Millions) Pulses (Rs. 2834.29 Crores/ 379.75 USD Millions), Groundnuts (Rs. 4697.10 Crores/ 629.26 USD Millions), Guargum (Rs. 3334.77 Crores/ 446.77 USD Millions), Jaggery & Confectionary (Rs. 2797.85 Crores/ 375.18 USD Millions), Cocoa Products (Rs. 1145.48 Crores/ 153.71 USD Millions), Cereal Preparations (Rs. 4862.19 Crores/ 652.26 USD Millions), Alcoholic Beverages (Rs. 2070.92 Crores/ 277.85 USD Millions), Miscellaneous preparations (Rs. 7406.98 Crores/ 993.85 USD Millions), and Milled Products (Rs. 2286.11 Crores/ 306.08 USD Millions).

The Indian food processing industry is primarily export oriented. India's geographical situation gives it the unique advantage of connectivity to Europe, the Middle East, Japan, Singapore, Thailand, Malaysia and Korea. One such example indicating India's location advantage is the value of trade in agriculture and processed food between India and the Gulf region.

Retail (food & grocery retail market), one of the largest sectors in the global economy (USD 11.32 Trillion in 2021), is going through a transition phase in India. It is expected to grow at a Compound Annual Growth Rate (CAGR) of 3.0% from 2022 to 2030. One of the prime factors for non-competitiveness of the food processing industry is because of the cost and quality of marketing channels. Globally more than 72% of food sales occur through superstores. India presents a huge

opportunity and is all set for a big retail revolution. India is the least saturated of global markets with small organized retail and also the least competitive of all global markets.



Schematic illustration on the utilization of banana/plantain by-product processing for food and non - food

Banana processing

About 90% of banana produced is consumed domestically as fresh fruit. Merely 5% is consumed in processed form providing a good potential for future processing. About 2.5% is only processed purely as banana products and the rest as an ingredient in other foods. About 50 varieties of products could be made from banana. The primary product of banana in market is "**fried chips and candy**" which constitute around 31 %, **rest as banana puree 9%, banana pulp 3%, banana beer 3%, banana wafers 3%, banana powder 6% and others.** There is a good market demand of all banana products. There is an ample of new local market growing in India. Most of the banana product manufacturers are in the small scale sector.

Banana value added products

Bananas can be processed into different value-added products to enhance their shelf life and market value. Processing is recognized as a way of preserving the fruit. The ripe banana can be utilized in a multitude of ways in the human diet, from simply being peeled and eaten out of hand to being sliced and served in fruit cups and salads, sandwiches, custards, and gelatins, being mashed and incorporated into ice cream, bread, muffins and, cream pies. Thousands of value-added products can be made from bananas. Some of the value-added products are briefed below.

Brief overview of banana wafers/chips industry

Banana chips are a popular by-product of bananas. Rapid industrialization and a fast-paced urban lifestyle have also fueled the global demand for banana chips. Asia-Pacific region had the highest demand at 19%. The rising demand from small and medium enterprises (SMEs) is also an important trigger for increasing demand. **Online sales channels will boost the banana chips market and global demand.** While plain banana chips continue to remain the most popular, manufacturers are being innovative and using different flavors in banana chips. Jaggery or spice coated chips are popular in the Indian market and are being exported.

Vacuum fried banana chips

Osmo vacuum - IMF dried banana

Vacuum fried banana chips

Banana chips, one of the Kerala origin snacks made by deep-frying raw or ripe bananas usually in coconut oil. Banana chips contribute to the value addition of bananas to extend their shelf life but this deep fat frying of bananas increases the oil content and darkens the colour of chips due to their sugar content. **This condition can be controlled by novel frying technology in which frying the raw or ripe banana under reduced pressure is called vacuum frying technology.** The raw banana chips are produced without removing the peel, this could enrich the fiber content of the banana chips and also enhance their appearance.

The attractive factor of vacuum frying is that the oil can be reused more than 60 times and the quality is maintained. **The vacuum fried product has very little oil content, nearly 90% of oil can be reduced compared to atmospheric fried banana chips.** The fried banana chips made from this vacuum frying technology can be stored for more than three months under active modified atmosphere packaging using nitrogen flushing.

Osmo vacuum - IMF dried banana

Osmotic dehydration is one of the food preservation techniques used for partial removal of water from fruits by immersing in aqueous solutions of high osmotic pressure viz., sugar and salts. This could be prepared by a two-stage drying process i.e., **osmotic dehydration followed by any other secondary drying. The ripen banana is sliced and soaked in sugar syrup for osmotic dehydration and further dried using a cabinet dryer/blancher cum drier during the preparation of IMF dried banana.** Osmo-vac-dried banana is an intermediate moisture food product and is not only delicious but also conserves attractive colour and nutritional elements. This processed product has a shelf life of six months, which could reduce the wastage of surplus ripened bananas.

Future scope and demand

India and the Philippines are the key banana chip manufacturers in the world. There is abundant cultivation of banana in these countries. The high production and supply of bananas make it possible to produce by-products like banana chips. Recession and economic slowdown have not affected the industry and it is likely to grow at a healthy annual rate of 10%. **In 2008, the banana chips industry was valued at more than $56.3 billion. Consumers are moving towards consuming banana chips and other banana by-products in addition to only consuming a fresh banana. In 2011, the Philippines exported nearly 30,141 tons of banana chips worth more than $50,000 million.** The country controls a major share of the global banana chips industry.

In India, MTR, Haldiram, Balaji and Bikaji are the key players in banana chips segment.

Banana flakes market overview - Global

Banana Flakes market size was estimated **at $682 million** in 2020, and it is projected to grow **at a CAGR of 4.5%** during the forecast period 2021-2026.

By Nature: Organic and Conventional

By Application: Household, Food and Beverages, and Others.

By Distribution channel: Supermarkets/Hypermarkets, Convenience Stores, Online Retail Stores, and others.

By Geography: North America (U.S., Canada, Mexico), Europe (Germany, United Kingdom (U.K.), France, Italy, Spain, Russia, and Rest of Europe), Asia Pacific (China, Japan India, South Korea, Australia, and New Zealand, and Rest of Asia Pacific), South America (Brazil, Argentina, and Rest of South America), and Rest of the World (Middle East, and Africa)

Banana flakes market drivers

Increasing consumption of banana flakes

Increasing consumption of banana flakes owing to nutritional benefits as it is rich in vitamins (A, B, B6, C, and E), iron, potassium, calcium, zinc, and magnesium is increasing the growth of the Banana Flakes Market. Additionally, frequent consumption of banana flakes will reduce the risk of colon cancer as banana flakes contain a high amount of fibers which helps to

reduce risk of colon cancer is also practiced to increase the growth of the Banana Flakes market during the forecast period 2021-2026. According to the Center for Disease Control and Prevention (CDC), in America, colon cancer is the second leading cause of death.

Rising prevalence of cardiovascular diseases

Increasing prevalence of cardiovascular diseases such as strokes and heart attack is increasing the growth of the Banana Flakes market. In banana flakes potassium is present which tackles the narrowing and hardening of arteries as a result it reduces the risks of strokes and heart attacks. According to World Health Organization (WHO), cardiovascular diseases are the leading cause of death across the globe and around 17.9 million people die per year due to cardiovascular diseases. Moreover, banana flakes helps to reduce and manage diarrhoea so that consumers are increasingly including banana products in their diet thereby increasing the growth of the Banana Flakes Market during the forecast period 2021-2026.

Development

In February 2020, Bunge Ltd., Van Drunen Farms, leading player in agriculture, food science, and dehydrating fruits, vegetables, and grains has partnered with FutureCeuticals to expand their product distribution network in worldwide.

Banana flour based ready-to-eat products

Nowadays consumers are trending towards healthy nutritive processed products and also ready-to-eat foods. Diversified combinations of banana flour and other healthy ingredients such as Njavara rice, yarm powders, ragi flour, etc can be utilized for the development of healthy RTE products. These healthy banana-based RTE products can be stored for up to six months under active modified atmosphere packaging using nitrogen flushing.

Fibre enriched banana peel pasta

At present, consumers are focusing on healthy and nutritive processed products. The pasta that we usually get in the market has refined wheat flour as a major ingredient. In the nutritional aspect, fibre enriched pasta has good marketability. Banana peel is a major byproduct of the banana flour industry; it has good fibre content and can be used for making pasta. The banana peels are washed, blanched, dried, and powdered to form banana peel powder. All the processing parameters to produce banana peel powder are standardized. The produced banana peel powder is then used to fortify wheat flour in a different ratio to produce banana peel pasta. This standardized fiber-enriched pasta is good for weight loss, rich in antioxidants, and reduces constipation problems. The shelf life of banana peel pasta is more than one year.

Banana powder

Banana powder is a powder made from processed bananas. It is used as a component for production of milk shakes and baby foods. It is also used in the manufacture of various types of cakes and biscuits.

Banana powder market is segmented on the basis of application and geography. Based upon application, banana powder market is segmented into food, pharmaceuticals, animal feed, and cosmetics. Food application can be further sub-segmented on the basis of puffed food, infant food, seasonings, instant food, and others. Food is expected to attain relatively higher market share in the banana powder market.

Globally, Banana Powder Market size is estimated to reach **$1.6 billion by 2027**, growing at a **CAGR of 3.9%** during the forecast period 2022-2027. The banana pulp, which is processed using a colloidal mill is taken into account for making banana powder.

The powder is not deemed a rich protein source but it contains a plethora of carbohydrate and calories. The powder increases cell growth and rehabilitates the areas affected by ulcers; moreover, it is of extreme significance in curing dyspepsia. Bananas are home to resistant starch which might play a noticeable role in the upgrading of insulin sensitivity in patients suffering from diabetes; moreover, their potassium-rich nature endorses heart health and relieve stress. In addition to that, regular intake of banana powder for people suffering from their thin frame could be beneficial. Therefore, proliferating diabetes incidences, swelling cases of stress and anxiety, soaring health awareness among people, refining retail infrastructure following internet penetration, improving per capita incomes in developing countries, and growing use of banana powder in confectioneries and **baby food** are factors set to drive the growth of the Banana Powder Market for the period 2022-2027.

The process as follows:

By Nature: Organic and Conventional.

By Drying process: Freeze dry, Drum dry, Sundry, and Spray dry.

By Applications: Food and beverages, Dietary supplements, Cosmetics, Animal feed, and others.

By Distribution channel: Offline (Supermarkets/Hypermarkets, Convenience stores, Retail Pharmacies, and Others) and Online platforms.

By Geography: North America (U.S., Canada, and Mexico), Europe (Germany, UK, France, Italy, Spain, Russia, and Rest of Europe), Asia-Pacific (China, India, Japan, South Korea, Australia & New Zealand, and Rest of Asia-Pacific), South America (Brazil, Argentina, Chile, Colombia and Rest of South America) and Rest of World (the Middle East and Africa).

Key takeaways

- Geographically, the Asia-pacific banana powder market accounted for the highest revenue share in 2021. The growth is owing to undisturbed supply because of high banana production in Asian countries, rising disposable incomes of people, colossal population, growth stunting of youth, and bettering retail network.
- Increasing demand for carbs rich food, escalating popularity of RTD beverages and confectionery items, enlarging quality of life in low-income countries like China, Indonesia, and India, growing internet penetration in impoverished areas, hike in the number of smartphone users, and innovative marketing strategies are said to be preeminent driver driving the growth of Banana Powder Market. A plethora of alternatives, rising cost of living, startling unemployment post-covid-19, and environmental calamities are said to reduce the market growth.

Banana powder market drivers

Enlarging health complications are anticipated to boost market demand

Owing to their fiber-rich nature and low GI index bananas are an appropriate choice for diabetic patients because they play a significant role in reducing sugar spikes. Therefore, swelling cases of diabetes are likely to enhance the demand for the banana powder market. According to a report, around 12 percent of adults worldwide are anticipated to develop diabetes by the year 2045. The figure is whirling around 10.5 to 11 percent as of 2022. Moreover, bananas are home to minerals and amino acids like potassium and tryptophan that are vital for the formation of serotonin and melatonin (hormones responsible for feeling good and decent sleep); therefore, bananas are also supportive in pacifying the mind by curing stress. Also, the augmenting complication of nutrient deficiency among youth in developing countries is likely to stimulate market growth.

Bettering retail infrastructure, soaring GDP per capita, and augmenting usage in cosmetics, baby foods, and confectioneries are expected to boost market demand

Overwhelming penetration of the internet in rural areas has completely revolutionized the retail industry in the last decade. E-commerce platforms are all set to overtake conventional distribution channels of retail. As of 2022, nearly 60 percent of the total world population (more than 4.6 billion people) is vigorously using the internet. The number is projected to reach 7.5 billion by the year 2030. The growth in any market depends upon purchasing power of consumers; whereas, the purchasing power of consumers in a geographical location is directly proportional to economic prosperity. Therefore, the proliferating economic affluence of developing countries is a primary driver driving the aforementioned market. For example, from $5,624 in 2020, South Africa's GDP per capita income reached $6,861 in 2021; nevertheless, the figure is anticipated to reach $7,081 in 2022. Other developing nations like India, China, and Indonesia are too witnessing a slight surge in per capita incomes. Besides, extensive use of bananas in baby formula and various cosmetics products has spiked the pace of growth.

Banana powder market challenges

The presence of several substitutes, environmental calamities, and the rising cost of living across the globe are the factors anticipated to hamper the market growth.

In March 2022, India witnessed 17 months' highest CPI inflation rate of 6.95 percent. The extensive surge in prices is putting extra pressure on consumers' pockets. In addition to that, overwhelming inflation fueled by the Russia-Ukraine war has soared the cost of living across Europe. According to the Statistical Office of the European Union, in march 2022, annual inflation rates in the euro area soared to 7.4 percent from 5.9 percent in February. In addition to that, the availability of a plethora of alternatives that can easily substitute bananas, the changed duration of seasons, loss of agricultural land because of soil erosion, deforestation, and vanishing organic content are some crucial factors posing severe challenges to the growth of banana powder market.

Banana powder industry outlook

Product launches, mergers and acquisitions, joint ventures, and geographical expansions are key strategies adopted by players in the aforementioned Market. Banana Powder market top 10 companies include -

- NuNaturals Inc, Aarkay Food Products Ltd., Mevive International, Naturalin Bio-Resources Co Ltd., Banatone Food Industries Kochuveli, Royal Nut Company, Saipro Biotech Pvt Ltd., Taj Agro International, Varmora Food Pvt Ltd and National Food 'n' Spices

Recent developments/product launches

- On January 5, 2022, The Federation of Indian Export Organization (FEO) announce teaming up with other authorities like the Agricultural and Processed Food Products Export Development Authority (APEDA) and Directorate General of Foreign Trade in order to revolutionize overseas exports of Poovan variety of banana through an infusion of high-tech in cultivation processes.
- On October 30, 2021, ICAR-NRCB (National Research Institute for Banana) transferred banana powder making technology with Trichy, TN -based confectionery "Cake Bee." The technology makes use of low-cost foam mat drying to fabricate powder from the green banana pulp. This move is anticipated to help cake Bee to further expand its banana-based products in other parts of the state.
- On February 16, 2021, Del Monte International (a subsidiary of Florida, United States-based distributor of fresh-cut fruit "Fresh Del Monte Produce Inc") publicized that company has successfully partnered with Brisbane, Australia-based Queensland University of Technology. The partnership aimed at bringing unprecedented ways of growing ailment-resistant bananas to life.

Banana puree

Functional beverages including banana puree can gain from the presence of banana puree, which can improve the global banana puree market. An incremental potential worth nearly US$ 95 million for the period from 2022 to 2032 is waiting to be tapped in the beverage sector of the banana puree trade.

Globally, **Banana Puree market** is expected to grow at a CAGR of **6.29 %.** The market value is projected to increase from **US$ 593.4 Mn** in 2022 to **US$ 948.3 Mn** by 2032. Functional beverages contain vitamins, minerals, roots, and fruit purees. Some examples of functional beverages include energy drinks, performance drinks, and enhanced fruit drinks.

Developed countries in North America will remain the biggest markets for functional beverages due to demographic features like test and consumer awareness docket.

- The growing demand for child nutrition has led to the peak demand for baby nutrition food.
- The increase in the employment of women in the worldwide workforce has been helping to boost the worldwide demand for grocery Baby Food.
- Baby yogurt and protein-rich little cereal often contain purées with differing flavors as the key ingredients.
- The infant food segment has eclipsed every other segment in banana puree production due to the significant popularity of banana puree in the production of an assortment of edible products. The infant food segment is anticipated to be worth approximately US$ 948.3 million by year 2032, making it the largest segment in the banana puree market.
- False claims for beverage manufacturers are making consumers sceptical and suspicious

Consumers quickly find beverages that provide them maximum health benefits based upon sound reasoning and facts. Regrettably, they are quite often wary of the big claims about ingredients and health benefits offered by big-name beverage manufacturers. This can spur some degree of uncertainty and confusion in regard to specific ingredients of functional beverages that are marketed aggressively.

The greater the emphasis on the security and labelling of products, the more prominent the manufacturing of false health claims for legitimate products appears. This poses a threat to banana puree market expansion.

The rising income levels, interest in convenience foods, and rising consumption of health foods have helped turn the bakery business upside down. The baked goods category offers items like pizzas, breads, rolls, biscuits, and desserts. Banana cakes are famous among European consumers in general, and French banana cakes are a particularly popular item. Globally, the bakery and dessert sector had a market share of around 4.9% of the banana puree market in 2022. It's estimated that it will lose 66 BPS by 2026.

Fueling the global banana puree marketplace is the popularity of banana shampoos

Cosmetics Europe estimates that the personal care and cosmetics market in Europe had a worth of about $90 billion at retail expense in 2016. Major cosmetic manufacturers such as Procter & Gamble, Unilever, and L Oreal have invested greatly within the industry, with several corporation's eagers to introduce products that include fruit ingredients.

For example, **Body Shop International**, a subsidiary of L'Oréal Group has created a banana shampoo with banana puree as a key ingredient. Cosmetics is part of other in the Western Europe banana puree market and is expecting to have a volume of more than 2900 metric tons by end 2032.

Country-wise insights

How is the U.S banana puree market shaping?

The United States, the banana puree market is growing rapidly. This is due to the increasing popularity of health drinks and smoothies. More and more people are looking for healthy options when it comes to their beverages. Banana puree is a great alternative to sugary drinks because it is low in calories and fat. In addition, banana puree is a good source of vitamins and minerals.

What is the performance of the Indian banana puree market?

The performance of the banana puree market in India has been strong in recent years, with sales growing steadily. There are several reasons for the strong performance of the banana puree market in India. First, the population of India is growing rapidly, and as incomes rise, more people are able to afford to purchase processed foods like banana puree. Second, the climate in India is conducive to growing bananas, and there is a large supply of fresh bananas available for processing into puree.

Third, Indian consumers are becoming increasingly health-conscious and are looking for healthy food options that are easy to prepare. Banana puree fits this need perfectly, as it is a healthy food that can be easily added to smoothies or used as an ingredient in recipes.

How will market players target the emerging market of china for the banana puree market?

In the past few years, China's economy has been growing at a rapid pace and is now the world's second largest economy. This economic growth has led to an increase in the purchasing power of the Chinese consumer. As a result, many international companies have started to target the Chinese market for growth. The banana puree market is no exception.

Many market players see China as a potential growth market for banana puree due to the increasing demand from Chinese consumers. The Chinese government's policies also support the growth of the domestic food processing industry, which is expected to boost the demand for banana puree in China. In addition, China's large population and growing middle class provide a significant opportunity for companies operating in this market.

How Japan and Indonesia are growing as a fastest banana puree market?

Banana puree is a popular product in both Japan and Indonesia. The countries have seen a surge in demand for the product, and they are working to meet this demand. Japan and Indonesia are both tropical countries, so it is no surprise that they are among the top producers of banana puree. The two countries have seen a surge in demand for the product in recent years, and they are working to meet this demand. Banana puree is used in a variety of products, including baby food, ice cream, and baked goods. It is also a popular addition to smoothies and other beverages. Japan and Indonesia are working to increase their production of banana puree so that they can meet the growing demand from consumers.

Competitive landscape

The global market for Banana Puree is incredibly fragmented and competitive due to the existence of several local and regional rivals. Key players employ a range of marketing strategies, such as partnerships, expansions, mergers and acquisitions, and collaborations.

Some of the leading companies operating in the Banana Puree market are Symrise AG, Döhler GmbH, Kiril Mischeff, Riviana Foods Pty Ltd, Nestlé S.A., The Hain Celestial Group, Inc, The Kraft Heinz Co., Ariza B.V., Newberry International Produce Limited, Grünewald Fruchtsaft GmbH, Tree Top Inc., Hiltfields Ltd., Shimla Hills Offerings Pvt. Ltd., Antigua Processors S.A., SunOpta Grains and Foods Inc.

What is the role of banana in global competition?

Bananas play an important role in global competition because of their high nutritional content, high fiber content, low fat content, and high enzyme content.

Nutritional Value: Bananas are rich in vitamins, minerals, and antioxidants. Vitamins include vitamin A (pregnancy listed as an essential vitamin), C, K, and M, iron, manganese, and zinc. Mineral content includes zinc, iron, manganese, cobalt, and selenium. Fiber content is moderate, but significant amounts of magnesium, Vitamin B - 12, and omega - 3 fatty acid are important inosteine.

Fiber Content: Bananas contain moderate amounts of dietary fiber, which provides a needed serving of protein and complex carbs.

Healthy Eating: Bananas provide optimal amounts of vitamins, minerals, and essential fatty acids. Eating Bananas is Not a Street Food

What are the challenges in developing a business model for banana processing in India?

There are a number of challenges that stand in the way of banana processing in India, including the lack of awareness of the industry and a lack of finance for growth. These challenges are expected to be overcome over the next few years.

Revenue: The production of bananas and the demand for their products is expected to rise at a rapid rate, making it important for companies to remain relevant in the competitive market. At the same time, there is also a risk that the competitive landscape changes and a new product becomes more appealing than an old one due to marketing or regulatory reasons.

Control: The larger the company, the greater the risk that any changes will have an effect on the business. The same goes for the decision on whether or not to produce more goods and services. - Regulatory uncertainty: The goods and services sector has recently seen the entry of several new countries in the Asia-Pacific region, making the situation more complex for small and medium-sized companies. - Execution. The execution of a business model is essential to win new customers. Companies need to do their due diligence before starting the process of seeking customers. This includes exploring possible competitors and seeking independent verification of the goods and services sold by the company.

Future of Indian food processing businesses

- According to a Deloitte India survey, the Covid-19 epidemic has caused customers to place a higher emphasis on sustainability, health, and convenience while turning their attention to proteins and fresh proteins.
- These consumption-related changes are influencing changes in the value chain with an increased focus on elements like traceability, mechanization, intensification, and regenerative agriculture promoted by investments in the Ag-tech space which is attracting venture and investment capital like never before."
- The use of agriculture, which accounts for more than half of the world's livable land, has a large negative impact on global emissions.
- "Health-conscious, modern customers prefer to eat foods that have a less environmental imprint."
- Beyond only being concerned with their own health, people are now more aware than ever of the ecology.

Following are a few significant trends from the "Future of Food" report,

Healthy eating: Grain intake made up 55% of daily calories, down from 63% in 1961. Protein consumption climbed to 63 gm in 2015–17 from 55.3 gm in 2000–2002, while superfoods like olive oil and green tea are also becoming more popular.

With an increased emphasis on leading a healthy lifestyle and practising preventative medicine, Nutri-cereals like millet have begun to supplant everyday mainstays like wheat and rice. Consumers are also enthusiastic about food augmentation to improve nutrition.

Conscious sourcing: Modern customers are also worried about the safety of their food, which has caused them to favor organic food. The Indian organic food market is anticipated to increase at a compound annual growth rate of 21% from its present level of Rs 60 billion to Rs 182 billion by 2026.

Conscious preferences: The rise of regional brands is a result of consumer demand for foods that suit their own area tastes. This can compel companies to design their product mix carefully. The emphasis on national brands is shifting to include regional variations as well. Customers now choose packaged necessities over unpackaged goods while making purchases. This development was enhanced with Covid-19. This penchant for low-cost packaged food is giving private-label retail businesses more popularity.

Conscientious convenience: The frozen and **ready-to-eat** sectors have seen a notable increase as well. From 2020 to 25 there is expected to be a 28% compound annual growth rate for the online meal delivery business and a 53% CAGR for online groceries.

Analysis and conclusion

Food processing is the process through which agricultural materials are turned into consumable food items. It encompasses a variety of processing techniques, including home

cooking, industrial techniques, and grinding grain to form raw flour. These techniques are used to manufacture convenience meals like noodles, spaghetti, and chips. Because India harvests and subsequently processes a wide range of food items for consumption, the food processing sector plays a significant role in the country's economy.

India is the world's top producer of milk, bananas, mangoes, guavas, papayas, ginger, and okra. It ranks second in the production of wheat, rice, fruits, vegetables, tea, sugarcane, and cashew nuts. India is also the world's third-largest producer of cereals, coconut, lettuce, chicory, nutmeg, mace, and pepper. This business is expected to survive all seasons and never worry about a recession because of rising wages and growing demand for healthy, packaged foods. Government support for the sector is also rising.

Market statistics

- One of the largest food processing industries in the world, India's output is anticipated to exceed US$ 535 billion by 2025–2026.
- By 2024, 9 million new employees in this industry are anticipated.
- The **food processing** sector represents 32% of the overall food industry in India, which is growing at a CAGR of 11%.
- Between April 2014 and March 2020, India's food sector garnered $4.18 billion in foreign direct investments.
- The yearly household consumption in India is anticipated to quadruple by 2030, elevating the country to the fifth-largest consumer in the globe.

Key trends & growth drivers

- The organized food retail industry is expanding, and urbanization is rising.
- MSMEs are making significant contributions to the food processing chain in India through a variety of techniques and skill developments.
- In India, the internet meal ordering industry is expanding rapidly.
- Packaged, healthful, and immunity-boosting foods like roasted nuts, popcorn, and roasted pulses are in hot demand.
- A change from loose to branded packaging is occurring in the market.
- This industry is given importance by the government's "Atmanirbhar Bharat" project, which provides support through a number of measures.

Recently enacted government initiatives

In its "Make in India" initiative, the Indian government has given the food processing industry top priority and encourages investment there. In order to improve the food processing supply chain, the government has also developed 134 cold chain projects and 18 mega food parks. These measures will probably benefit businesses that process food. Additionally, the food processing sector is on a strong development trajectory as a result of recent government measures,

such as the Rs. 10,000 crores ($1.35 billion) program launched by Government of India , to boost this sector.

The government of India has set up a separate full-fledged ministry named “Ministry of Food Processing Industries “for the development and promotion of food processing industries. To boost fruits and vegetables processing, the ministry is extending financial support for setting up new units, modernization and up gradation of existing units. India has an excellent scope for development of several value added products like juice, biscuit, banana powder and industrial amylase enzyme with longer shelf life.

Creation of cross functional convergence with development agencies, converging Farmer producer organizations (FPOs), market linkages and assessment of the impact through technological incubation and cross cutting initiatives are the primary steps for the successful establishment of processing Industry.

The bigger players such as ITC, Britannia, Parle - G, Horlicks, Boost, Bourn vita, Pepsi, Coco - Cola and Dabur should come up with the plan to utilize the Banana powder, Flour, Puree, Juices in their product portfolio to scale up the industrial use and market it effectively to benefit both for Consumer and Organization.

Banana By-products - Innovation - a true success story

Solar Dehydration of Banana (Thottiam banana Producer Group- Thottiam of Trichy Dist. Tamil Nadu. Member of Tamil Nadu Banana Producer Company Ltd).

Thottiam Banana growers association is one of the primary producer of banana fruits in an area of about 4000 acres comprising around six revenue blocks of the taluk.The members group comprises of small and medium farmers,tenency holders with an average land holding of less than one hectare wet land that are irrigated by cauvery river distributory canals.

It is in this context and back drop, Sustain project offered by M/S Bayer Material science ltd and ASSIST gave us an excellent oppurtunity to convert the banana fruit in to solar dried banana fig, an unique cost effective value addition that will meet out our fruit production cost and manage the unsold and ripened bunches. Farmers themselves are highly enthused to bring the ripened fruit bunches to the project site and get agreed price credit thereby ensured to avoid distress sale. However the marketing of solar dried banana needs further improvisation on packaging,flavouring,coating as a basic need to compete with the leading consumer brands. Further scaling up the production capacity Is also needed to cover volumes during harvest season.The solar drier capacity is just 0.1% of daily arrivals.

Looking at the scope of success of this project, Thottiam Banana Producer group was formed as a partner ship company by 13 progressive Banana growers who are all member share holders of Tamilnadu Banana Producer company Ltd (A Pan tamilnadu FPO company). In the year 2014. They further invested money to increase the production capacity from the present 400q.ft drying area to 1450 Sq.ft installing two more green house solar dryer with UV radiation mask and Infrared heater facility to maintain inhouse temperature during overcast climate condition. Now , the unit is capable of producing 3 M.T dry fruits average in one month.

The main motive force behind this project is Mr. G..Ajeethan, A Technocrat turned fulltime agriculturist from Mohanur village of Namakkal District. He is a banana grower by tradition and also Gen.secretary of Tamilnadu Banana Growers Federation and Managing Director of Taminadu Banana Producer company Ltd.Trichy. This group is the first Farmers company to market their products through an international online marketing company – AMAZON india and Q-trove. The company has diversified in to making five products derived out from Banana. Thottiam Banana Producer group has grown to a level of 20 Lakhs turnover in a year over the five year period.

Madhur Fruits™

Including banana in the ambit of crop insurance: Issues and Opportunities

Srinivasan C A

Vice President
Corporate Solutions Group
Alliance Insurance Brokers Pvt Ltd, Chennai, Tamil Nadu
Corresponding author: srinivasan@allianceinsurance.in; 9444928388

Introduction

Agriculture plays a vital role in India's economy, wherein 54.6% of the total workforce is engaged in agricultural and allied sector activities (Census 2011) and accounts for 17.8% of the country's Gross Value Added (GVA) for the year 2019-20 (at current prices) . According to the Agricultural Census 2015-16, there are about 146.7 million operational holdings, of which about 86 % are under small and marginal categories. With over 86 per cent of the farmers depending on their small and marginal farms for their livelihoods, sustainability of their subsistence and rising above subsistence, call for determined efforts to increase productivity, prevent post-harvest losses and enhance value addition. The initiatives entail innovative interventions with a priority accent on economic efficiency and ecological compliance. Given the importance of the agriculture sector, the Government of India has taken several steps for its development in a sustainable manner and also to improve the income of farmers in view of the fact that India's endeavour to achieve rapid economic transformation is apt to be **won or lost** in the agricultural sector.

It is a known fact that large majority of farmers, about the 86 per cent, are small and marginal operational holders with miniscule income. These farmers have small farms, have no/low access to capital, cannot afford technology to improve productivity, and are further unskilled. Key risks in Indian agriculture include **production risk, market risk, asset risk, operational risk, financial risk, institutional risk and personal risk etc.**

Risks inherent in banana crop insurance

1. **Basis risk:** Basis risk refers to the possibility that the insured person may not receive any pay-out even though they have faced a loss. Alternatively, it could also refer to the possibility that a farmer who has not suffered any loss will receive a pay-out. Therefore, basis risk refers to the errors made by the insurance company.
2. **Spatial risk:** Banana Crop insurance is prone to spatial risk. This is because one farm in every particular area is considered to be the reference farm. Hence, there might be spatial differences in the weather conditions in the reference farm as compared to the actual farm. This leads to wrong interpretation of the yields at the ground level and leads to the two incorrect possibilities as mentioned in basis risk.
3. **Design risk:** Every insurance company has a cause effect relationship which has been mapped between identified causal factors and crop yield. For instance, rainfall may be considered a risk factor. Therefore a variation in the level of rainfall should ideally have a 100% correlation to the crop yield. Well, sometimes it does not. Hence even if the rainfall was poor, there may be a good crop or vice versa. Such scenarios are covered in design risk.

4. **Other factors ignored:** Crop insurance considers all farms in a given area to be homogenous units. In reality, this is not the case. The yield would widely differ from farm to farm even if there were no human interference. This difference would be caused by an differences in the availability of irrigation, the soil type of the farm etc.

Banana production in India

During fiscal year 2022, the volume of bananas produced across India accounted for around **32 million metric tons**. This was an increase as compared to the previous fiscal year. Around 70 per cent of the country's banana production takes place in Andhra Pradesh, Gujarat, Tamil Nadu, Maharashtra, Kerala, Uttar Pradesh, Bihar and Madhya Pradesh. **Banana exports jumped 703 per cent in value terms from Rs 26 crore in April-May 2013 to Rs 713 crore in April-May 2022.**

Agricultural insurance for banana rop with a priority accent on protecting farmers

Farmers are vulnerable to agricultural risks and therefore need a trustworthy insurance system. Agricultural insurance is an important instrument for management of production risks, but because of inadequate access to information, relevant stakeholders are unable to device a suitable risk management strategy resulting in serious losses to the farmer. Governments are important catalysts for developing agriculture insurance market through a variety of interventions such as provision, administration and management of subsidies, support for developing infrastructure for effective implementation of insurance programmes, investment in collection and sharing of data and customer education. In addition, the government's role is very important in developing enabling regulations and using insurance as a part of their social protection and agriculture development agendas.

Agricultural insurance is a means of protecting the agriculturist against financial losses due to uncertainties that may arise from crop failures/losses arising from named or all unforeseen perils beyond their control. Insurance for Indian agriculture has been more challenging than in the developed countries, due to its inherent nature - a large number of small and scattered landholdings, varying climatic and soil conditions, lack of basic data, and variety of agricultural practices, making it practically impossible to implement the scheme on an "**individual basis**" on a wide scale. Further, there was widespread lack of knowledge about the nature and functions of crop insurance amongst the farmers. In 2016, there were four crop Insurance schemes viz., **National Agricultural Insurance Scheme (NAIS), Pilot Modified National Agricultural Insurance Scheme (MNAIS), Pilot Weather Based Crop Insurance Scheme (WBCIS) and Pilot Coconut Palm Insurance Scheme (CPIS)**, operational in the country. On 18th February 2016, the Government of India introduced the **Pradhan Mantri Fasal Bima Yojana** (PMFBY) (www.pmfby.gov.in), which aimed at supporting sustainable production in agriculture sector by way of:

(a) Providing financial support to farmers suffering crop loss/damage arising out of unforeseen events;

(b) Stabilizing the income of farmers to ensure their continuance in farming

(c) Encouraging farmers to adopt innovative and modern agricultural practices, and

(d) Ensuring flow of credit to the agriculture sector.

The **PMFBY** has been envisioned to contribute to food security, crop diversification and enhancing growth and competitiveness of agriculture sector, besides protecting farmers from production risks, and is based "**an area approach**" which means that all farmers in a particular area, must pay the same premium and have the same claim payments. The **Weather Based Crop Insurance Scheme** (WBCIS) aims to mitigate the hardship of the insured farmers against the likelihood of financial loss on account of **anticipated crop loss,** resulting from incidence of adverse conditions of weather parameters like rainfall, temperature, frost, humidity etc. Many insurance providers are looking to digital ecosystems to give them the required agility and customer reach that they require to thrive in the post-digital era where digital technology is everywhere. Unleashing Technology, Creating World-class Agripreneurs, by providing Risk Management Solutions – **Insurance in Everything – Interface of Things (IoTs)** - is **the Way Forward** to overcome repercussions on Farmers' Income, Market stability and Food Safety.

Under the Indian conditions, implementing a viable crop insurance scheme for banana crop at the "individual farm unit level" is beset with problems, such as:

- Non-availability of the past records of land surveys, ownerships, tenancy and yields at individual farm level
- Small size of farm holdings
- Remoteness of hamlets and inaccessibility of some farm-holdings
- A large variety of bananas grown, varied agro-climatic conditions and package of practices, and
- Inadequate infrastructure.

Key risks in inuring banana crop: challenges and priorities

In India, the Agriculture sector has a high dependence on rainfall, limited irrigation facilities, weak institutional structures and low use of technology, thus instrumental for **Operational Risks, Financial Risks, Institutional Risks and Personal Risks**. There are the challenges faced by the Indian farmers as of today, and such challenges are to be understood in a right manner and the farmers are to be protected by creating a right environment.

Insurance is the **Informal Risk Sharing Mechanism** whereby the exposures are shared with others. Insurance intends to protect farmers, protect their income and give access to institutional credit in an institutional environment, eliminating the second and third generation of non-institutional credits, and thus playing a very critical role to the farming community.

In times of volatile prices, agricultural insurance helps protect revenue, provides greater profitability over long term and gives reassurance to the farmers. Risk management can unleash opportunity, and **risk management tools** - such as improved information, crop insurance, and employment diversification - can help people mitigate risk. The ability to mitigate risk, in turn, can allow people, especially the poor, to overcome their aversion to risk.

Agriculture Insurance is a means to protect the farmer against the risks faced due to natural factors such as natural fire, weather, floods, pests, diseases etc. It helps to minimize the loss to the farmers' incomes due to uncertainty and guarantees a minimum level of income/ return.

Agricultural insurance can serve as collateral for operating loans which improves producers' access to credit.

Insurance in Indian agriculture is more challenging than in the developed countries due to its inherent nature – a large number of small and scattered landholdings, varying climatic and soil conditions, lack of basic data, and variety of **agricultural** practices, making it practically impossible to operationalize agricultural insurance products.

- Current insurance scheme for banana and other fruit crops has been beset with **several problems such as lack of transparency, high premium, delay in conducting crop cutting experiments (CCE) and non-payment/delayed payment** of claims to affected farmers.
- Challenges facing Agri-insurers include:

(a) **Moral and adverse selection, post-disaster relief, absence of infrastructure support, intensive data collection**; demand constraints caused low incomes for the vast majority of the population etc.

(b) Agricultural insurance, especially insurance of yield, is a very **complicated concept to administer,** as it has been witnessed. The reasons are many – the systemic nature of agricultural risks going against the working of the "**law of large numbers**" on which premium and indemnity calculations are based, the tremendous scope for moral hazard that contravenes the basic "**principle of utmost good faith**", the difficulty of curbing adverse selection and, above all, **the twin problems of non-viability and unaffordability** that result in a see-saw battle of judgment to continue with the subsidized flat premium.

(c) The biggest challenge for farmers continues to remain the unusual way agricultural insurance works in India: **Farmers are not provided with insurance policy documents or receipts of premiums from banks or insurance companies** that would tell them who their insurer is or received their premium (deducted at the time of taking loans).

Lessons of a case study: Tamil Nadu Banana Farmer Producers Organization (Tiruchirapalli) - A grassroots level situational study and analysis

When Alliance Insurance Brokers Pvt Ltd approached the farmers groups associated with the Tamil Nadu Banana FPOs (Trichy), for insuring their banana crops, the farmers were doubtful on the trustworthiness of the proposed weather based insurance products. As the farmers had bitter experience from earlier agricultural insurance companies of not receiving "any claim", even after paying the required insurance premium, they have shown their reluctance and questioned the basis of insurance, and exhibited their "deficit of trust". Such situations were very touching.

It took about 6-7 months through the 8-9 continuous interactive meetings with the farmers associated with this FPO to get convinced on the insurance product offered by M/s Alliance Insurance Brokers Pvt Ltd, and also to have proper understanding the difference between PMFBY and WBCIS. The WBCIS Insurance product is designed based on the 5 or more years of the National Remote Sensing Agency (NRSA)'s Satellite Imageries and the Indian Meteorological Department (IMD)'s Weather parameters (temp, rainfall, humidity, atmospheric pressure, wind speed, etc.). Farmers were made aware of "Insurance deliverables" in clear terms: "if this situation

happens, we will pay" and "if this happens, we will not pay", "Whether such situation arrives or not is not for the insurance company to decide". Insurance pay-out to the insured should be automatic.

In fact, the farmers took every effort to save their crop and were fascinated to have "**automatic pay out**" of their claims to their bank accounts, when the weather parameters reach its criticality. This process has facilitated complete "elimination" of the perceived political lobbying by farmers for estimating extent of the damages caused due to unfavourable climate conditions, natural calamities and pandemic situations etc., by "village sarpanches and agricultural officers", and also for settling their insurance claims.

Lessons learnt

- It requires a continuous effort (life-long-learning) to educate farmers at grassroots level in terms of how they can protect themselves to grow and also de-risk themselves to a better environment.
- There is a need for coming together: Initiatives, Institutions, NGOs, Government, and Private sector etc., to have this "**Wheels of Change**"- a systems approach to change -start rolling.
- Farmers should be made aware of "Insurance deliverables" in clear terms: "if this situations happens, we will pay" and "if this happens, we will not pay". Whether such situation arrives or not is not for the insurance company to decide. This is the Universal fact.
- Adoption of Blockchain technology enabled "parametric" solution is expected to remove farmers' "Deficit of Trust" on insurance companies.
- Why should the Government subsidize and patronize PMFBY only, when the government is ready to allocate budget to protect farmers? The choice should be given to the farmers to choose PMFBY or WBCIS ("Let the Farmer to decide"). The Government needs to provide subsidy to both the schemes.
- Alliance Insurance is one of the largest re-insurance capacity providers to insurance, comprising of both PMFBY and WBCIS, and also direct distribution of WBCIS on a farm to farm basis (door delivery). Alliance Insurance is committed to communicate, educate, empower and encourage farmers to insure their crops.

Advantages to farmers in insuring Banana Crop

1. **Income stability -**It secures farmers against crop failure-related losses. It's a resource that assists farmers in managing yield and price risks.
2. **Minimum debts**- Even during crop failure, farmers will be in the condition to repay their loans with the help of crop insurance.
3. **Technological advancement** - Insurance companies can also provide information on how to reduce losses, which can help farmers. In addition, IoT can support in technological advancement.
4. **New agricultural practices** - By protecting against loss, Crop insurance assures economic interest. And farmers can adopt new agricultural practices in return to this and can try new measures to protect their crops.

5. **New Insurance Products are** available to protect farmers against sudden fluctuation in prices between the time of harvest and bringing the produce to the nearest market/mandi.
6. **Insurers can assist** in devising customized insurance products to take care of post-harvest losses including during transportation/storage.
7. **Tailor made policies can protect Exporters** against Transit Risks, Rejection and Contamination Risks and Credit Exposures. With Traceability Matrix being mandatory for Exports, there is an imperative need for insuring the same.
8. **Contract Farmers can be protected against** "Loss of Revenue on account of Crop Failure'', whereby the Contract Farmer's offtake is reduced adversely affecting his revenue/earnings.
9. **In case of loanee farmers a package policy can be structed to take care of**

    (i) Loan defaults for a specific period of 3-6 months in case of farmers meeting with major accidents or getting affected by major ailments which could affect their loan repayments. Hereunder, the Insurer pays the loan amounts due for the agreed period.
    (ii) Critical ailments.
    (iii) Worldwide Personal Accident Insurance.

Salient features of weather parametric banana plantation insurance

Who can be covered?

(a) Insured: Individual farmer whether owner or tenant engaged in cultivation of one or more of the crops specified above.

(b) However, a policy can be issued in the name of an Association or an Organized and Registered body of Farmers, engaged in the cultivation of the specified crops where such association or body has been formed and is functioning for the purpose of procurement of inputs, processing/marketing of the produce and /or any other allied activities provided the particulars of each beneficiary farmer is available.

What is the Scope of Cover?

- The Cover provided is Weather Based Insurance.
- Farmers are protected against ''Loss of Inputs Cost'', from the date of Sowing till Harvest.
- The Weather Based Crop Insurance offered covers the following perils:

(a) Excessive rainfall leading to floods.
(b) Deficit rainfall leading to drought;
(c) High temperature.
(d) Low Temperature.
(e) Unseasonal Rainfall.
(f) Losses caused by high speed winds.
(g) Pests and Diseases.

The farmers have the option to choose insurance cover for Excess Rainfall only OR Deficit Rainfall &Disease Conducive Days on account of Humidity/Heat OR a combination of all the exigencies, including wind speed losses. The premium rate is linked to the option chosen.

What is the subject matter to be covered?

The policy shall cover and claims shall become payable in the event of loss or damage to the Banana Crop.

What is the sum insured?

The Insurance herein is by way of Indemnity against pecuniary loss suffered by the Insured in respect of the cost of inputs on account of the loss of or damage to the Horticultural Crop/ Plantations by the perils specified in the policy. The expression "Cost of Inputs' shall mean the recurring expenses incurred to raise the Crop under the following items (wherever applicable and no other item unless specifically agreed).

1. Pruning and training, weeding, planting, seeding, de-thrashing.
2. Soil tillage
3. Fertilizer and manures
4. Maintenance of soil structure
5. Pesticides and insecticides
6. Watering plants (Irrigation)
7. Spraying of microelements
8. Use of synthetic hormones
9. Plant protection
10. Labour charges for the above

The total cost of inputs, to be reimbursed in the event of a claim, shall be the percentage of loss of the cost of inputs actually incurred up to the date of loss. Based on the requirements/specific inputs the above coverages can be modified.

Risk coverages for banana

- Unseasonal/Excess rainfall - Dec to Jan
- Pest & disease cover-Nov to Dec
- Temp Minimum Injury- Dec to Feb
- High Wind Speed cover- November to May/ Annual

Based on requirements/specific inputs the above coverages can be modified.

Weather data & sources:

- **Rainfall** -IMD gridded data
- **Temperature-** ERA-5 modelled data (Please refer attached ERA5 modelled data formation methodology)

- **Relative humidity** - ERA-5 gridded data
- **Wind speed** - ERA-5 gridded data

(1) Based on the Crop and Cropping period, the term sheets are designed dividing the cropping period into 2 or more phases, incorporating the Weather Perils likely to occur during those phases. The various breaches/triggers during the policy period and the respective payments due are collated at the end of the policy period and **within 30 days, the payment is credited to the Farmers' accounts**. In the event of a total loss at any point of time, **''the actual input costs incurred up to the date of occurrence'',** shall be paid immediately.

(2) The Weather Trigger Points will vary from Taluka to Taluka based on location and local weather data for the last few years. For example, the weather conditions like Wind Speed may be different at ODDANCHATRAM and FOOTHILLS of KODAI HILLS. Hence the breach parameters shall also be different.

(3) The biggest advantage is that this insurance involves little or no paperwork. The claim is settled within 30 working days of the policy-end date after collating the occurrences and respective pay-outs. **No elaborate claim formalities like Claim Form, Incident report, submission of newspaper cutting as proof or third party intervention in the form of surveys etc.**

(4) Under the PMFBY, a minimum 75% of the covered area has to be affected or the Collector has to notify the occurrence of the natural calamity. **This policy does not provide for any such stipulation.**

(5) **The Premium would range from 3% to 6% depending upon the risks to be covered. The premium rate would be applied on the production cost per acre. Any taxes including GST would be extra.**

Supply chain management in banana: Cold chain perspective - A Case study

Nagahari Krishna Lokanadham

Director and Head, Industrial Refrigeration
Danfoss Industries Pvt.Ltd, Chennai - 631 604, Tamil Nadu
Corresponding author: Nagahari@danfoss.com; 9500065867

Introduction

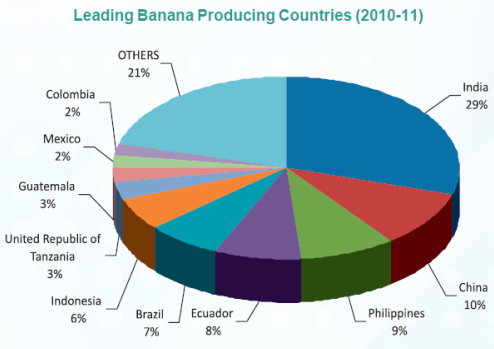
Importance of Banana in Indian Agriculture: Indian economy is still largely dependent on agriculture and Industrial system based on the raw material produced by rural production systems. Banana is an important crop in terms of value of production. If live stock based products are not considered, then it is **within the top 10 in the most important commodity for Indian agriculture. But in terms of investments made by private capital, it is negligible in comparison to Paddy/Rice, Wheat, Sugarcane, Cotton and potatoes.** Probably, the vegetables are the only other agricultural commodity which has not attracted the required investments especially in post-harvest processing systems.

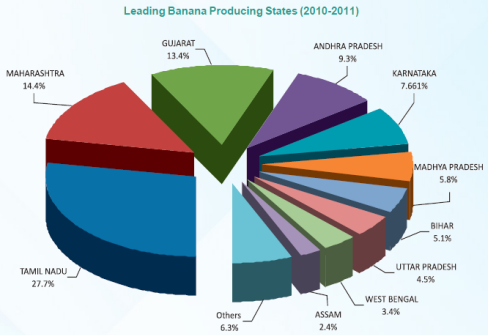
Banana supremacy in overall horticulture production by quantity is growing and has increased from 27.2 % in 19991 - 92 to 33% in 2001 - 02 and now would be around the 40% mark. The importance of banana amongst horticulture produce is only going to increase because of its advantages such as universal acceptance, less seasonality compared to other fruits and vegetables, availability of well-developed technologies for storage/transport internationally and better returns to farmers.

Why Tamil Nadu? Why banana?

One of the Largest producing states in the country, Some distinct characteristics of the State:

- Progressive state and progressive farmers
- Favourable agro climatic conditions, Quality planting material availability, Good local demand and Presence of large number of varieties





Indian value chain Characteristics

- The value chain still not up to date
- Middlemen centric

- Loss of quality and value prevalent in handling
- Negligible investment in infrastructure to prevent losses.

A possible solution: Create a model banana Cold Chain in Tamil Nadu.

Danfoss story

About ten years ago, Danfoss along with a few other industries started a task force with the Confederation of Indian Industry (CII) addressing the challenges around food loss. Realizing that the food supply had major challenges, and that demand for premium food is increasing, the task force sponsored an assessment of the Indian food market, which had not been done before. **As a result of its findings, the task force decided to focus on bananas, as the largest produce lost within in the Tamil Nadu region.**

A study from the CII task force showed potential incremental improvements for farmers in India. This included a possible doubling in income to the farmers and a longer shelf life for bananas. The report asserted that the following were possible:

- Reduction in loss or increase in sellable product by 15 percent;
- Increase in overall price realization by 10 percent;
- Increase in price for premium segmentation by 10 percent of the total value, getting 20 percent higher price realization; and
- The estimated benefit for a representative district in Tamil Nadu is 65 million USD and for the whole state is would stand more than 816 million USD annually.

Even though the facts were evidentially good, the journey was filled with obstacles. With facts in hand, the task force went first to the regional government. Appreciating the study and determination of the task force, the government encouraged them to seek a different path – they were of the opinion that they could not do anything further.

The task force was referred to the Agricultural University of the Region, which said it was unable to use the report but encouraged the task force to work with the more progressive farmers of the region. Finding one progressive farmer, the task force convinced him to implement the post-harvest methods that the study promisingly recommended. After he, and then others, saw success with post-harvest management, the first 'Banana Festival' was established in 2012. It became the first forum where farmers from the region could share their knowledge and help each other to improve their farming methods.

The festival has proven to be a huge success. And today the Indian government wants to take the concept and replicate it in many other regions within India. We've been able to change the production system to be oriented toward minimizing food loss, and this was from establishing the Banana Festival as a forum for knowledge sharing, which made farmers aware of the benefits of post-harvest management. Before the study, there were no or limited management systems and practices, and the cold chain infrastructure was either unavailable or inefficient. As an outcome, today the number of cold storage has increased in clusters.

Ultimately, the farmers' incomes increased three-fold, Mr. AP Karuppiah, Chairman of Tamil Nadu Growers Federation says: "Earlier banana farmers in this belt did not know that we have to take care of the produce post-harvest as well. We were concentrating on producing more. Now we understand the use of post-harvest management techniques like sorting, grading, pack houses, cold storages, and ripening chambers. This has enabled us to reduce losses as well as get better prices for our produce because of better quality. Knowledge transfer from companies has been immense due to the work undertaken by the task force. Markets such as Austria were not known to us earlier. However, this is only the beginning and we have to do so much more in the state."

Today, bananas from Tamil Nadu have reach Europe for the first time! The Festival has been a part of ultimately improving the life quality of the farmers, whose produce is now reaching markets that were unavailable due to the previous short life span of the banana. The farmers' incomes have increased by unbelievable numbers that would make farmers worldwide envious.

Not only do Indian farmers have a festival to get insights into tomorrow's post-harvest management, they have also formalized their organization into one of the first-ever farmer producer organizations in India. It's been exciting to see what's been achieved, and the lessons from this example can possibly have impact in other markets too.

Supply chain management in banana: Integration of tradition and innovation of world's favorite fruit

Karthik Jayaraman

CEO and Co-Founder
WayCool Foods and Products Pvt. Ltd., Chennai, Tamil Nadu
Corresponding author: karthik.jayaraman@waycool.in

Introduction

Banana is the world's most favorite fruit, comprising 14% of all global fruit trade. Banana has several unique characteristics as a traded commodity, as a fruit and as a plant. As a tradable commodity, it is produced predominantly in the Asia, Latin America and Africa regions, with countries like India (31.5 million tons) and China (11.5 million tons) contributing to almost 35% of the global production in 2020, and Ecuador, Costa-Rica, Philippines, Guatemala and Colombia contributing to almost 80% of the exports of this humble fruit. Banana is the primary source of revenue for more than 70 million people in low-income developing economies like Africa.

On the import figures, the top **5 international buyers (including plantains) are the United States of America, Germany, Russia, Belgium and Japan.** Collectively, this group of importers bought 43.4% of the world's bananas in 2021. The main importer of organic bananas is the United Kingdom. The fact that Banana is produced predominantly in the tropics, and its largest consumers are developed, temperate countries, makes the banana supply chain a long, complex and interesting one. **Indeed, this supply chain has, in the past, upended politics in many developing countries in Latin America, in the past.**

As a fruit, Banana is a rich source of carbohydrate and is rich in vitamins particularly vitamin B. It is also a good source of potassium, phosphorus, calcium and magnesium. The fruit is easy to digest, free from fat and cholesterol. Banana powder is used as the first baby food. It helps in reducing risk of heart diseases when used regularly and is recommended for patients suffering from high blood pressure, arthritis, ulcer, gastroenteritis and kidney disorders.

Processed products, such as chips, banana puree, jam, jelly, juice, wine and halwa can be made from the fruit. The tender stem, which bears the inflorescence is extracted by removing the leaf sheaths of the harvested pseudo stem and consumed as a vegetable. As a plant, Banana is probably the best utilized in India, wherein every part of the Banana is either consumed as food or used for other purposes. Some of the latest developments in this field include the use of fibre from Banana for fabric applications, and the treated sap as a soil nutrient.

Banana varieties and their target markets

There are more than thousand varieties of bananas produced and consumed locally in different parts of the World. The most commercialized variety is Cavendish (Dwarf and Grand Naine varieties), which accounts for around 47% of global production. Some of the other commercial varieties are Robusta, Red banana and Nendran. The Cavendish varieties are more commonly produced and exported because of its favorable varietal traits (shorter stem, higher yield per hectare) and marketability (**better resilience to impact to environmental changes and transportation**).

India is fast becoming an alternative source for Cavendish Banana to the Middle East as well as Europe, as their traditional sources, such as the Philippines and other regions are impacted by climate change, diseases and soil quality depletion. This makes the creation of good quality supply chains for Cavendish Banana very critical.

In India, there are several other varieties that are commercially produced for local consumption and trade. These include Rasthali, Poovan, Karpuravalli, Virupakshi, Pachanaadan etc. There are several indigenous varieties which have also obtained the GI (Geographically Identified) tag by the Intellectual Property India (IP India). **This recognition eliminates the unauthorized use of these banana varieties and also acts as a major boost in the marketability of the produce, especially for the International buyers.** In a significant milestone initiative, 22 tonnes of GI certified "Jalgaon banana" were sourced from farmers of Tandalwadi village in Maharashtra's Jalgaon district, a banana cluster identified under the Centre's Agri Export Policy - in June 2021. Other such Indian GI varieties include Moira Banana (Goa), Changalikodan Nendran (Kerala) and virupakshi in Tamil Nadu. It must be noted that these banana varieties are also increasingly being exported to the Middle East, where they cater to the diaspora from the Indian subcontinent.

Banana at WayCool

Banana as a SKU (stock keeping unit) provides a strategic opportunity for Waycool with its year-round supply and demand potential unlike many other seasonal fruits. Waycool has introduced Bananas in multiple lines of business viz. **Retail, Modern Trade, HORECA** along with its own **Sunny Bee** outlets and has developed a robust value chain with farm level sourcing from Mysore (Karnataka), Sathyamanglam, Trichy from Tamil Nadu and Andhra Pradesh. The key operating markets are Bangalore, Chennai, Kerala, Coimbatore and Hyderabad.

Banana Yelakki and Banana Robusta share the largest volume of the SKU with projected annual tonnage of 2000 MT and 4500MT for Yelakki and Robusta respectively alone in the domestic markets, which is altogether expected to **contribute INR 155 million to the topline of the company business.** The firm is focusing on building trust worthy and safety-first brand for Bananas under its umbrella brand of domestic fruits viz. "**Dezi Fresh"** to provide a hygienic and safe alternative to all the consumers against the existing market choices of fruits ripened with hazardous chemicals and ripening malpractices. Along with the domestic channels, Waycool also exports Premium Banana Robusta fruits to Arabian countries like Muscat and Oman.

Challenges in the banana value chain

Production challenges

- A serious threat to banana production continues to be the Panama disease (Fusarium wilt fungus) that has been affecting banana production in Asia. Present in 20+ banana producing countries, this pandemic disease is still challenging scientist around the world, working on its mitigation
- The banana industry is the **second largest consumer of agrochemicals, after cotton around the world.** With increased competition in terms of volumes and price, the intensive

monoculture practices in banana production poses a serious threat to the environment (soil, water, biodiversity) and its resources.

- The pressure on quality and volume involves high cost of cultivation for the smallholder farmers, who produce 80% of the global volume.

Other challenges

- Lack of awareness among producers and suppliers on the compliance, packaging and quality requirements of international markets, leading to minimal export volume for the country
- High production cost leading to lesser competitive price for international buyers
- Highly **sensitive ripening**, which needs to be managed with precision to deliver the right level of ripeness for the retailer, and consequently the customer

WayCool's integrated value chain for banana yelakki - A case study

Waycool has established a vertically integrated value chain Banana Yelakki in Karnataka region. In coordination of its Farmer support team of Outgrow, Waycool engages with the Yelakki farmers of Mysore-Hulahalli region by guiding them with scientific cultivation practices and safe crop protection methods. A regional aggregator is introduced above a particular set of farmers assisting them for labor and transport arrangements at minimum intermediary commission

WayCool ground team conducts field inspections at routine intervals and selects right fields for harvesting as per the maturity stage of looms. Post harvesting, a field executive of Waycool accompanies the aggregator for field level grading as per different customer requirements, segregating material into Premium and Economy grades suitable for different line of businesses. Farm level grading ensures minimum material handling in further steps of the value chain and also establishes a liquidation plan for all the harvested material irrespective of the quality deviations caused due to natural factors like fruit size, black marks etc.

Post grading, the material is then sent to a ripening chamber, where the material if exposed to three stage ripening process viz, **Pre-cooling, Gassing and Ventilation.** In gassing treatment, the material is infused with Ethylene gas, which speeds up the ripening process by 48-72 Hours without applying any chemical residues on the fruits. The gassing quantities are monitored strictly as per sales plans to avoid excess ripened stocks leading effectively restricting the spoilage and wastage. All the additional raw as well as ripening material is maintained at 13 ^{o}C to restrict the ripening. **With this level of controls, the firm has demonstrated to limit the material wastage to 0.2% of total traded volume.**

The use of cold chains in Banana

Highly sensitive ripening of Banana, makes temperature control an essential factor to minimize the wastage of the product. However, the cold chain use is limited to the export line of

business and not for the domestic resulting into large wastage volumes of Banana in domestic market. Thus, the cold chain perspective in Banana value chain can be looked with two aspects:

Cold Chain interventions in Export value chain

For perishable products in the export supply chain like the Cavendish Bananas, cold chain plays a crucial role in minimizing the quality impacts on the produce. The cold chain covers the transport of export quality produce all the way from the farm to the customer. The various steps include:

1. Reefer container at the farm.
2. Reefer container movement from farm to the port
3. Reefer container operation and maintenance at the port.
4. Building up of the pallet in a Reefer container at the port (if container is not stuffed in palletized form at the farm).
5. Shipment with continual temperature control and monitoring
6. Offloading at the receiving country, followed by local ripening

Throughout this cold chain, the use of ripening inhibitors is critical. $KMNO_4$ is the most common material used for this purpose which acts as an ethylene absorber in an export container. A newly developed equipment called "Ethylene Scrubber" is also used to absorb the existing ethylene gas in the air effectively slowing down the ripening.

Cold chain interventions in domestic value chain

The domestic markets of Banana operate at much lower margins compared to export lines, thus on rare instances temperature controlled referred vans are used to transport the material. However, some of the domestic value chains also **extend to 700-800Km in distances of road transport,** especially for traditional Banana cultivars which are only associated to particular regions, for such cases it becomes much important to find alternative solutions for ripening control. One of such solutions can be the use of thermal insulator pallet covers also called as **thermal pallet blankets** which help to keep the cold temperatures intact for longer time in transit and slows down the ripening.

Conclusion

The development of modern supply chains, incorporating appropriate cold chain and ripening control technologies for Banana will become imperative as India emerges as the primary alternative source of Banana for the Middle East and Europe in the next decade. Further, the increasing consumption of varieties of Banana across the country, as tastes universalize across India, will necessitate innovations in the post-harvest management of domestic varieties of Banana as well. **Institutes and enterprises investing in this value chain stand to gain significantly in the emerging decade.**

Reaching the new milestones in Logistics - Hurdles and Solutions - Maersk story

Kuljeet Rajora

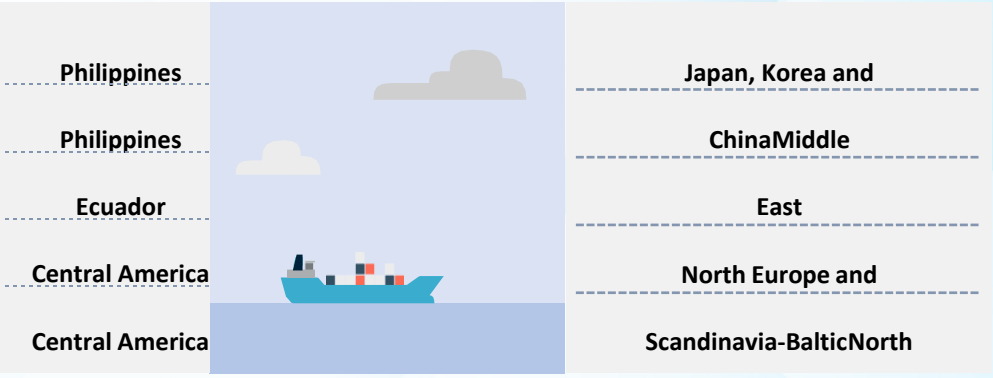
Reefer Sales Manager, A.P. Moller - Maersk
Maersk Line India Private Limited, Gurgaon
Corresponding author: kuljeet.rajora@maersk.com; 9872770703

World banana trade expanded to unprecedented heights in recent years

Bananas are among the most produced, traded and consumed fruits globally. More than 1,000 varieties of bananas exist in the world, which provides vital nutrients to populations in producing and importing countries alike. The most traded variety is the Cavendish banana, which accounts for just under half of global production at an estimated annual production volume of 50 million tonnes.

Bananas are particularly significant in some of the least developed and low-income, food-deficit countries, where they can contribute not only to household food security as a staple but also to income generation as a cash crop. The world banana trade has expanded to unprecedented heightsin recent years, with an estimated export volume of 21 million tonnes in 2019. Key drivers of the trade include abundant supply growth in the leading export countries of Ecuador and the Philippines, and a significant increase in import demand, particularly by China and the European Union (EU). **Report source: Fresh Plaza**

Major global trade lanes

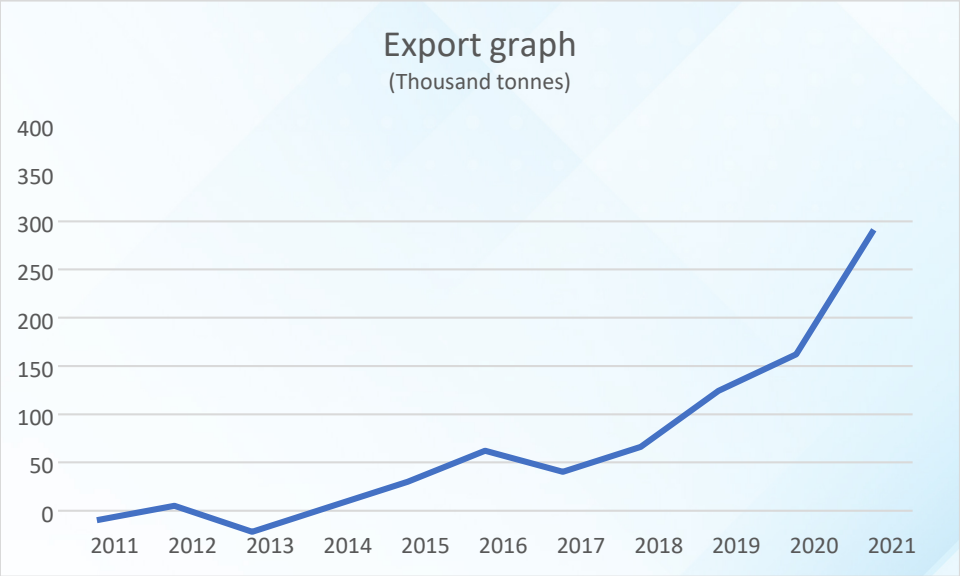


Indian Banana

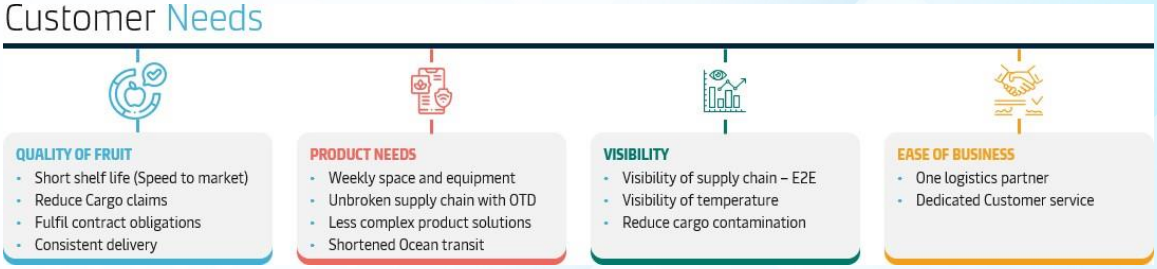
India being the largest producer of Banana, already on growth journey when it comes to export butlong way to go. India's banana exports grow 8 fold in 9 years during the April-May period. The rising exports benefit our farmers immensely while enhancing India's agricultural exports earnings'' **- Piyush Goyal**

Report source:

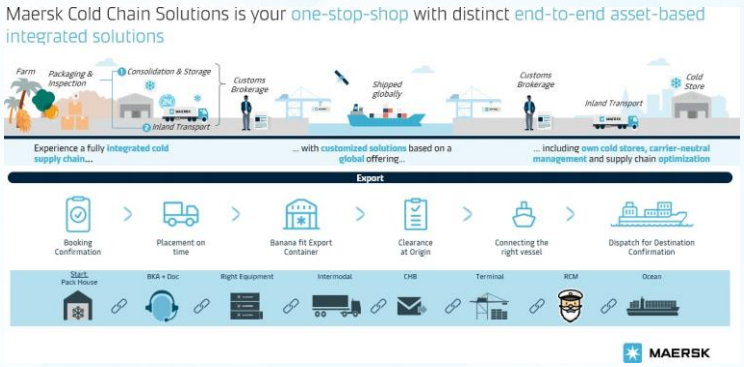
https://economictimes.indiatimes.com/news/economy/foreign-trade/indias-banana-export-increases-by-703-a-jump-of-8-fold-in-9-yrs-says-piyush goyal/articleshow/92820394.cms?utm_source=contentofinterest&utm_medium=text&utm_campai gn=cppst



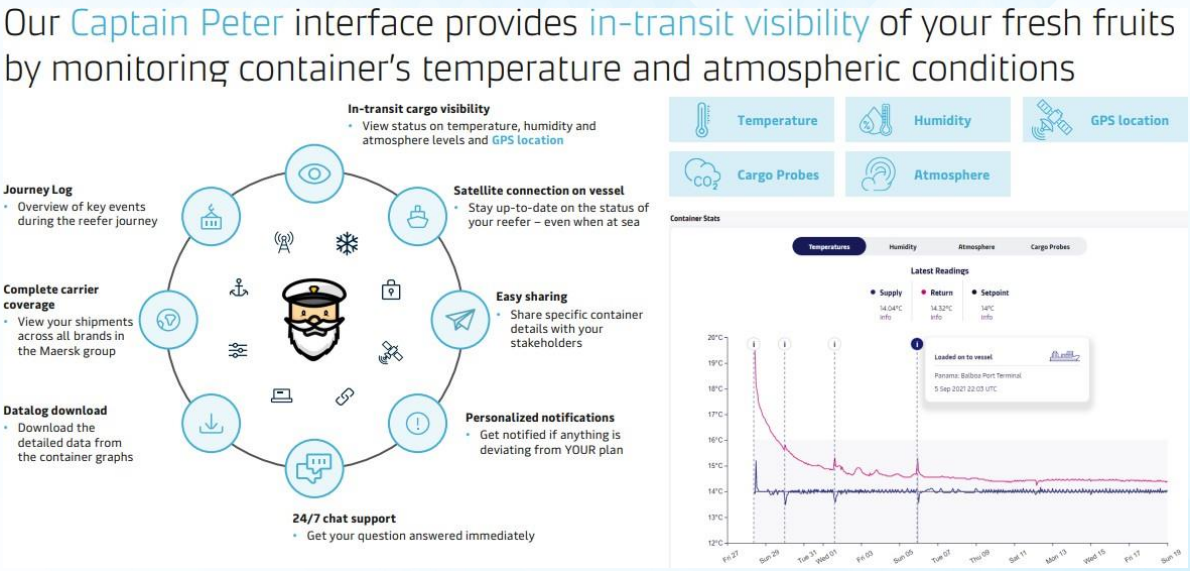
Major trade lane for Indian Banana are Middle East countries with huge potential to explore otherdestinations like Far East and Europe.



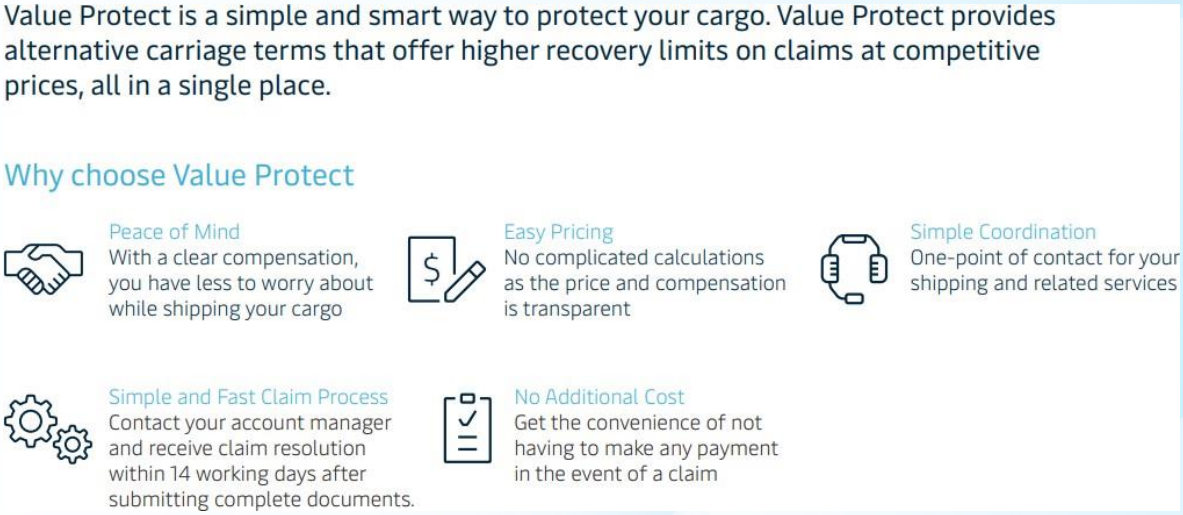
Maersk cold chain solutions



Captain Peter (Remote Container Management)



Maersk value protect



Maersk Cold Chain Solution is an end-to-end integrated logistics solutions right from **Farm atorigin to retail store** at destination with the scope of **packaging, cold storage and ripening chambers**, also we are open to understand **customer requirements to develop customized solutions.**

VI
Impact of FPOs / Entrepreneurs / Start up ecosystem on banana sustainability

Banana cultivation for export - Role of FPOs

Ajeethan G

Managing Director
Tamil Nadu Banana Producer Company Ltd. Thottiam, Tiruchirappalli, Tamil Nadu
Corresponding Author: ajeethkisan@gmail.com; 9443714352

Introduction

Being grown throughout the tropics and subtropics, Bananas are a source of food, nutrition and income for millions of rural and urban households. Banana contributes 37% of total fruit production in the world. Tamil Nadu is the fourth largest Banana producing state in India, with a cultivation area of one lakh hectares and producing around 40 lakh metric tons of banana in recent years (2020-21). The major Banana growing districts are Theni, Erode, Tiruchirappalli, Tuticorin, Cuddalore, and Coimbatore. The main commercial varieties grown are Grand Naine, Ney Poovan, Nendran, Poovan, Rasthali and Karpooravalli apart from Virupakshi (GI) hill banana that is grown in lower Palani hills.

Production and Marketing challenges

The basic weakness as well as the strength is the **fragmented land holding** of the farmer in Tamil Nadu. There is no discipline or control over the method of farm practice. However best bananas are produced by small holdings. The recent change in the mindset of the banana growers in adopting best farm practice by way of use of Tissue culture seedlings, Drip and fertigation methods, following pre and post-harvest practices recommended by our research institutes and Universities. **This has improved the overall production performance by 32% (NHB-2020/2021) over past five years.**

Banana being the fast-perishing nature of the fruit, it faces may problems till it reaches the hands of the consumer. A chain of middle men, transportation damages, loss during storages etc., which eventually makes the producer to opt for a **pre-harvest contract system**. At the time of fifty to sixty percent maturity of the crop, majority of the growers search for the traders to enter into a **rate contract** harvest. The prime reason stated is that pre-harvest contract gets advance payment to meet their immediate needs for production, procurement of supporting poles and other family expenses. This type of **contract system provides a kind of insulation due to wide market price** fluctuations. The **absence of timely institutional credit and crop insurance** force down the grower to a level of insecurity during high monsoon and cyclonic winds causing physical damage to the banana fields. Unable to get bailed out of the dept trap and the long association with the contractor and high risk in marketing cost sustain the continuance of the contract system.

However many constraints noted in the contract system of marketing are, undesirable and un healthy marketing practices of the private contractors by **way of deduction of 2 to 5 bunches for every 100 bunch as profit bunches, combining two small bunches as one bunch during counting for fixation of price, leaving small bunch in the orchard as unfit for sale, delay in payment of balance amount after contract, violation of contract terms, abandoning the harvest in the event of slump in the market price.** Furthermore non-availability of pack house,

good storage and cost effective ripening facility are also contributes to post-harvest loss in bring down the revenue of the grower.

Need for Farmer Producer organizations

The ultimate solution for the farmers to improve their revenue is to sell their produce collectively and competitively. The government of India embarked a programme of forming commodity producer groups and convert them in to Farmer producer companies with special amended rules in companies Act and financial support through agencies like SFAC and NABARD. The state departments were also directed to form producer companies and special state level financial support and interventions are also provided to them. The Scheme is intended to undertake and provide following relevant major services and activities for their development which would cater to increasing farmer's income,

- Supply quality production inputs like Tissue Culture seedling, fertilizer, pesticides and such other inputs at reasonably lower wholesale rates.
- Make available need-based production and post-production machinery and equipment like cultivator, tiller, sprinkler set, combine harvester and such other machinery and equipment on custom hiring basis for members to reduce the per unit production cost.
- Make available value addition like cleaning, assaying, sorting, grading, packing and also farm level processing facilities at user charge basis on reasonably cheaper rate. Storage and transportation facilities may also be made available.
- Undertake higher income generating activities like seed production, bee keeping, mushroom cultivation, Banana fiber production etc
- Undertake aggregation of smaller lots of farmer-members' produce; add value to make them more marketable.
- Facilitate market information about the produce for judicious decision in production and marketing.
- Facilitate logistics services such as storage, transportation, loading/unloading etc. on shared cost basis.
- Market the aggregated produce with better negotiation strength to the buyers and in the marketing channels offering better and remunerative prices.

Tamil Nadu Banana Producer Company

Tamil Nadu Banana Growers Federation which was started in 2005 is sensitized to form the Tamil Nadu Banana Producer Company Ltd (2014) in line with the guidance of SFAC (Small Farmers Agri-Business Consortium, Dept. of Commerce, Govt. of India, New Delhi) and Tamil Nadu Agricultural Marketing & Agri-Business Department to effectively cater to the business needs of the Banana growers in Tamil Nadu. We have 1060 banana growers as shareholders in our company which has been formed with Four Banana Producer Societies and 47 banana grower Groups covering from 12 banana growing districts of Tamil Nadu. It is envisioned to work and transact business for the holistic development of cultivation and marketing of Banana and its products. Caring for the Banana growers Wealth and Consumers Health as well.

Activities and Achievements

The producer company geared up to facilitate Business oriented activities through their member groups adopting various agro technologies in utilizing the pack house and ripening chamber facilities provided by Tamil Nadu government under supply chain management scheme. Starting from Fresh fruit sales to value added products from our native banana varieties. That apart, the company associated with Tamil Nadu agricultural university and ICAR- National banana Research center to design Cable way conveyor handling for banana and to develop protocols by sea and air for exporting Tamil Nadu grown bananas to foreign countries. The Confederation of Indian industry (CII) has joined hands to help the banana growers and to familiarize the Tamil Nadu grown banana varieties in upcountry and international Markets.

- Four editions of Banana festivals (between 2012 and 2017) and dissemination programmes were conducted successfully in association with Confederation of Indian Industry (CII) as a strategic partner.
- Gross root level study on pre and post-harvest intervention required for quality production and marketing of Banana was conducted by our company with experts at South, East and Western parts of Tamil Nadu comprising 100 progressive banana growers and report submitted to Govt. of Tamil Nadu.
- Submitted a proposal to GOI to link North-South corridors with reefer cargo train link on PPP mode for cost effective transportation of perishables and other commodities.
- An MOU made with National Agro Foundation, Chennai partnering for the development and distribution of tissue culture seedlings to rejuvenate the traditional banana varieties grown in Tamil Nadu.
- An MOU made with Tamil Nadu Consortium of Farmer Producer Company Ltd for establishing network retail business centres (Unnatham Uzhavar Angadi) of FPOs in Tamil Nadu. The company has promoted a confederation of farmer producer companies of Tamil Nadu (CONSFPOT) to include different commodity grower companies as members to derive the benefits of collective strength and inclusive growth.
- A MoU made with Indian Institute of Food Processing Technology, Tanjore to develop technology to produce Banana Juice, Banana Stem Juice, Banana Puree. For the benefit of the grower groups to venture into value addition.
- A MoU was signed with ICAR - NRCB, Trichy for transfer of technology to start commercial venture to Produce Banana ready to serve juice (RTS) and Banana juice with Basil seeds.
- Sample shipments of Cavendish, Red, Elakki variety of bananas were successfully exported to European countries that has successfully opened up new opportunities of banana trade from Tamil Nadu.

Our sustained efforts started yielding good results in cultivation and marketing of banana as well. The Cavendish variety (Grand Naine) growers have recorded around 60 M.T of yield per hectare in Theni district of Tamil Nadu that has brought their income level to an extent 2.5 lakh per

acre from 75 to 1 lakh rupees per acre. Thanks to the introduction of improved agro technologies from the ICAR- National Research Centre for Banana (NRCB) and Tamil Nadu agricultural university which has changed the Economic status of the banana growers who adopts these improved farm practice. In the post Covid scenario, bigger export opportunities are awaited for our native banana varieties and it is right time that banana growers in Tamil Nadu should form more producer companies and focus on collective marketing which will certainly will more than double the farm revenue in the years to come.

Banana Export - Challenges, scope and solutions - an importer perspective

FG Zinggl

Managing Director
Avieko Trading Ltd. (Trade in Fruits and Vegetables)
Vordere Zollamtsstrabe 111030 Vienna
Corresponding author: fg@avieko.at

Historical - difficulties to overcome

About ten years ago when the first troubles started with TR4 and the Panama disease, journalistic panic distributed as if the commercial banana would have arrived at its physical end and along with it, the livelihood for millions of people. The then known extent of the disease was limited to the economically important countries in Central America, who are the export champions on the banana sector. Europe and North America were frightened by the news and as one of the many players in the industry I turned my head to alternatives.

Besides the tropical Americas there are the Philippines, East Africa and India as important growing areas and when the first news appeared that also the Philippines and some East African country showed signs of the diseases, I turned my head to India to see, whether business can be done with local exporters there.

To my big surprise there were no such exporters on a big scale. In my investigations I heard about big American companies who had tried to implement vast plantations (as they did in Central America), but stumbled by the stubbornness of the Indian mentality. It should turn out that this probably saved India from the fast distribution of the diseases as by the traditional cultivation of rather small units the diseases cannot spread so quickly. Exports were undertaken only in a very limited way and then to the Gulf countries where lots of Indians work and want to be supplied by their traditional food, to which obviously also bananas belong. In the official statistics the figures were neglectable.

Touring around India and speaking to many players in the industry, I found out that the care of cultivation in India was on a very low level, whereas the technical research and development stood at the contrary. The gap in between was something that had to be overcome. To check that as a foreigner was impossible so I had to start from scratch and find someone who was willing and, in a position, to pull along.

Initiating a project with four local players we moved forward in very small steps as everything seemed to take ages when you are not behind it and motivation has to be your best friend. Finally, we arrived at the point where we could say that we had achieved an exportable quality, a trial container was sent on its way and success proved us right. How to overcome the price gap between the cost structure of Indian bananas and those industrially exported by the American countries was the next challenge. Looking at all options one had to give in and realize that you cannot catch up with a 70years' advantage of other countries, having also a marketing machinery at their side.

The alternative had to be looked for in another variety and investigations were started to test and select which other variety should be laid concentration on.

Present - What has been achieved, what is still to be done

The Red banana turned out to be the most 'exotic' and interesting one. Not that other countries had already tried to introduce the Red banana on the European market, but the quality and taste of the Indian red banana was so much superior that it could not be compared.

Since the Red banana is much more costly and has a considerably lower yield too, the final selling price in a shop on the European market was calculated to be approximately triple as high as the G9 from America. Would the consumer accept this at all? Would there be sufficient buyers to make it popular among a bigger crowd?

We have not been able to find out as two world-wide hindrances stopped all our efforts and planning, the pandemic and the energy crises caused by the war in the Ukraine. Consumers strive to pay their heating bills, scrimp and save wherever they can – and that is mostly with food – and are absolutely far away from trying new fruit varieties.

Therefore, the initiation of a 'new' product for the European market has to be postponed.

Preview - An unknown perspective

Until when it has to be postponed, we all don't know with today's perspective of the situation. But what can be done in the meantime is the following; it is essential and necessary and a must to enter into business with the big players in Europe and America, without that nobody can start to do business anymore: **certification**.

Global GAP certificate is the minimum level to handle fruit exports and there India is still far behind. It shows the consumer and above all the decision makers with the purchasing departments of the supermarket chains that standards will be kept with regard to hygiene, social measures (e.g., no child labor), phytosanitary spraying kept to a minimum and that no prohibited agents are sued in the process of packing, etc.).

The initial costing for it is rather high and a small producer is not in a position to cover the costs for the certification process. There governmental institutions have to take money in their hand and try to support clusters to make it financially bearable. But there is no way that leads to exports without Global GAP anymore. This certainly does not reflect the marketing measurements that are also required to promote a new product on a far-away market.

India through her embassies overseas has to organize **road shows** to make the fruit popular, 'create a brand' as one would say in the professional dialect. There will be better times, for sure and then India has to be prepared. So, the gap between the first steps taken and the final stage of harvesting the success MUST be used to prepare these two issues. Otherwise, the exports will further concentrate on the Gulf countries with their limited capacities.

Another disadvantage that India has versus banana producing countries in other parts of the world and that is the **transport situation**; there is no fast and direct connection by sea between India and Southern European ports. A distance which could be overcome in 9 days currently takes at least 21 with one or two transshipments.

Relying on international shipping companies has proofed to be wrong. Every little crisis will be strategically used by them and leave the exports (as well as the necessary imports) in a dramatical position. We have experienced this in the recent years when prices for sea-freight containers went up to triple the amount of the period before. If India had her own transport system in place, the country's economy would be independent from such developments – as currently South Africa is exampling it now. Whether the economic situation in world trade is improving fast or will take some more years is unknown to us and depends more on world politics than on our good will. But we have a chance to utilize this time to be prepared for the moment when it will be better.

Building modern integrated fruit value chains in India; reaping the banana potential

Vineet Munjal[*] and Marcel Stallen[**]

[*]*Managing Director, Aurick Initiatives Pvt. Ltd., Managing Director, Popma Fruit Expertise.*
[**]*Consultant, Holland Door Cooperative*
Corresponding author: vineet.munjal@aurickinitiatives.com; frits@aurickinitiatives.com; m.stallen1@kpnplanet.nl

Introduction

Aurick Initiatives Private Ltd. in collaboration with public and private partners in India and the EU will professionalize and improve the performance of the banana sector in India through a value chain approach (from farm to fork) in the coming years. To achieve this goal multiple synergetic and complementary projects will be initiated by Aurick Initiatives and partners in India. Activities comprise, among others, the introduction and demonstration of modern ripening equipment and protocols and capacity development of actors engaged in the banana value chain, both for domestic and export markets.

The banana sector in India - Current situation

Currently the Indian banana sector is **poorly organized and in transparent; post-harvest handling of bananas is insufficient or non-existing and losses are high**. Modern pack houses and ripening centres are absent or not functioning. Whereas India is the largest producer of bananas in the world (31,000 MT in 2020), **less than 1 % of the Indian production is exported and Indian bananas represent only 0.3% of the international banana trade.**

The average Indian production levels are 20 tons banana/acre, which is much below the Indian yield optimum of 25 to 30 tons/acre but also below the production figures of major exporting countries such as Ecuador and the Philippines of 50 tons/acre.

It is estimated that 30% of the Indian banana goes wasted, in particular during transport of bananas from the farm to grass root collection centres and rural markets. As a result of the poorly functioning of the value chain in combination with un trained farmers and operators, the cost price of Indian bananas is high; quality is low; losses are high and shelf life is limited to 1 to 2 days only. Hygiene, certification and traceability of bananas in India does not meet international standards and Indian products face difficulties entering EU and Middle East markets.

The opportunity - Fruit and vegetables in India

At the **demand side** it is envisaged that domestic consumption of fruits and vegetables in India will increase in the coming years due to rising income levels of the population and the need for nutritious, healthy, pesticide free fruits and vegetables. The population of India is young (almost 50 % is below 25 years of age) and they are increasingly aware of the health benefits of fruit and vegetables. Fruit and vegetables fit in a diet to control diabetes and in general the health and wellness market is a growing market in India and globally and will ultimately boost fruit and vegetables consumption.

At the **supply side** there is an urgent need for introduction of **climate smart and good agricultural practices** in India, in particular for bananas, which is a major crop in India and consumes a lot of water. There is also a push by the Government to increase farmers' incomes, through higher productivity, reduction of losses in the value chain and increasing product quality of fruits and vegetables.

Investing in fruits and vegetables will give a quick return on investments as compared with field crops (cereals, pulses & oil seeds). Fruits and vegetables are also popular with farmers, having smaller land holdings. Additionally, the Federal and State Governments in India are promoting exports to earn hard currency and to generate additional income in particular for small farmers.

Reaping the Indian banana potential: Partners and strategy

India has considerably potential to produce more efficiently, better quality bananas; both yellow bananas for the domestic market as well as green bananas for export markets. Improvement of on farm productivity and enhancing and controlling banana quality in the value chain will result in increased production, lower cost prices, lower losses, higher farm gate prices and eventually in a better quality and extended shelf life of bananas in the retail. By doing so thousands of small Indian banana producers will be directly connected with modern, lucrative markets and in combination with the introduction of contract farming, farmers' incomes will increase. Higher farmer incomes will support larger socio-economic structural changes in India.

The following public and private partners will cooperate to improve banana value chains and reap the banana potential: **Aurick Initiatives Pvt Ltd** is a company registered in India, orchestrating and managing fruit value chains together with progressive companies. Aurick also represents a group of Dutch and Indian companies, active in among others, banana ripening (technology and construction); cold storage, tracing and tracking of agricultural commodities, packaging, trade, retailing, training, quality controlled logistics. The Aurick mission is to introduce modern integrated value chains for fruits and vegetables in India; starting with banana.

Partners have carved out a strategy of modernizing and rationalizing the entire banana value chain (VC) and consolidation of the VC through ripening centres and (close to farm) rural collection, collection, washing, quality control and packaging centres. Major components (not exhaustive) of the strategy, with banana as a pilot crop, are:

1. **The introduction of new technologies and innovative practices**, encompassing climate smart production methods; pre and post-harvest management including packaging; ripening of bananas; certification and quality controlled logistics, in order to enhance the overall performance of Indian banana value chains.
2. **Capacity Building** of actors across the banana value chain, including staff of fruit ripening and packaging centres, producers, extension staff, services and input providers and retail staff.
3. EU and Indian companies will establish modern, commercial ripening facilities in Chennai. Apart from demonstrating modern technologies and products, companies will also optimize and finetune their hardware (ripening rooms) and software (ripening protocols) for the local Indian conditions and markets.

Banana as a pilot product

Modern banana value chains, including ripening and distribution centres are labour intensive and create extra jobs to supervise and manage the ripening process. But also the initial washing, grading, packaging close to the farm and transport under hygienic and quality controlled conditions requires skilled labour.

Added value and efficiency in the banana value chain is created among others through packaging bananas in (biodegradable) plastic bags in standardized, reusable and foldable plastic crates for transport and subsequent ripening. The introduction of sustainable plastic crates for transport and ripening of bananas for the domestic market will improve quality and hygiene of the bananas and reduce the use of corrugated carton boxes. Meanwhile a feasibility study on the use of plastic crates in India has been conducted and the outlook for plastic crates in the fruit and vegetables sector appears to be positive.

It is estimated that overall, 30% of the Indian banana goes wasted, in particular during transport from the farm to collection centres and rural markets, due to poor quality control and post-harvest practices. To improve this situation, the consortium will introduce interventions throughout the banana value chain. In particular the introduction of improved handling practices "upstream", close to the farm and controlled ripening will reduce waste levels considerably.

Worldwide bananas are an important retail product in terms of profitability and traffic (consumers) generator. Therefore, an attractive presentation and a daily, fresh supply of high quality bananas with good shelf life in the retail will attract many customers and thus boost overall retail sales. A number of retailers have already shown an interest in high quality, yellow bananas and are in the process of signing an agreement with Aurick.

Projects

Aurick, in collaboration with partners in India and the EU (= the consortium) will launch the following projects to improve and rationalize banana value chains in India from 2023 onwards.

The 1st project ("**Modern Banana Ripening technology for the Indian market**") focusses on the construction of a commercial ripening and distribution centre for bananas for the domestic retail market in Chennai, Tamil Nadu. Demonstrations and finetuning of state-of-the-art fruit ripening technologies and equipment (hardware and process technology) for local Indian conditions will also be conducted at these ripening facilities in Chennai.

The 2nd project ("**Capacity Development for improving the banana value chain in India**") focusses on skills and capacity development of staff operating modern fruit ripening rooms as well as packaging, collection and distribution centres. This comp rehensive project intends to uplift the capacities of all actors of the banana value chain in India, encompassing producers, input and services providers, technicians (constructors of collection, ripening and distribution centres), transporters and retailers.

The 3rd project is the **commercial upscaling and duplication** of the pilot ripening and distribution facilities, established in Chennai in major banana clusters, near big cities in India. Aurick intends to establish and operate multiple modern banana ripening and distribution centres for domestic and export markets in the coming years all over India.

What is new for the Indian Fruits and Vegetables sector

The following innovative aspects can be identified in the consortium approach and projects to "**build 21st century integrated value chain for fruits and vegetables in India**"

1. **Capacity Development** through public and private partners such as hardware suppliers, training consultants, coordinated by the Centre of Excellence Banana in Trichy. Indian trainers will be supported and coached (ToT, Training of Trainers) by the consortium to train banana value chain actors, starting with staff engaged in the operations of the consortium ripening centre in Chennai.
2. Effective **Training modules** on major topics of the banana value chain will be developed for farmers, extension workers and other stakeholders, using tablet computers and smartphones. The pilot ripening facilities and model packhouse / distribution centre in Chennai and other training facilities at the CoE for banana, Trichy will eventually become the central training hub for fresh fruit and vegetables chains in India. **contract farming** will be introduced by the Aurick Initiatives led consortium, with guaranteed prices for farmers (and a topping up if agreed quality standards are met). Contracts between Aurick Initiatives, retail partners and Farmer Producer Organizations will be signed to ensure an uninterrupted and planned supply of bananas to the packhouses, ripening centres and retail shops.
3. **Partnerships with farmers producer organizations** will be strengthened and the consortium, through the proposed capacity building project, will invest in farmers skills development. So called Farmer Business Schools will be established and supported in the banana sourcing districts.
4. The introduction of **quality-controlled fruit ripening,** using gas tight cells, controlled temperature and atmosphere (Eco Top System) for improved banana quality is also new at the Indian market.

The art of banana ripening

Modern ripening facilities play a pivotal role in quality controlled banana chains. How does ripening work?

After the arrival of green bananas in seaports of Canada or United Arab Emirates, to mention a few Indian export destinations, or in New Delhi for the domestic retail, bananas are moved into special banana ripening cells.

Controlled banana ripening takes place in specially constructed, gas tight, insulated and standardized banana ripening rooms. In a 20 MT cell, 20 to 24 pallets are placed in a single tier. Each pallet contains 48 boxes of 18.4 kg bananas.

Before starting the actual ripening process all bananas should have the same product temperature. **The temperature of the bananas determine the duration of the ripening process. Normally, banana temperatures vary from 15° C, resulting in an 8 day ripening schedule, whereas bananas of 19° C can be ripened in 4 days. However, the higher the banana temperature, the shorter the remaining shelf life of the bananas in the retail.**

When all bananas in a cell have reached the required temperature, ethylene gas is injected. Ethylene gas is a natural ripening gas, produced by bananas, apples and many other fruits. Ethylene activates certain enzymes in the banana pulp and skin which facilitate the conversion of starch into sugar and acid, such as fructose, glucose and sucrose. During this enzyme regulated conversion process the green colour of the banana peel turns yellow.

5. A **digital platform (dashboard)** will be established for banana farmers, transporters, ripening centres, financial institutions and market agencies for multiple purposes. Among others this dashboard will provide tracking & tracing services, digital mapping, document tracking, production analysis and on-line communication with farmer communities (farmer producer organizations) and in general to streamline Information.

Viable banana clusters and centre of excellence banana

The before mentioned banana development projects, initiated by the Aurick led consortium, are aligned with the Horticulture Cluster Development Programme, launched by the National Horticultural Board (NHB) in India. In the NHB view, clusters should leverage geographic specialization and promote integrated market-led development, including the strengthening of Farmer Produce Organizations. Sectoral or commodity organized Centres of Excellence (CoEs) play a pivotal role to accelerate and modernize Indian agriculture.

In the context of cooperation between India and the Netherlands Government a Centre of Excellence (CoE) should serve as:

- Demonstration centre of appropriate, modern Dutch, location specific technologies for sustainable and safe food (crop) production and modernizing the agricultural sector in India.
- Training centre for latest technologies in agriculture for building competence (knowledge and skills) with stakeholders of the industry
- Source of quality planting material for fruits, vegetables and floriculture for protected cultivation and well as open field cultivation.

A CoE can be initiated by the public sector as well as by private partners; in both situations CoEs are instrumental for enhancing public private cooperation. CoEs are also structures in which development projects implemented by the State Government of India can be captured.

Capacity development is pivotal for improving banana value chains in India

Project activities on “Capacity development for improving banana value chains in India” will primarily focus on:

a. Training of trainers and coaching of CoE staff on all aspects of the banana value chain. The CoE team of banana experts will subsequently train the actual stakeholders and actors of the banana value chain on production; ripening, packaging and logistics; post-harvest handling, business management and marketing.

b. Applied research and technology development and implementation under Indian conditions. Newly developed and / or assembled knowledge, such as appropriate ripening protocols for the various Indian banana varieties, will directly feed into the training and demonstration activities.

c. Demonstrations and hands on, real life experiencing of ripening technology and practices, which are crucial for quality control and reducing wastage in banana value chains. Secondary, the project will also focus on:

d. Establishing a Banana knowledge and innovation platform for among others public private dialogues with stakeholders; to stimulate an integrated supply chain approach and to introduce market driven training modules on bananas in India.

Project impact and sustainability

The proposed banana development projects will contribute among others to: reducing losses and waste in the banana value chain; reducing the impact of climate change (through the introduction of climate smart agricultural practices), creating jobs and income in particular for women and youth, improving occupational health and working conditions in the banana value chain (through reduction of and safe use of chemicals).

Policy compliance

Activities are fully compliant with the with Federal and state policies and the policy of the National Horticulture Board (NHB) in India. For example, NHB has adopted a Horticultural Cluster development strategy and supports Centres of Excellence (CoE).

The following development priorities of the Netherlands Government are addressed through the proposed projects: reducing waste and losses in the chain; introduction of climate smart agricultural practices; capacity and skills development; empowerment of farmer producer's organizations; economic empowerment of women and youth; support and promotion of Dutch technologies and companies and cluster development. The Government of the Netherlands has signed a Memorandum of Understanding with the Indian Government to support the implementation of horticulture clusters and CoEs.

The proposed banana value chain projects contribute to the United Nations Sustainable Development Goals (SDGs), in particular SDG 1 (no poverty), SDG 5 (gender equality), SDG 8 (decent work and economic growth), SDG 9 (industry, Innovations and infrastructure) and SDG 12 (responsible consumption and production).

Voluntary compliance certificates: GAP certification and others, need and procedures for export of bananas

Kaushik Sengupta

Head Food Business
Bureau Veritas India
Corresponding author: kaushik_sengupta20022002@rediffmail.com

Introduction

Globalization brings new opportunities for food producers, along with new challenges to meet growing demands for quality and food safety. Capturing new opportunities to export high-value horticultural products will require producers to manage safety from farm to table and to meet increasingly stringent food-safety standards in import markets. The public sector can play a role in improving food safety and quality to meet export-market standards, and addressing domestic issues of consumer safety at the same time. To enable farm produce to be internationally competitive innovative farming practices incorporating the concept of globally accepted Good Agricultural Practices (GAP) within the framework of commercial agricultural production for long term improvement and sustainability is essential. GAP in addition to improving the yield and quality of the products, also has environmental and social dimensions. Implementation of GAP would promote optimum utilization of water resources such as pesticides, fertilizers, water and eco-friendly agriculture. Its social dimension would be to protect the agricultural workers' health from improper use of chemicals and pesticides. It is a particularly opportune time to promote GAP when second generation of reforms in agriculture which would have a Critical impact on Indian agriculture, are planned by the Indian Government. There are different systems and standards available for control measures in value addition through processing of food meant for human consumption. Although grade standards on size, shape, colour and local preferences are available for most of the fruits and vegetables marketed and consumed in India, their quality in terms of maturity standards, residues of pesticides and other contaminants, microbial loads, etc. have not been adequately addressed. The Indian Good Agricultural Practices (INDGAP) takes into account not only the quality and quantity of the produce obtained from a unit area but also the care is taken in integrating pre-harvest practices like soil & water management, nutrient management and pest management, harvesting, post-harvest handling and other logistics. It is therefore necessary to have a comprehensive view while defining control and compliance systems for different farm produce covering horticulture, floriculture, food grains, etc. The areas where appropriate control measures need to be strengthened are farms producing raw material such as food grains, fresh fruits and vegetables, floriculture, etc. to ensure sustained supply of produce of the desirable quality.

Scope of the standard

These standard covers control points and compliance criteria for the following farm produce in fresh unprocessed form for direct human consumption or for further processing for human consumption by food industry. The main components of this standard are base modules and crop-based modules:

Basic Modules

i) All farm base module ii) Crops base module

Crop Based Modules

i) Fresh fruits and vegetables ii) Combinable crops iii) Tea iv) Green Coffee

What can be done to comply with food safety standards? Capacity building at macro level

Extension agents should be trained in

- GAP basic principles
- Integrated Pest Management (IPM) and integrated crop management
- European Union/United States/Japan food regulation and market
- Requirements for exports /SPS/TBT agreement
- Packaging and post-harvest technologies
- Traceability procedures
- GAP auditing
- Market information systems

Capacity building at farmer level farmers need to be trained in,

- Pesticide management
- Traceability and record-keeping
- Farm business management skills
- Environmentally and socially sound practices
- Basic food hygiene and sanitation
- Post-harvest management.

Certification criteria

The criteria contain Control Points and Compliance required to be followed by the individual producer or a producer group as well as by the certification bodies for verification purposes. These criteria are divided into main sections and are marked as Critical indicating these have a definite effect on the quality of the produce and should, therefore, be complied with, or should give adequate assurance about the safety of the produce. Similarly, major and minor requirements are indicated in the mentioned requirement.

Control points and compliance criteria

This section describes control points and compliance criteria for different modules. These control points and compliance criteria are based on Indian Farming Practices and regulatory requirements.

Compliance to control points

To achieve certification the producer must demonstrate compliance level of the Control Points and Compliance Criteria to the levels as indicated below. The Certification Process is aimed at covering Individual farms or Group certification. For group certification the requirements and quality management system shall be addressed separately.

Compliance requirements

The level of compliance shall be established based on the following: G.A.P.
Critical - 100% Compliance of all applicable Critical control points is compulsory
Major - 95% Compliance of all of applicable Major control points is compulsory
Minor- No minimum percentage of compliance required

Labeling requirements

One of the objectives of this Scheme is to provide information to the stakeholders - secondary processors, aggregators, buyers and retailers about the status of the produce being adhering to G.A.P. This shall help them to maintain the integrity of the produce while the produce is being handled in the supply chain.

Besides all essential information like the details of farm and or marketing organization, batch number or lot number being mentioned in transaction documents such as invoices, bill of lading etc. they shall also bear the Certification Mark against which the produce is certified.

The off product material such as invoices, letter head, promotional material shall be labeled with the Certification Mark as 'G.A.P.' Any additional information that adds value and apprises customer will be encouraged, provided it is not inaccurate or misleading.

Labeling requirements as per the relevant regulations of the country where it is produced and will be sold shall also be ensured.

Key stakeholders within horticultural supply chains

The consumer is the ultimate buyer and/or end-user of produce in horticultural supply chains. A consumer may be a business, a household or an individual.

Consumer within the chain refers to business within the chain that has direct dealings with each other. Packing houses, for example, are the customers of growers of horticultural produce, while retail stores are customers of packing houses.

Flows with the modern supply chain that govern optimal functioning three major flows within horticultural supply chains govern their optimal functioning:

Product flow: Fresh produce flows in one direction through the chain, starting with input supply and ending at the retailer, who makes the final product available to consumers.

Financial flow: Financial flow takes place in the opposite direction of produce flow, whereby payments go to suppliers as produce moves downstream (from the producer through the various customers within the chain) towards consumers. Financial flow is generated through the willingness of the consumer to pay for produce that meets his/her requirements.

Information flow: Information flows in both directions throughout the supply chain. Market information on consumer requirements, as well as information about what is demanded by customers at successive steps of the chain, travels upstream (from the retailer through the various customers to the producers), while information about supply conditions and product attributes travels downstream.

Information flow is very important in coordinating activities at the different steps of the chain in order to assure that these activities satisfy market requirements. It facilitates planning and coordination of supplies and therefore helps to minimize losses. Information related to the identity of produce (for example, origin, variety, orchard block from which harvested), treatment at the pack house and handling (for example, the temperature and relative humidity during distribution) through

Enabling Environment

- Financial flow
- Information flow
- Input supply Growing Post-harvest operations Distribution Retailing Consumers Product flow

The enabling environment

An enabling environment consists of those factors external to the chain that impact upon optimal functioning of the chain. Elements of the enabling environment include:

- Enabling policies and regulations
- An infrastructural support base to facilitate chain operations
- Business development support services, which include:
    - ✓ Banks that provide loans
    - ✓ Companies that provide market information
    - ✓ Equipment hire services
    - ✓ Logistics companies that transport and/or store produce
    - ✓ Trainers and technical assistance providers

Consumers, the driving force of the horticultural supply chain Value-creating activities are applied within horticultural supply chains to impart attributes that are of value to and which are demanded by the final consumer.

Consumer demands define the quality of production inputs as well as production, post-harvest and distribution practices. Information flow up and down the chain is, therefore, a crucial element in meeting consumer requirements.

Each participant in the chain requires its upstream producer to supply produce that will allow it to meet the requirements of the downstream customer. This is applied until the end of the chain, where retailer provides produce that satisfies consumer requirements. Thus, by delivering value to its customer, each supply chain partner effectively delivers value to the final consumer.

A packing house, for example, requires growers to supply fruits of the appropriate quality that will allow it (the packing house) to grade, treat and package the produce to meet the needs of retailers. These retailers will, in turn, supply fruits that meet the needs of consumers.

Value chains

A value chain is a particular form of supply chain that is created when chain partners have a shared vision and common goals that aim to meet specific market objectives and consumer needs. The value chain may encompass the entire spectrum of the supply chain, from customer to producer. It is differentiated from a generic supply chain by the following characteristics:

- Participants in the value chain have a long-term strategic vision.

- Participants recognize their interdependence and are disposed to work together to define common objectives, share risks and benefits, and make the relationship work.
- Participants have a shared commitment to control product quality and consistency.
- Participants have a high level of confidence in one another, which allows greater security in business and facilitates the development of common goals and objectives.

Maturity Indices for Banana

- Bunches are harvested when the top leaves start drying
- The colour of the axis of the finger's changes from dark to light green Brittleness of the floral ends should fall with slight touch
- Changes in the angularity of fingers from triangular to round or sharp
- Number of days from emergence of inflorescence: 95 - 110 days

Crop Protection

Planting material

- Seeds/planting material must be free from pests and diseases.
- Seed records must be kept to indicate variety, purity, germination, batch number, seed supplier and country of origin.
- All seed treatment (products) applied should be recorded, together with the pests/diseases targeted.
- Seeds must be handled carefully to avoid contamination.
- Planting material must be stored according to the manufacturers' instructions in order to prevent damage or contamination.

Site Selection/Management

- Land for crop production should be selected based on previous land usage/history/capability/ suitability.
- Test sites for contaminant(s) if land history is unavailable/unknown.
- Check sites for potential biological/chemical/physical hazards.
- Crop production activities should be located at a suitable distance from livestock operations to avoid animal contamination.
- Fields should not be sited near feedlots or points where animal waste can contaminate.
- Run-off/contaminated water should not be allowed to enter fields.
- Map out production areas (field/orchard/greenhouse) prior to planting.

Land Preparation

- Soil must be properly tilled and weathered before planting.
- Avoid over tillage.
- Prepare land using techniques to improve/maintain soil structure and to avoid compaction.
- Avoid mechanical land preparation on slopes above 20 degrees.
- Use equipment appropriate to soil type and moisture content.

- Mechanical land preparation should be done on land where it will improve/maintain soil structure

Soil Management

- Prepare soil maps prior to planting.
- Soil conservation measures, such as contouring, cover cropping, mulching etc, should be employed to prevent erosion and soil degradation.
- Soil type should be appropriate for the crops being grown.
- Only properly composted/aged manure must be used in fields.
- Manure should be incorporated into the soil before planting.

Water Management

- Put water-conservation methods (dams, tanks) in place before planting.
- Records of water consumption must be kept.
- Use water-saving irrigation methods, e.g. drip, micro - sprinkling.

Irrigation/ Fertigation

- Identify water source before planting.
- The irrigation water source should be protected from animals and other sources of contamination.

Crop Protection (Pesticide Usage) field application

- Pesticide application should be controlled throughout every phase from usage to storage.
- Pesticides should be obtained from approved sources.
- In selecting an area on the farm for handling pesticides, users should take note of the location of water sources to avoid contamination.
- Establish vegetation or other barriers to help limit contact between chemicals and water sources.
- •Use environmentally friendly chemicals. - Use only chemicals approved for crops being grown.
- Pesticide handlers must wear the appropriate protective gear

Sanitary facilities

- Clean, well-serviced toilets (one toilet to 10 workers) must be easily accessible during working hours.
- Staff doing field work should be provided with facilities for showering and changing of clothes during fieldwork.
- Hand-washing stations/facilities should exist in the same ratio as toilets. Soap, single-use towels and potable drinking water should also be provided.
- If portable toilets are used, they must be serviced regularly, and the sewage disposed of by qualified service providers. (Cleaning schedules should be in place).
- Drinking water must be provided in sufficient quantity for all employees.
- Lunch rooms/changing rooms and toilets should be located away from food-handling areas.

- Equipment/material used for sanitizing and cleaning should be provided for use in these areas exclusively. (Do not use bathroom equipment to clean food-handling areas).
- Consumers need to be assured through traceability regarding products they eat Traceability food-safety approach In for Banana supply chain, consumers and other clients require:
- Information on production of the product: where, when, how, with what components;
- Respect for the technical specifications: adeptness, control, audits;
- Crisis management: competence to find and withdraw defective or dangerous products from sales points;
- Assurance that the company produces in a socially responsible way. Traceability is the ability to trace the history, application and location of any entity by means of recorded identification.

Seed and planting material procurement related rules

G. A. P. certification covers fruit and vegetables used for fresh, cooked, or processed consumption by humans.

Maximum Residue Limit (MRL)

In India, the main purpose of setting a MRL is to ensure that the best methods of crop production – known as Good Agricultural Practice (GAP) - are being used to keep residues in food as low as possible. When registering a compound, registrants must provide information on the least amount of that compound required to control the pest / disease and measure the residue that results from that use (if any). The MRL is then set at that level so that if residues exceed this level, it indicates GAP and label directions have not been followed.

MRLs are outlined in the regulation Food Safety and Standards (Contaminants, Toxins and Residues) Regulations, 2011 and amendments thereunder. 5% of the MRL Value is applicable for organic food under Food Safety and Standards (Organic Foods) Regulations, 2017 for specific crops or crop groups and compounds. The India MRL regulation is regularly updated and can be accessed on the FSSAI website: https://www.fssai.gov.in/cms/product-standards.php

Unless exporter have Exporter manufacturing category specifically mentioned in his License issued by FSSAI under FSSA 2006, in such cases non-confirming products cannot be sold in India, in such cases, it is necessary for producer to declare on record that the crop is cultivated only for export market and not for India market.

Residue Management System (RMS)

In the IndG.A.P. Scheme, the scheme requires the producers to be a part of RMS or as RMP mandatorily. The said document details the requirements of RMP is being mandated by APEDA, the apex agro export promotion body of the Government of India. The details of the same are available in the APEDA website (https://apeda.gov.in/apedawebsite/Grapenet/Hortinet.htm). Mandatory minimum criteria of a Residue Monitoring System (RMS) is as under.

Definition of first, second - and third-party sampling,

a. First-party sampling: When the producer (Option 1) or a producer group member (Option 2 member) takes the product sample from its own production. For certification, the first-party sampling (self-sampling) is acceptable, but an RMS cannot be based on first-party sampling.

b. Second-party sampling body: The sampling organization is a 2nd party sampling body when it is a separate, but identifiable part of an organization that is involved in production, supply, purchase and/or or ownership of the products sampled by the RMS (e.g., the option 2 QMS runs an RMS for the program on their supplier, an independent laboratory runs an RMS). Second party sampling bodies supply sampling services only to their related organization. A second-party sampling body may form a part of a user or supplier organization, or an intermediate or end customer of the products sampled.

c. Third-party sampling body: The sampling organization is a 3rd party sampling body when it is a separate organization that is not involved in production, supply, purchase or ownership of the products sampled (e.g., an independent company, an inspection body or a CB runs an RMS). It shall demonstrate that it does not have common ownership with the sampled producer, nor have common ownership appointees on the boards (or equivalent) of the organizations, is not directly reporting to the same higher level of management, does not have contractual arrangements, informal understandings or other means that may have an ability to influence the outcome of the sampling.

Records

a. Records (e.g., test results, correspondence with producer and, if applicable, actions taken because of non-compliances) shall be kept for a minimum of 2 years.

b. Records shall include:

i. System documentation including the risk assessments

ii. Annual update of the risk assessments including the determination analysis method, the list of active ingredients to be analyzed

iii. The annual monitoring plan

iv. Analysis reports

v. Records of follow up actions

vi. Communication with producers

Certification requirements

To be GLOBALG.A.P. Certified, banana producers must comply with the Control Points and Compliance Criteria (CPCCs) for fruits and vegetables.

This covers all stages of production, including pre-harvest, soil management and applications of plant protection products, as well as the post-harvest processes, produce handling and storage on farm.

There are two certification options:

Individual certification: a single producer applies for the certification and holds the certificate. Producers with multiple production units can apply for individual certification with or without a quality management system (QMS).

Group certification: a group of producers request certification and the group, as a legal entity, is the certificate holder. In this case, the implementation of a QMS is required.

In an option 2 producer group the producer members can deliver product as CERTIFIED only with the written consensus from the producer group's QMS representative. The transaction can be done physically directly form the member farm, but under the control of the producer group's QMS. The sold amounts (certified and non-certified) and the buyer must be registered by the producer group's QMS to enable the CB verifying mass-balance. The producer group's QMS management cannot sub-grant or sub-license certification and/or issue a statement or any letter suggesting that the member is individually certified. The selling entity on the sales invoices must be the same as the legal entity of the producer group.

Assessment Process

Inspection Timing

The following rules apply together with the inspection timing rules described in G.A.P. Regulations.

Initial (First) Inspections

a. The initial inspection shall cover harvesting activities of each product to be included for certification, as well as produce handling if it is included. Other field work can be checked at a different time where feasible, but this is not obligatory.

b. The inspection shall take place as close to harvest as possible for the inspector to verify as many control points as possible.

c. If the inspection is made before harvest, it will not be possible to inspect certain control points. As a result, either a follow-up visit will be required, or proof of compliance shall be sent by email, photos or other acceptable means. No certificate will be issued until all control points have been verified and all non-conformances have been closed.

d. If harvest takes place before the inspection, the producer shall retain evidence (Video Clips, Photos, Record of transactions) for compliance of control points related to that harvest, otherwise some control points may not be able to be checked and certification will not be possible until the following harvest.

e. The CB shall make sure that in the sampling for unannounced visits, those producers that did not receive a first inspection or the subsequent inspection during harvest have a greater chance of getting an unannounced inspection during the next harvest (this needs to be conveyed to the producer when discussing inspection timing). Additionally, the CB shall make every effort to carry out the subsequent inspection during harvest.

f. Multiple crops: The producer may be seeking certification for more than one crop and the crops may not all have the same seasonal timing, i.e., harvest of one crop does not necessarily coincide

with the harvest of other crops. The requirements above are applicable to crop groupings based on similarities in production and harvest processes and their risks. The CB shall verify all control points of these groupings before the product(s) can be added to the certificate. Example: A visit during apple harvesting is not required when apples are being added to a certification scope that already includes pears.

However, the banana can only be added to the certificate once all control points applicable to them have been verified.

Subsequent Inspections

a. The inspection shall be carried out at a time when relevant agronomic activities and/or handling (but not only storage) are being carried out.

Inspection timing shall allow the CB to gain assurance that all registered crops, even if not present at the time of inspection, are handled in compliance with the certification requirements. Inspections off-season or when the farming activities are minimal shall be avoided.

b. If produce handling is included in the certification scope, the produce handling facility (ies) shall be inspected annually. This inspection shall be carried out while in operation. Only when the CB has carried out a risk assessment that clearly shows that the risk is low, can produce handling be inspected during operation once every 2 years. The risk assessment should take into account the product(s) being packed as well as known food safety incidences related to the respective product(s) and any directives from G.A.P. to look at specific points. The CB shall keep justification of the reason for the chosen inspection timing on record. This exception is only applicable for Option 1 producers without QMS.

c. If produce handling is excluded from the certification scope, inspection has to be scheduled during harvest season at least every 2 years. In the respective year, the harvest season of at least one registered product per product grouping has to be inspected. Crop groupings are based on similarities in production and harvest processes and their risks. The CB shall keep justification of the reason for the chosen inspection timing and the crop groupings used on record.

Crops may be grouped according to the following,

i. Mechanical harvest: The only method of harvesting. In this case there is no need to observe the harvest while in operation. It is sufficient to check only the machine and harvesting machine operation related records after or before the harvest.

ii. Manual harvest of low-risk products. The product is low risk when:

- Always cooked before eating, or
- Always cleaned before eating i.e., cannot be eaten without cleaning, or
- Dry nuts, Dried Spices on Farm or
- Products with inedible skin or shell, or
- Product with pathogen reduction step after harvest (still unprocessed) and/or,
- No known food safety incidences related to the respective product

iii. Manual harvest of high-risk products. All other products that are not under are considered as high risk.

iv. Harvest that involves water or ice

v. Packing in field

d. If the producer does not commit to continue with the certification for the next cycle, the CB shall ake sufficient provisions to avoid situations where one certificate could be used to cover more than one harvest and growing cycle of the same annually harvested crop, e.g., by shortening the certificate validity. The CB can set the deadline for reconfirmation according to the harvest period of the crop.

e. Example: Harvest season for blueberries is the entire month of October. The first inspection takes place during October 2015 and the certificate is issued from the end of November 2015 to the end of November 2016. This certificate may cover the harvest and sales of the 2015 and 2016 harvests. Therefore, the CB shall set the deadline for reconfirmation (re-acceptance of the product), e.g. for October 1st, 2016 and if the producer does not reconfirm by that date, the CB shall shorten the validity of the certificate.

f. Multiple consecutive crops: During the inspection, the production process of all crops included in the certification scope shall be assessed on farm via site visits, interviews with the producer and workers, review of documents, records, etc. The producer shall keep evidence of compliance with the applicable control points for all registered crops.

g. In the years during which there is no requirement to carry out the inspection during harvest season and where crops do not have the same seasonal timing, the CB shall select a date where relevant agronomic activities can be seen on farm for at least one of the products.

Unannounced Inspections (Option 1 only)

a. If during a producer transfer the incoming CB has not seen the harvest season of all products included in the certification scope, an unannounced inspection (within the 10 % rule) shall be scheduled during the following 12 months, in order to inspect the harvest process of products not seen.

Inspection of Product Handling Units (Option 2 and Option 1 Multi-sites with QMS)

In fruit and vegetables, for the annual CB audit the square root of the total number of central product handling sites registered (those where the products of more than one grower is handled) shall be inspected while in operation. If there is only one central product handling facility, it shall be inspected every year.

Inspection duration

The inspection duration shall allow for an opening meeting with the farm management, a complete evaluation of all standard requirements, completion of the applicable checklist and the presentation of the results to the producer.

The usual G.A.P. production site inspection duration for IndG.A.P. Crops are between 3 and 8 hours (Option 1 producer). The minimum of 3 hours duration shall apply to the simplest circumstances (one location, one or few crops, simple machinery, few workers, no produce handling, subsequent inspection, documentation is well organized, etc.). Option 2 producer group members might have inspections of shorter time duration depending on the complexity of the farming situation.

Factors that will increase the minimum of 3 hours (the list is not exhaustive and is applicable for Option 1 and for Option 2 members) are as follows:

a. Initial inspection
b. Addition of new crops during subsequent inspections
c. Addition of new locations during subsequent inspections
d. Storage included
e. Produce handling included
f. Different types of products (product groups)
g. Multiple sites and locations
h. More sub-scopes
i. Subcontractors used (not checked by third party)

Fees of certification

The G.A.P. fee calculation is based on the type of the standard or the kind of assessment (e.g., Integrated Farm Assurance or GRASP), the scope (e.g., Crops), the product (e.g., Banana), and often also the production quantity (e.g., 5 hectares or 1,000 tons).

1. Producers will be charged a service fee for this option by their Certification Body/Trustee.

Fees are as follows:

a) Single Producer - Option 1: 10 EUR

b) Producer Group - Option 2: 25 EUR per producer group and 1 EUR per producer group member

This fee applies only once, irrespective of the number of other programs registered.

2. Due to technical constraints, registrations of other programs are only valid for 1 year and must be renewed annually.

3. The producer is solely responsible for informing the Certification Body/Trustee in the case of any changes.

Conclusion

If correctly implemented, GAP can limit the following risks,

Microbiological contamination of water and tools; Unsuitable or contaminated soils;Inappropriate tool or machinery handling; Dangerous product storage and chemical contamination; Contamination of the fruit due to inappropriate chemicals doses; Introduction of new pests, pathogens or diseases into the production area; Health risks for workers related to

pesticide use; low fruit quality; low production. Many GAP guidelines and standards have been created at the international, national and local levels by international organizations, industry groups, companies and civil society organizations.

Definition of Terms Used

(a) Applicant grower/grower group: Person/organization for certification that has applied for certification to GAP accredited certification body.
(b) Approved grower/grower group: Person/organization that has successfully applied and obtained a certificate from INDGAP accredited certification body.
(c) Non-Conformance: means an incident where the requirements of the scheme are not met.
(d) Pack-house/produce handling unit: Any facility set up for handling harvested produce (do not process the produce by changing its shape or appearance). Packing carried out at point of harvest is considered produce handling. Also any storage, chemical treatments, trimming, washing or any other handling where the product may have physical contact with other materials or substances.
(e) Pesticide: Plant protection product.
(f) Certification Body: An organization that has been accredited to grant INDGAP certificate as per the procedure laid down in this document.
(g) Food safety: An assurance that food will not cause harm to the consumer when it is prepared and consumed according to its intended use.
(h) Global Trade Item Number (GTIN): The global identification key of GS1 system used to identify trade items in a unique manner.
(i) Global Location Number (GLN): The global identification key of GS1 system used to identify physical locations uniquely.
(j) Global Traceability System (GTS) : is a generic framework of GS1 which can be used by any business, any industry sector, any organization, large or small, to meet the core need of traceability (one step up, one step down as a minimum) at any point in the supply chain.
(k) Harvesting containers: Containers used for transporting produce during harvest.
(l) Hazard: A biological, chemical, physical or any other property that may cause a product to be unsafe for human consumption.
(m) Individual grower: An organization or person legally responsible for on farm production, who retains ownership of all the produce covered in this INDGAP certificate.
(n) Inspection: An examination of systems for control of food, raw materials, processing and distribution including in process and finished product testing in order to verify compliance to requirements.
(o) Critical/Major non-conformance: Means an incident that results in decrease in confidence in the product compliance with quality and food safety requirements and requires corrective action to be implemented in order to regain confidence.
(p) New agricultural site: Land being planted for the first time
(q) Post – harvest chemicals: Includes post-harvest plant protection products, detergents, and lubricants.

(r) Potable water: Water which needs the quality standards of drinking water such as those described in the WHO published guidelines for the safe use of waste water and excreta in agriculture and aquaculture.
(s) Primary produce: Produce at a stage before processing.
(t) Processed product: When the structure of the product is altered in appearance or form.
(u) Produce: The harvested product of the crop before it is sold.
(v) Product: The produce sold to the customers.
(w) Product tracking: Ability of a system to track the movement of food products in the food supply chain and to record the information about related attributes from Farm to Fork. This is also termed as downstream traceability.
(x) Record: Document showing objective evidence of the tasks performed and results achieved.
(y) Registered product crop: The crop that produces the product that has been registered by the grower with the certification body under INDGAP.
(z) Registered product produce: the produce that is the result of the registered product crop.
(aa) Registration Number: The number given to grower or grower group when he has completed the registration.
(bb) Self-Inspection: Internal inspection of the registered product crop carried out by the grower on his farm using Control Points and Compliance Criteria.
(cc) Sub-Contractor: Specific farm operations performed under the contract between the grower and the contractor that are covered in the INDGAP Control Points and Compliance Criteria.
(dd) Trace-back: Ability of a system to trace the movement of food products in the food supply chain and to record the information about related attributes from Fork to Farm. This is also termed as upstream traceability.
(ee) Worker: Any person on the farm that has been contracted to carry out a task. This includes farm owners and managers.
(ff) In-organic Fertilizer: Commercial chemical fertilizer.
(gg) Grower group: Group of growers applying for certification with an internal procedure and internal control of 100% members registered to the INDGAP requirements, which has legal structure and complying the requirements as specified in this document.
(hh) Field, Orchid/Green-house: Separate units of land within a farm.
(ii) Farm: A farm is an agricultural production unit or group of agricultural production units; covered by same operational procedures, farm management and INDGAP decision-making activities.
(jj) Environment: Water, air, land, wild species of fauna & flora and any inter relationship between them, as well as relationship with living organisms.
(kk) Customer: A customer is anyone who purchases products or services from a supplier.
(ll) Crop year : Generally, the 12 month period from the beginning of harvest of a particular crop rotation.
(mm) Annual crop : When the time period between end of propagation stage to first harvest date is less than 12 months.
(nn) Crop rotation : The practice of growing different crops in recurring succession on the same land. It also includes crops on certain plot are following other crops according to pre-defined plan.
(oo) Certification : All those actions leading to the issuing of an INDGAP certificate.
(pp) Crop : The plants, which produce the produce.

Voluntary compliance certificates: Organic certification, need and procedures

Bhimsen Joshi

Aditi Organic Certifications Pvt. Ltd. Bengaluru, Karnataka
Corresponding author: bhimsenjoshi@aditicert.net; 9423858996

According to the NPOP, (Govt. of India), the US National Organic Program (NOP), EU Regulations, COS and ADITI Private standard interpretation; the following details are to be taken care of for Organic Certification: -

Group certification

- Is a necessary tool to allow smallholders access to organic markets
- Requests a high level of commitment and knowledge by the organization or certificate holder
- Is possible for crop production, animal husbandry, or beekeeping

Normative framework

- According to NPOP, the group certification system shall be based on an internal quality system and shall apply to groups, cooperatives, contract producers and small-scale processing.
- According to **NOP**, farmers with less than 5,000 USD annual turnovers can sell organic products without certification; this, however, refers more to smallholders in the USA, who sell directly to consumers. These producers are not allowed to display the USDA - seal.
- The International Federation of Organic Agriculture Movements **(IFOAM)** organized several meetings on groupcertification, and then published a set of normative and training documents.
- ADITI, taking into account these different approaches, has worked out its own policy; the following is based on this interpretation.

What are smallholders

We take the definition of small holders according to **NPOP/EU**, which states that the producers in the group must apply similar production systems and the farms should be in geographical proximity. Farms with land holding of 3.9 ha and above can also belong to a group but will have to be inspected annually by the external Inspection and Certification agency. The total area of such farms shall be less than 50% of the total area of the group.

What is a producer group

- ✓ Producer groups can be cooperatives, associations, or similar organizations; but also processing or trade companies can organize their suppliers in a producer group. Producer groups must be located within the same geographical region, have the same kind of product and similar production systems.
- ✓ In case the group is spread over a large region, it has to be subdivided in smaller groups. Group certification makes sense only for groups from **25 members** on; nevertheless, also smaller

groups should feel encouraged to set up their own internal control system, independently from the percentage of external control by the certifier.

Internal control

- The group should have a legal status (registered)
- As a basic requirement, **all producers** have to be controlled at least **twice** per year by the **internal inspectors.**
- Internal inspectors must be adequately **prepared** for performing their job; we recommend training by our staff.
- **Conflicts of interest** must be avoided when selecting internal inspectors; nevertheless, we recognize thatsituations may exist, where consultants will have to do the internal inspections
- Internal inspections must be documented in **reports**, signed by the producer and the inspector; and the reportsmust be properly filed.
- Internal inspectors must dedicate enough **time** to each inspection.
- Reports must describe all relevant features of the operation, and must outline **non**-conformities.
- Results of internal control must be **evaluated** and summarized in the organic management plan and in the Internal Inspection Report Revision Spreadsheet.

Internal Quality System (IQS) or Internal Control System (ICS) and approval

- The group must have **Standard Operating Procedures (SOP),** including, among others, registration of thefarmers, remediation measures and sanctions for non-conformities.
- The group should have an **Internal Standard,** which is a simplified and customized version of theNPOP/EU/NOP/COS.
- The internal regulation must be written in a local language, which is understandable for all group members.
- The group must have sufficient **Staff** to operate the internal control system including but not limited to internal quality manager, internal inspectors, approval committee, field officers, purchase officers, processing officers depending on the size of the operations.
- An internal **approval body** must evaluate the reports, supervise the inspectors, pre-approve growers, and imposeremediation measures.

External control

The sampling plan for inspection shall be based on the inspector's perception of riskbased on the following factors:

1. Size of holding
2. Number of the members in the group
3. Degree of similarity between the production system and crop system
4. Inter-mingling / contamination
5. Local hazards

- The number of producers controlled by the external inspector, is determined by the square root of the number ofall growers, multiplied by a risk factor:

- **y = r x √x** (y = producers controlled by our inspector, r = risk factor, x = number of all group members); theminimum is 10
- The **risk factor** "r" can vary between 1 and 4: groups with a low-input crop, good internal control system (ICS) and low rate of nonconformities, will have a low risk factor, and vice versa; example:

Pesticide use	ICS	Risk factor	Number of producers					
			15	25	50	100	200	400
			Producers to be visited by ADITI inspector					
Common	Poor	4	15	20	28	40	56	80
Uncommon	Good	1	10	10	10	10	14	20

- The sample for external evaluation must, of course, be **representative** for the whole group; in big organizations, each subgroup's ICS has to be evaluated separately.

Records

- The group must present a detailed organic **management plan.**
- Farmers must keep a minimum of records (see "brief information on crop production")
- Records on purchased, stored, processed, and sold quantities must be kept at each step, from the producer toexport or final sale.

Certification

- The group can **only be certified in case the ICS works properly**; this includes, among others that internal inspectors must detect non-conformities, and the approval body must react properly and implement the respective corrective actions.
- **New producers** can be included in the organic farmers list only after approval by the certifier.

Note: *Please be aware that this is only a selection of essential requirements of the organic standards, meant as an introduction. The operator, of course, has to learn about and meet all requirements of the respective standard.*

Steps to organic certification according to NPOP, Govt. of India, EU Regulations, US National Organic Program (NOP), Canadian Organic Standard (COS) and others

S.No	Procedure	Applicant or Client	ADITI
1	**Request**	Commonly, applicants present a first general request, asking about requirements, procedures, prices forcertification	The applicant receives from ADITI a first package of information, by e-mail or mail often combined with individual additional information by phone. This package includes: • the present document, • a company profile, • a brief information concerning requirements in the respective area (e.g. crop production, beekeeping, wild collection, processing). • An application form. The applicant is asked to fill in the application form, giving some details about

			his/her unit. This written application form is reviewed by ADITI and checked if viable.
2	**Offer**		Based on our daily fees and the size of the unit to be certified, we calculate the certification fees. We submit the applicant a written offer. Normally this is a flat fee, meaning that the applicant knows definitively, how much the procedure will cost, independently from how long the inspector stays on the holding. Only costs for travelling and accommodation are usually not included in the offer. Together with the offer, we submit a certification contract.
3	**Contract**	Once the applicant and ADITI have agreed on the fees, the applicant signsthe contract. By doing so, he/she is committed to fulfilling the organic standards.	ADITI sends back a counter-signed copy of the contract.
4	**Pre - payment**	The client pays 70% of the quoted feein advance.	ADITI submits the client a second package of information,including, among others: • relevant ADITI policies, • relevant standards, • standard inspection program(s) • the organic management plan.
5	**Working out the organic manageme nt plan**	The client fills in the organic man - agreement plan. The template invites him/her to do at the same time a self- audit, identifying eventual deficiency, i. e. aspects, where the unit does not (yet) fulfil the standard, and to establish the respective corrective actions.	* If requested by the client, an ADITI inspector can help the client to work out the management plan, during a pre-inspection.

	Corrective actions	In case the client finds considerable non-conformities, it sometimes makes sense to solve these problems, before the inspection takes place. Example: Establishment of a clear separation system between organic and conventional in processing companies.	ADITI checks the management plan. An inspector authorized for NOP inspection does this.
	Scheduling inspection	Inspector and client schedule a date for the inspection	
8	**Inspection**	The responsible person must be present, records should be prepared. The inspection report is signed by the client or responsible person.	The inspector verifies, whether the management plan is consistent with the reality, and defines eventual corrective actions.
9	**Inspection report**	*In many cases, the unit has to submit additional documents.	Immediately after the inspection, the inspector finishes his/her report. As soon as all documents have arrived, they are submitted to the ADITI headquarter.
10	**Evaluation**		The report is evaluated by the responsible certification officer. Sometimes, additional questions have to be clarified with the inspector.
11	**Corrective actions**	*In some cases, as a result of the inspection, some corrective actions have to be implemented **before** the certificate can be issued.	
12	**Final invoice**	Payment of the remaining 50% plus travelling/boarding cost of the inspector(s).	Issues the invoice and debit note
13	**Certificate**		Issues the certificate, submits it by e-mail, followed by original through courier or post.

* ***Steps marked with an asterix are relevant only in the indicated cases***

This whole procedure is apparently very long and complicated. Nevertheless, many steps, which are presented here one after the other, in reality often take place at the same time. Clients can contributeto **acceleration** by:

- Paying on time.
- Filling in immediately and thoroughly the necessary forms, contracts etc.
- Implementing immediately eventual corrective actions.

Block chain-enabled traceability of the banana supply chain to achieve export compliance

Ramaa Rao, Raghava T and Srivatsa S

TraceX Technologies, Bengaluru, Karnataka, India
Corresponding Author: ramaa.rao@tracextech.com, raghavat@tracextech.com, srivatsa@tracextech.com; 98862 65858

Introduction

The Fruit sector has been driving agriculture growth tremendously. It plays an important role in Indian economy by generating employment in a labor-intensive value chain. The Indian climatic and geographical conditions also render it suitable for growing all types of fruits. Fruits and vegetables alone amount to 22% of food production globally and India is its second-largest producer having an export worth of Rs. 9,940.95crores comprising of fruits worth Rs. 4,971.22crores. India's major exports in fruits are Grapes, Pomegranates, Mangoes, Bananas, and Oranges.

Banana market

India is the world's leading producer of bananas, accounting for almost 26 % of total production. It is one of the major globally exported fruit and an important source of livelihood and food. The global banana market is projected to reach a CAGR of 4.5% during the period 2022-2027[1]. The growing awareness among consumers about healthy food has led to a focus on safe and quality food production. Bananas are a rich source of vitamins and minerals along with dietary fibres and proteins, used in food products like desserts and cereals, apart from direct consumption. Bananas are inexpensive and easily available fruit. Hence the banana supply chain management is oriented towards the satisfaction of social, economic, and environmental aspects.

The journey of the banana and its challenges

The global banana supply chain is complex and depends on the collaboration of several players, with a resource-intensive requirement. The journey starts with the producer, packaging, exporter, distributor, retailer, and finally the consumer. It begins with the cultivation and planting of the banana in the exporting country. The complex journey requires more effort and quality measures to protect the fruit as it is vulnerable to mishandling and damage.

- Sustainable farming practices and compliance with fairtrade certifications
- Cultivation and harvesting are labour-intensive with post-harvest losses and wastage.
- Climatic impacts during the transportation phase contribute to 67% of the carbon footprint of the banana cycle.
- Packaging and Labelling need to be ideal to export requirement
- The process is resource-intensive with requirements of refrigeration, storage, ripening, transportation, and distribution facilities.

Challenges in fruit exports

Though there are excellent export opportunities, India' share in the global market is insignificant and accounts for only 0.5% in fruits

- **Quality requirements for export:** There is an inability to meet the quality requirements for export. The quality specification for products is different across different countries and this creates a block for the farmers in terms of catering to export market on account of increased price. Quality control, Phyto-sanitary requirements, pre-shipment inspection processes need to be streamlined and recorded.
- **Gap between farmers and exporters:** The fruits and vegetable supply chain are fragile in India. This broken chain increases credit risk and limits credit flow creating a poor link that has kept the farmers at bay.
- **Export laws:** The export market is very demanding, and the mandatory requirements are hard to navigate.
- **Legal procedures:** Apart from export laws in the exporting country, an exporter must have a clear idea of rules related to taxes, custom duties, tariffs, and insurance.
- **Adequate infrastructure:** An efficient workforce and proper coordination both in the exporting land as well as foreign land is required. Cold chain facilities, warehouses, traceability, technological infrastructure, information sharing, financial platforms, etc, must be made available.

The export markets for fresh fruits are highly competitive among the top exporters. It is necessary to conform to quality standards and certifications to satisfy the stringent export requirements. Farm Management solutions enable organizations to have a connected supply chain with end-to-end traceability and streamlined pre-harvest and post-harvest management to realize quality yields and boost productivity and profitability.

Why traceability matters in the Banana supply chain?

Transparency about the origin and method of production enables the consumers to understand the environmental and social consequences while purchasing a product. Managing a transparent data exchange throughout the supply chain is difficult part with paper-based system. The globalization of the supply chain has rendered it opaque and vulnerable with a vast network of stakeholders in the chain. The emerging technologies like Blockchain technology has ensured a shared ledger platform for supply chain transparency. It ensures hassle free verification of certification standards, assuring credibility of the produce. Data driven insights help to assess the environmental and social impact of a product in accordance with standards.

Traceability is an enabler for achieving transparency throughout the supply chain and providing data visibility to all the stakeholders.

Need for traceability solutions

The need for food safety and consumer demand on "how the food is produced, processed?" and "what is the origin?" have triggered the necessity for traceability systems in the banana supply chain. Authenticity and product provenance are of vital importance. Track and Trace systems are a necessity to ensure timely product recalls in case of food security incidents[2]. Banana production also need to satisfy the certifications like Fairtrade, Rainforest Alliance, etc, and the like to guarantee sustainable production, and promote the conservation of the environment and biodiversity. Certification labels are necessary to prove their authenticity and consumers are ready to pay the extra price for this.

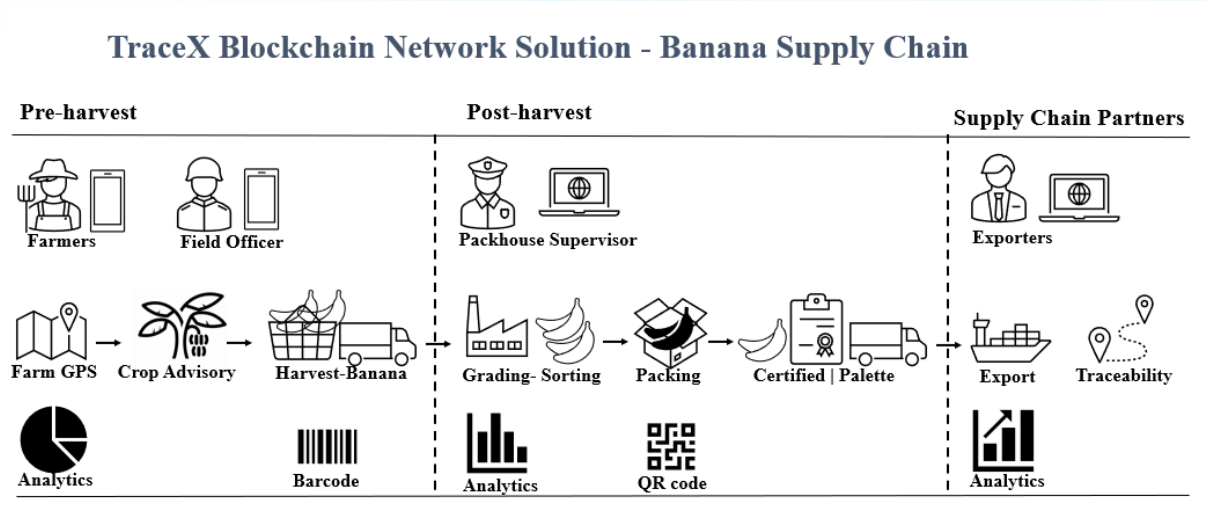


Figure 1 The standard workflow and operating procedure across Banana supply chain on TraceX Foodsign platform

The banana supply chain also needs to conform to the quality standards for the export market. The banana producers need to have an established set of practices for crop management. Farm management and Harvest management help farmers to build better market linkages with effective crop yields. Streamlining of post-harvest processes and efficient inventory management help to reduce wastage. The end-to-end traceability gives a digital identity to the banana, assuring consumers of safe and trustworthy produce [Fig 1].

Blockchain technology, the way ahead

Block chain technology has revolutionized the fruit supply chain. The end-to-end traceability solutions built on the blockchain platform brings trust, transparency and visibility to the fruit supply chains. The data capture at all stages of the supply chain in real-time helps in reducing food losses and in recall management. It also provides the end consumer with a farm to fork story of the product, thereby proving the authenticity of the produce. Blockchain provides a connected platform across all the stakeholders in the supply chain and builds trust and transparency among them [Fig 2]. Smart contracts on Blockchain ensures an immutable and decentralized compliance data, providing a single source of truth.

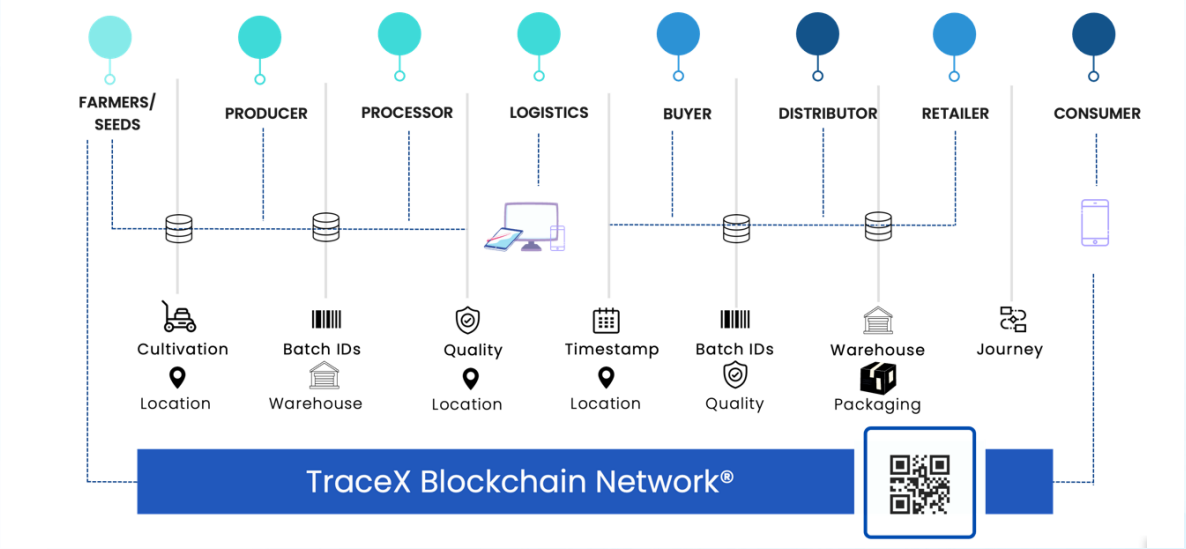


Figure 2 Typical workflow of blockchain solution implementation in the supply chain management

Supply chain transparency is going to become a world standard by 2030 and this will be possible through digital interventions with block chain technology.

Blockchain Solutions

- Collaborative and multi stakeholder platform to share real-time data
- Tracking of preharvest stages for quality and effective yield
- First mile traceability to prove the origin and authenticate the growing conditions to comply with sustainability standards
- Digital identity with a farm to fork story showcasing transparency and accountability to meet regulatory compliance.

Benefits

- Smart contract for each transaction b/w stakeholders
- Increased Quality improvement
- Reduced food wastage and recalls
- Cost reduction in supply chain
- Efficient product planning
- Achieve Regulatory compliance
- Easy certifications to satisfy sustainability

A decentralized management system brings opportunities for improved transparency and traceability and verification in the context of certification systems such as Fairtrade [3]. There is also an increase in operational efficiency resulting in reduced costs. The consumers can evaluate the provenance of the product and verify the carbon footprint stated on its packaging. Purchasing Fairtrade certified products, consumers pay a premium for the guarantee that products are produced under healthy environmental and social conditions. Transparency in supply chains drives more social responsibility and influences purchasing behaviours of consumers.

Case study - Indian Nendran in the UK

TraceX's FOODSIGN, a digital traceability platform powered by blockchain provides end-to-end traceability of the supply chain. The Vegetable and Fruit Promotion council (VFPCK), Kerala incorporated FOODSIGN to digitize the banana supply chain and track their journey from the Kerala farms to the UK. The Nendran banana from Kerala is GI-tagged and validating the sourcing claims on this platform was a boost to the export process. The entire journey was captured on a QR code to help consumers recreate the transparent journey of the banana from farm to plate.

The VFPCK export project digitized the whole production practice for 10-ton Nendran banana production with post-harvest data in the year 2020-21. The complete digitization of the planter information, farm location of banana production, field practices with standard operations, safe way to harvest, and post-harvest process with cleaning, grading, packing, and shipping was captured on the Foodsign™ application[4]. The application provides a single unique QR code for tracking the origin of products for the end consumer with feedback provisions. The banana reached its export destination via ship route with all goodness of healthy information.

Farmer profiling

Working with a known producer/planter for any organization makes business transactions hassle-free. Foodsign™ applications provided the easiest way to capture the farmer profile and connect with ease to the VFPCK organization. The basic to advanced information was captured and communicated across stakeholders. A total of 16 planters were profiled across 10 villages of the Thrissur district of Kerala under the export project. Each planter was assessed for their landholding information for banana cultivation.

Geo tagging of farms

Tracking the Farm produces is made easy with Foodsign™ application allowing each harvest connected to Geo-coordinates and unique barcode number. The produces grown in a particular location are tracked based on the geocoordinate captured for each farm holding and their crop cultivation information by planters. The Nendran begin the geographical indicator crop is supported with authentic geo coordinate to ensure the product origin. The VFPCK field agent captured the 20 Geo maps of farms accounting for 10 hectares growing area under the export project.

Package of practices

Cultivating safe produce needs a strict follow-up on the best practices. The standard production practices are derived with expert advisory in the production loop. Communicating the standard practices between the advisors and planters was possible on a single digital platform.

Foodsign™ ensures the scheduled field activities as per the standard package of practices applied based on the crop assigned to each farmer. The NRCB team designed 33 field activity-based POP for Nendran banana production and was applied to each of the selected farmers recognized under the VPFCK export farmer groups. The individual planter was followed up on the practice and field condition to keep a tab on the quality of produces in the real-time scenario with regular interactions between the planter - field agents and NRCB advisors. Complete crop management, pest and diseases management, and bunch management were tracked until the harvest time points.

Post-harvest

The export qualities produce demand the meeting of the post-harvest process quality adherence. The banana upon harvest was subjected to cleaning and sorting with various treatments to ensure the safe produce reaches its destination. Each of these processes is detailed with quality parameters to ensure the standard are achieved. Foodsign™ application provided an option to capture the post-harvest process executed at Naddukar Packhouse with requisite quality parameters for traceability. The product sailed through the sea route for its destination and were available in various super market across UK. The banana on shelves was provisioned with a unique QR code for end consumers to scan, know the origin and provide their feedback for exporters to undestand the demand and supply were met [Fig 3].

Figure 3 Nendrana Banana export consignment on TraceX blockchain network connecting Banana Supply chain from Farm to market shelve.

Conclusion

The traditional banana supply chains are vulnerable to environmental degradation, high water usage and biodiversity loss resukting from its production. The social inequality among the stakeholders causes unequal distribution of wealth from the banana trade profits. Bananas are one of the most traded fruits in the world ansd produced in over 135 tropical countries with an economy value of USD 52 billion. 85% of production is consumed locally, with the remaining being exported to countries.

Sustainable practices drive more transparency and incentivize consumers to make responsible purchases. Blockchain is a game changer, known for its immutability and transparency which can build trustworthy and sustainable banana supply chains. Creation of a digital identity for the product and the ability to real-time tracking and tracing ensures end to end transparency and sustainability and permits sharing of information within a network of authorized users.

Block chain allows visibility till farm-level and enables upstream actors and policymakers to monitor deforestation and other environmental degrading activities. It also detects food contamination ensuring food safety to the consumer. Agri food supply chains are complex and involve numerous actors that limit farm to fork traceability, which is a key for sustainability in these supply chains. Blockchain solutions build sustainable, inclusive, and resilient supply chains for a greener future.

Rural digital empowerment through free digital marketing: MarketMirchi.com is a boon for farmers

Pragati Gokhale

Chief Mentor Mission MeraMobile MeraMarketing Via Marketmirchi.com,
Advisor Rajiv Gandhi Science & Technology Commission,
National Resource Person Ministry of Rural Development, Govt. of India.
Corresponding author: pragatikin@gmail.com; 9822719618

Introduction

In an effort to support the Indian farmers, a mission called 'Mera Mobile Mera Marketing' was launched to enable farmers to sell products online. The main motto of this mission is to digitally empower farmers, agro-entrepreneurs, self-help groups, farmer producer organisations, artisans to do free online marketing of their products/services using their mobiles.

Important Milestones

The social mission 'Mera Mobile Mera Marketing' is the brainchild of Pragati Gokhale who is an Advisor at the Rajiv Gandhi Science and Technology Commission and a National Resource Person in the Union Ministry of Rural Development. Retired as the Principal Scientist of the Ministry of MSMEs, Gokhale shared that the three pillars of this mission include Marketmirchi.com, creation of back-end linkages and creation of front-end linkages.

Pragati Gokhale's work 'MarketMirchi.com' has become very useful for farmers to reach out to more and more people through their mobile products. Gokhale who has been working tirelessly for the initiative, said that the movement has been instrumental in effectively providing an online market to rural entrepreneurs, farmers, artisans, self-help groups, farmers; producer organizations and other rural stakeholders. Her initiative to change the rural economy has been noticed globally.

While working as a Principal Scientist at the Mahatma Gandhi Institute of Rural Industrialization, she realized that marketing was a major obstacle to the growth of the rural industrial sector. Rural industries are centred around raw materials, local agricultural income sources and not in close proximity to the market. Naturally, all the benefits of this go to the brokers. She decided to enable rural entrepreneurs for digital marketing using the mobile in their hands.

Pragati Gokhale, a gold medallist, is a software expert who created MarketMirchi.com using her computer knowledge. It is an indigenous, user-friendly and multilingual web portal covering all rural-agricultural products for digital marketing of rural products, agricultural products, rural services and rural employment.

Developed in new progressive web technology, this portal is best suited for rural areas as it does not require download. But it has all the features of a normal app. Importantly, it sends a link to buyers as soon as the ad is posted, so rural sellers and buyers can contact each other directly for free. Since there is no business model like e-Commerce or Trade India, all sellers and buyers can contact each other for free.

For Training to farmers, self-help groups, rural entrepreneurs Maharashtra Knowledge Corporation Ltd (MKCL) has developed beautiful Hindi videos for training on how to post their own advertisements as well as how to interact and deal with buyers by making effective use of MarketMirchi.com. Gokhale has created a network of people from all walks of life working in rural

agricultural organizations across the country through whom these videos are disseminated to farmers, artisans, women in self-help groups.

What is special is that even during the Corona era, their effective efforts to reach out to rural entrepreneurs through various webinars continue. Nearly twenty thousand rural entrepreneurs and farmers from all over the country are using their mobiles to advertise themselves on MarketMirchi.com and have managed to find a market for themselves through direct marketing.

"IIT Mumbai has also given the technical strength of Artificial Intelligence to this venture. At the request of the National Bamboo Mission, marketing facilities for bamboo and other forest products have also been made available. In particular, Big Basket, Reliance Retail have also taken the initiative to take goods directly from farmers at Marketmirchi.com", said Gokhale who was honoured with 'Global woman of worth Award'.

In a heart-warming exchange with *The Reformist*, Pragati Gokhale talks in depth about Market Mirchi and its role in bridging the gap by improving farmer incomes"

"Mera Mobile Mera Marketing"

Mission "*Mera Mobile Mera Marketing"* via MarketMirchi.com is a pan India movement through which we are empowering farmers, farmer producer organizations, self-help groups to do Free Online marketing of their produce and other intermediary products via their mobiles. Our goal is to make rural stakeholders *"Atmanirbhar"* for their marketing.

Historically, geographic barriers between farmers and retail consumer have prevented farmers from realizing the price discovery. Farmers sell their produce at a pittance to agrarian commodity brokers who realize profits by selling the same at the retail market. Market Mirchi solves this problem by directly linking farmers to end consumers via their smartphone. The Market Mirchi app, available on the Google play store, is customized to be friendly for the demography it aims to target.

In 2013-14, we had first developed this platform. Internet penetration was non-existent at the bottom of the pyramid. We used to visit exhibitions such as Khadi exhibitions, Handloom exhibitions among others where rural stakeholders had their stalls. We would interact with farmers at these exhibitions to enquire about produce which they wished to sell online.

Following the conversation, our data entry operators back home would upload the information on MarketMirchi.com. However, because we were **doing it for them**, a disconnect/gap existed. I would like to bring up an example which further elaborates on this point. Farmers would post an advertisement and would forget about them until buyers contacted them after some time. Once a group of farmers based in Hosur, Tamil Nadu had placed an order for the sale of herbal oil on MarketMirchi. However, they had forgotten about it until a buyer from Germany showed interest. Fortunately, my phone number was also mentioned in the advertisement and I could link the farmers with the buyer. However, the disconnect existed as farmers could not monitor the status of their advertisements on a real time basis. Someone else was monitoring the status of their advertisements.

Things changed after Prime Minister Modi launched the "***Digital India***" mission in 2016. Because of this, internet penetration reached the grassroots of rural India. The small, handy, and affordable smartphones became game changers.

The story of **our Mission Mera Mobile Mera Marketing Via Marketmirchi is also interesting one**. In 2016, I had gone to Bhuj for **giving training on Marketmirchi in Agri exhibition.** My laptop suddenly stopped, and a youngster suggested that I can train Farmers on using Marketmirchi by using Marketmirchi.com on Mobile. At that moment, it suddenly dawned on me that the mobile was a far more potent platform for MarketMirchi. On the same day, a talented girl at the reception desk announced "*Maro Mobile Se Maro Marketing*" (my mobile for my marketing). On that day, there was a long line of farmers enquiring about how they could use MarketMirchi on their mobiles to sell produce such as Pomegranes,Cotton. So that day we named our mission, as "*Mera Mobile Mera Marketing*"via Marketmirchi

Today, every rural family has one smartphone, and this had made MarketMirchi successful. Now, as to your question about overcoming digital barriers, the key lies in the design of the mobile application. A farmer who is not literate can get comfortable with the application in under two minutes because of its user-friendly nature. Within two minutes, farmers can post advertisements and can contact buyers within next five minutes as we show him call list of all buyers immediately after posting his Ad. It's a combination of simplicity and speed. The app is multilingual. A farmer using the application can post an advertisement in a single click without prior registration and get information about prospective buyers at an instant. While posting the advertisement, farmers can just put the number (denoting value) they wish to receive for the produce without mentioning the currency. They can even state whether the price is negotiable by putting 0 in price box

Thereafter, farmers will be directed to the registration button where first-time users must just feed in their name, address, district, a mobile number & a simple password. This information is at the fingertips of every individual, irrespective of their literacy. Once a user posts the advertisement, the app sorts buyers based on their activity. The website algorithm ranks active buyers and sellers higher vis-à-vis buyers who are not as active. Thus, farmers posting an advertisement for the first time can

quickly identify active buyers and contact them and also become active seller by calling many buyers (For each call his active rank increases by 2 points)

Uniqueness of the platform

It is a free and open social mission. Thus, those who are active on the website/App are given a higher priority. I recollect an instance where farmers had posted an advertisement for the sale of Haldi. On not being able to find buyers, farmers contacted me claiming that no one had shown interest in their products. They could actively contact buyers and benefit by achieving a higher rank and more visibility than their counterparts. This activity-based ranking is deeply intertwined with our purpose of helping farmers that need the most help.

MarketMirchi can be used for retail buying and selling. However, for commodities like grains, pulses procurement is largely by businesses. Large brands such as Big Basket & Ninja Cut are also buying some of their materials through MarketMirchi. However, the application is just as it does not discriminate between sellers based on their sales volume. It ranks buyers and sellers based on their activity. Thus, sellers who are more active will get ranked higher.

Regions where farmers can benefit from access to a market linkage platform

IIT Bombay through Coal India Project, one of patrons, has asked to do workshops in the sixty aspirations districts of India to promote the MarketMirchi platform. It will begin these workshops shortly, starting from the Eastern state of Odisha.Also Nabard ,Baif ,Nrlm are organising trainings for rural stakeholders on how to effectively use Marketmirchi.com IIT Bombay has also prepared several explainer videos in regional languages which are promoted via community-based radio stations to generate a buzz among rural stakeholders for the application. The financial capital for the same is provided by IIT Bombay under its rural technology action project. They also provide with technical support if required. This platform use data mining also to identify prospective buyers who will find the produce sold by our farmers useful. In this manner, this also continually expand the geographical base of our buyer pool so that farmers across different parts of India find MarketMirchi a useful platform to sell their produce.

b. Reduce harvest and post-harvest losses by developing/expanding/upgrading infrastructure for post-harvest handling of produce, value addition and market linkages

c. Facilitate the introduction of innovative technologies and practices to enhance the global competitiveness of focus cluster crops

d. Facilitate the dovetailing of resources, including the convergence of various government schemes, to entrench stakeholders in the global value chains

e. Build stakeholder capacity and enhance farmers' income through cluster-specific interventions, including brand promotion

Pilot Phase of Programme

The list of identified crops and clusters for the pilot phase to be launched during the current year include:

SI No.	Crop	Identified cluster	State
1	Apple	Shopian Kinnaur	Jammu & Kashmir Himachal Pradesh
2	Mango	Lucknow Kutch Mahbubnagar	Uttar Pradesh Gujarat Telangana
3	Banana	Anantpur Theni	Andhra Pradesh Tamil Nadu
4	Grapes	Nasik	Maharashtra
5	Pineapple	Sepahijala	Tripura
6	Pomegranate	Solapur Chitradurga	Maharashtra Karnataka
7	Turmeric	West Jaintia Hills	Meghalaya

Financial Assistance

The clusters have been categorized into three categories–Mega, Midi and Mini depending upon the area to be covered under each cluster. Accordingly, the extent of financial assistance for each cluster is proposed as under:

Sl. No.	Type of cluster	Area* of cluster (in hectares)	Amount of financial assistance admissible per cluster (INR in crore)
1.	Mega	More than 15,000	Up to 100
2.	Midi	5,000-15,000	Up to 50
3.	Mini	Up to 5,000	Up to 25

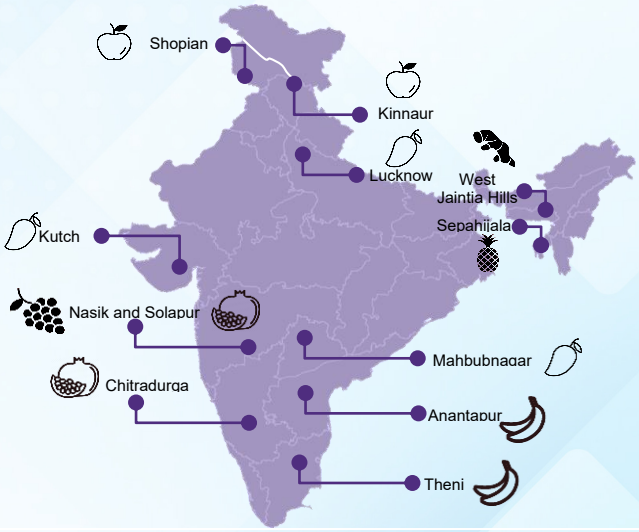
Likely Impact

Upon successful implementation of programme in all the 55 identified clusters during next 5-7 years, the overall impact of the programme is envisaged as under:

Horticulture cluster development programme - Role of Grant Thornton

Udit Paliwal* and Chirag Jain

**Associate Director*
Grant Thornton Bharat LLP, New Delhi
Corresponding author: Udit.Paliwal@in.gt.com; 90990 01315



India is the second-largest producer of horticulture crops globally, accounting for approximately 12% of the world's production of fruits and vegetables. However, the country's share of horticulture export in global trade stands at just 1.7% and 0.5% for vegetables and fruits, respectively. A significant amount of horticulture produce is imported, and studies have indicated that post-harvest losses of fruits and vegetables range 1.8-18%, on account of inadequate infrastructure for post-harvest handling of produce and its value addition. Several initiatives, at the central and state levels, have been undertaken to address the issues leading to a positive impact. However, the lack of an integrated approach to resolve issues of the entire value chain, including production, post-harvest management, logistics and marketing, continues to be a major impediment to progress.

To address challenges and enhance the global competitiveness of the Indian horticulture sector, the Ministry of Agriculture and Farmers' Welfare (MoA&FW), Government of India, has launched the Cluster Development Programme (CDP). It is a central sector programme, implemented by the National Horticulture Board (NHB). The programme aims to enable holistic growth and development of identified horticulture clusters to make them globally competitive and entrench them into national and global value chains.

Details

CDP is designed to leverage the geographical specialization of horticulture clusters and promote integrated and market-led development of pre-production, production, post-harvest, logistics, branding and marketing activities. MoA & FW has identified 55 horticulture clusters, of which 12 have been selected for the pilot launch of CDP. Based on the learnings from the pilot project, the programme will be scaled up to cover all the 55 clusters.

Objectives

The main objectives of the programme are to:

a. Address concerns of the horticulture value chain, from pre-production, production, post-harvest management and value addition to logistics, marketing and branding, in an integrated manner to accelerate competitiveness in the domestic and export markets

b. Reduce harvest and post-harvest losses by developing/expanding/upgrading infrastructure for post-harvest handling of produce, value addition and market linkages

c. Facilitate the introduction of innovative technologies and practices to enhance the global competitiveness of focus cluster crops

d. Facilitate the dovetailing of resources, including the convergence of various government schemes, to entrench stakeholders in the global value chains

e. Build stakeholder capacity and enhance farmers' income through cluster-specific interventions, including brand promotion

Pilot Phase of Programme

The list of identified crops and clusters for the pilot phase to be launched during the current year include:

SI No.	Crop	Identified cluster	State
1	Apple	Shopian Kinnaur	Jammu & Kashmir Himachal Pradesh
2	Mango	Lucknow Kutch Mahbubnagar	Uttar Pradesh Gujarat Telangana
3	Banana	Anantpur Theni	Andhra Pradesh Tamil Nadu
4	Grapes	Nasik	Maharashtra
5	Pineapple	Sepahijala	Tripura
6	Pomegranate	Solapur Chitradurga	Maharashtra Karnataka
7	Turmeric	West Jaintia Hills	Meghalaya

Financial Assistance

The clusters have been categorized into three categories–Mega, Midi and Mini depending upon the area to be covered under each cluster. Accordingly, the extent of financial assistance for each cluster is proposed as under:

Sl. No.	Type of cluster	Area* of cluster (in hectares)	Amount of financial assistance admissible per cluster (INR in crore)
1.	Mega	More than 15,000	Up to 100
2.	Midi	5,000-15,000	Up to 50
3.	Mini	Up to 5,000	Up to 25

Likely Impact

Upon successful implementation of programme in all the 55 identified clusters during next 5-7 years, the overall impact of the programme is envisaged as under:

- An estimated investment of INR 10,000 crore ($ 1.3 Billion) to be leveraged [approx. INR 3,500 crore ($ 0.45 Billion) as financial assistance and approx. INR 6,500 crore ($ 0.85 Billion) as private investment]

- Approximately 17 million MT is the quantum of produce expected to be handled which will benefit more than one million farmers and other stakeholders of the value chain

- An estimated increase in export of the targeted crops by approx. 20%

Indicative Value Chain Activity (Vertical) Wise Interventions

1. Pre-production and production –

- Setting up of secondary hardening Nurseries
- Tissue culture labs with virus indexing facility
- Import of Planting Material
- Area expansion through High Density Plantation integration with Drip
- Rejuvenation of old and senile orchards
- Farm mechanisation banks
- Micro Irrigation
- Adoption of Integrated Nutrient Management
- Adoption of Integrated Pest Management
- Adoption and adherence to Good Agricultural Practices (GAP)
- Fruit/Crop Care Practices
- Soil, Leaf and MRL Testing labs in Cluster
- Bee -keeping for crop pollination
- Meteorological Station
- Usage of Drones for the Cluster
- Development of farm management software with Database
- Capacity building and awareness programmes

2. Post -harvest management and value addition

- Integrated Pack house
- Cold Storage
- Primary processing centres
- Collection centres
- Pre -cooling unit
- Mobile packing Unit
- Conveyor Belt for transportation of bunches
- Packaging infrastructure
- Ripening Chamber

3. Logistics, Marketing and Branding

- Refrigerated Transport vehicles
- Retail Markets / outlets

- Rural Markets/Apni mandies/Direct Market
- Terminal markets/Wholes ale markets
- Market Promotion Distribution Infrastructure in the cluster
- Exit Point Infrastructure
- Backward and Forward integration / connectivity
- Proposed multimodal transport requirement for seamless transport
- Marketing, Market Intelligence Services, statistics and Export Promotion Council (EPC)
- Branding & Marketing activities for promotion of Cluster Brand abroad (In -store Branding, Shelf Space Renting, Listing Fee, Electronic/ social media and Print Media, outdoor publicity, billboard, commercial advertisement on channels etc.)
- Branding & Marketing activities for promotion of Cluster Brand in domestic market
- Development of Sea protocol & R&D

Implementation Structure

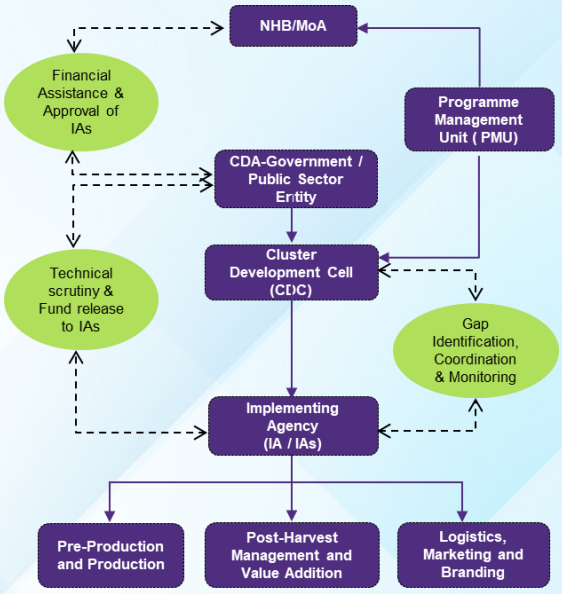
a. NHB shall provide Financial Assistance and supervise the overall implementation of the programme.

b. A government/public sector entity recommended by the state/central government shall be appointed as a Cluster Development Agency (CDA) for each identified cluster to implement CDP.

c. Each CDA will establish a Cluster Development Cell (CDC) with a dedicated team of officers within the CDA for the smooth implementation of the programme.

d. The CDAs shall select the Implementing Agency(ies) (IAs) through a Call for Proposal in an open and transparent manner for the different verticals of the cluster, including:

   - Pre-production and production
   - Post-harvest management and value addition
   - Logistics, marketing and branding



Programme Implementation Structure

e. The PMU shall provide technical assistance to NHB and CDA for the effective implementation of the CDP.

Scan QR code to get the operational guidelines of CDP:

Contact us for more information

National Nodal Agency

राष्ट्रीय बागवानी बोर्ड
NATIONAL HORTICULTURE BOARD

E: clusters.nhb@gov.in
T: +91 92058 35769
W: www.nhb.gov.in

Programme Management Unit

Grant Thornton

E: cdp.nhb@in.gt.com
T: +91 90990 01315
W: www.grantthornton.in

Innovative, functional food products of Banana and market innovations to attract new age consumers

Davanam Srikanth[1], Akalya Shanmugam[1, 2, *], Vadakkepulppara Ramachandran Nair Sinija[1, 2], Loganathan Manickam[3]

[1]*Food Processing Business Incubation Centre, National Institute of Food Technology, Entrepreneurship and Management - Thanjavur, India*
[2]*Centre of Excellence in Non-Thermal Processing, National Institute of Food Technology, Entrepreneurship and Management - Thanjavur, India*
[3]*Department of Academics and Human Resource Development, National Institute of Food Technology, Entrepreneurship and Management - Thanjavur, India*
*Corresponding author: akalya@iifpt.edu.in.

Introduction

With the everchanging world, there has been a drastic change in the purchasing behavior of consumers. This can be observed from the difference in buying patterns between the Gen X, Millennials, Gen Z populations. The so-called “Millennials” and “Gen Z” are more aware of what they want and more cautious while making purchases. They are more knowledgeable about the trend, new products, and the advantages of each. They are more willing to search thee products online before making a buy. It has become difficult for brands to attract these consumers’s attention. In the online world, they do many activities like opening & checking for ratings and reviews before any purchase making it difficult to capture and hold their attention. So, companies are also developing products according to the convenience of these consumers which fit in their fast pace life style. Marketing these products has been extremely different with the patterns followed in earlier days and that’s why companies are adopting new age marketing techniques to attract these new age potential consumers, eg: Search Engine Optimisation, Augmented Reality, Virtual Relality, Chatbots. Developing new products in all possible categories and to attract all possible age groups are the challenges taken up by the companies. The “new age customer” is expecting a food product to be sustainable, healthy, convenient to afford and to consume, and to be developed in an ecofriendly way. All these requirements are being continuously met by different companies with their innovations in different food categories.

Innovative food products

The Innovative Food Products are different from the existing food products and are often oriented towards problem-solving and/or towards achieving an easy and sophisticated lifestyle for the consumer. Food innovation is very important to meet the everchanging consumer demand. Food innovation takes many different shapes, with businesses vying to produce foods that are more nutrient-dense, environmentally friendly, and even more delectable—often while reducing costs and more choices. Food innovation can happen at different stages of a food life cycle before it actually goes into the hands of the consumers. It can be based on convenience of the consumer preference as in food products which are served as ready-to-cook/ready-to-eat products (Bigliardi & Galati, 2013). This trend is already being followed by many different companies. For instance MTR introduced ready-to-cook - 3 minute poha), Instant soup mix by Banamin are some of them in the market which can be prepared handy by just adding hot water to the product.

In Ready-to-eat category, non-vegetarian meal with different fish curries and cooked matta rice (Kerala red rice) is being sold by a company called Tasty Nibbles. To give the feel of actual meat to the vegetarians, plant-based meat has been developed which has almost same texture and tenderness as of real animal meat using vegan ingredients like of protein from wheat, soy, pea, peanut with different technologies such as extrusion technology, shear cell technology, spinning (wet-spinning and electrospinning) and freeze casting. Some of the key market players in this category are Beyond Meat (US), Kellogg Company (US), Impossible Foods Inc. (US), Maple Leaf Foods (Canada), Unilever (UK), Conagra Foods (US), Tofurky (US), Gold&Green Foods Ltd (Finland), Sunfed (New Zealand), and Monde Nissin (Philippines). Plant eggs are already in the market from Evo Foods Company and are made of different types of plant-based ingredients (e.g., proteins, polysaccharide hydrocolloids, or emulsifiers), alone or combined, to replace regular eggs in food products with technologies such as proprietary texturizing technology. The vegan egg provides almost similar nutrition compared to the actual egg. These innovative food products made the life of the consumers easy and comfortable especially in the populated urban and metro cities. Advantages of having vegan products in the market include sustainability, nitrogen fixing capability of plants to soil, soil replenishment, low carbon foot print, low water requirement and also aids in weight loss, reduces the risk of heart diseases by lowering cholesterol, lowering the chances of colon cancer. Likewise, special products especially for pediatric and geriatric people are being sold by different companies. Nutritional Growth Solutions Ltd., is one such company which launched Healthy Heights KidzProtein and KidzProtein Vegan Shakes for the childhood growth and development. For geriatric people, the micronutrient-rich product has been developed by Kanaus University of Technology (KTU) team with creamy consistency to be easily consumable for people with swallowing difficulties.

Innovation can also on food packagings such as smart packaging, active packaging, oxygen/carbon dioxide/ethylene scavengers, and flavour and odour absorbers. Latest innovative packaging of coca cola drink includes a temperature indicator on the surface of the packaging. When the temperature of the product is cool enough for the drink to be consumed it shows a colour on the outer surface of the packaging. The innovation based on the size can also be seen in sauce sachets. These sachets are extremely convenient for those who needs for a onetime use. Similarly, new technique of providing accompaniments like sauce/mayonnaise sachet with a pack of pringles potato wafers is being adopted by the companies. The heating bags are made from finely powdered magnesium metal alloyed with a small amount of iron, and table salt, have been developed to cook food especially for the soldiers who stays in the extreme low temperatures and during the situations of war. Innovation always drives the markets and people's preferences in the market thereby increasing the customer base and the sustainability of the company. However, constant innovation requires investment in developing and marketing of a new product.

Functional food products

The functional foods are those that are characterized as whole foods combined with fortified, enriched, or enhanced foods that have a potentially favourable influence on health when consumed as part of a diverse diet on a regular basis at effective levels (Nandi Topolska et al., 2021). The Institute of Medicine's Food and Nutrition Board (IOM/FNB, 1994) defined functional

foods as “any food or food ingredient that may provide a health benefit beyond the traditional nutrients it contains.” The Institute of Food Technologists provides another well-known definition: “Foods and food components that provide a health benefit beyond basic nutrition (for the intended population).” (Henry, 1999). The International Life Sciences Institute defines functional foods as “Foods that by virtue of the presence of physiologically active food components provide health benefits beyond basic nutrition” (Henry, 1999). The goals of functional foods are diverse: they enhance overall body conditions (e.g., pre- and probiotics), lessen the risk of certain diseases (e.g., cholesterol-lowering products), and may be used to treat certain illnesses. There is a rise in trend in the demand of functional foods due to the increase in awareness of consumers about their personal health and healthy food choices especially in the fastmoving consumer products category in urban areas. This can be observed in the increasing market size of functional foods from the Fig. 1. The compound annual growth rate of functional foods worldwide is 6.3% and the revenue of this market as of 2020 is 267Bn USD worldwide. Even though they are not evenly dispersed across all areas of the food industry, functional foods have been produced in practically all food categories. As a result, consumer preferences may differ between markets. Functional foods have primarily been introduced into the dairy, confectionery, soft drink, cereals, bakery, and infant food segments out of all the food categories (Chaya, 2022; Hill et al., 2014; Khalaf et al., 2021). The functional foods have been fortified with additional substances including vitamins, minerals, probiotics, or fiber.

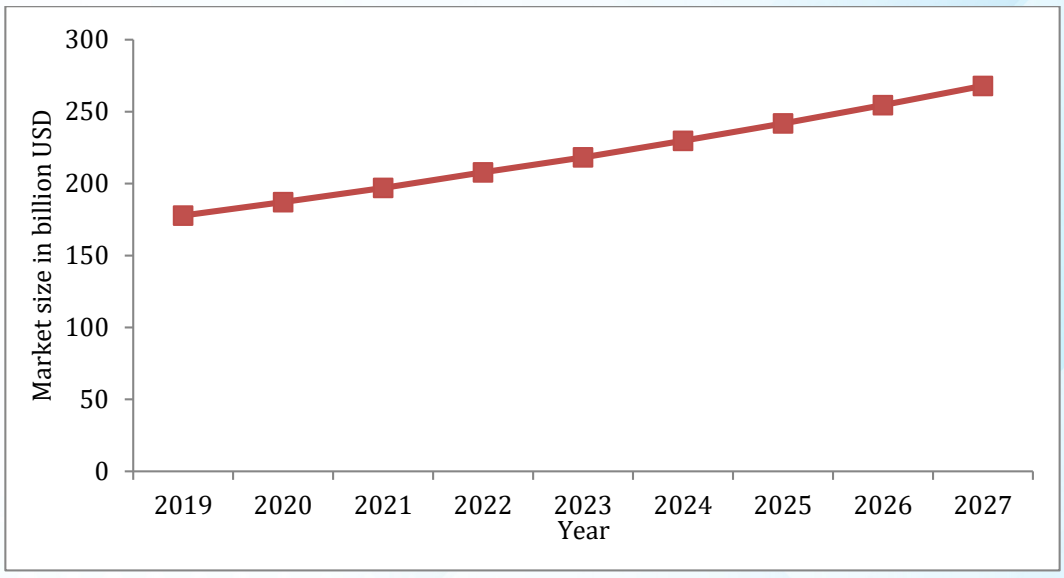


Fig. 1. Pictorial representation of size of functional food market worldwide from 2019 to 2027 (in USD Bn)

Categories of Functional Foods

Fermented Foods: Yoghurt, Tempeh, Kefir, Kombucha, Sauerkraut; Fruit and Vegetables: Fortified Orange juice, Fortified Apple juice, Pickles; Dairy and Milk Alternatives: Coconut Milk, Cashew Milk, Rice Milk, Almond Milk; Grains: Cereals, Granola, Black rice

Fermented Foods

The fermentation is a process takes place by bacteria on food to modify the food and improve nutritional benefits. This process occurs in the absence of oxygen and is carried out by

anaerobic bacteria. After being fermented, the original food gains more nutrients and value. The beneficial health effects of fermentation are related to the live microorganisms in the food and the bacterial metabolites/biogenics (vitamins, amino acids) that are produced during the fermentation process. The fermentation process improves food digestion; for example, milk's lactose (milk sugar) is converted to lactic acid when fermented, therefore lactose-intolerant persons prefer yoghurt and cheese to milk to prevent unpleasant side effects like flatulence (Milks et al., 2022). Other benefits of fermentation include the elimination of contaminants, boosting aroma, and enhancing the bioavailability of important nutrients (amino acids), as well as improving the structure of the food and removing toxins. As a natural method of food processing and preservation, fermentation was once crucial. Fermented foods like dairy, soy, fruits, vegetables, and legumes can be stored longer at room temperature. Bacterial fermentation typically results in the production of weak organic acids such lactic, propionic, and butyric acid, which lower the pH of the meal and make it more acidic. Fermentation's acidifying ability has been employed to destroy dangerous microorganisms and extend the shelf life of food. The most common fermented food we consume is pickles in our home. Sauerkraut, Kombucha, Kefir all falls under the fermented foods category. Probiotics foods are classified under fermented foods but not all fermented foods are probiotics. For example bread, chocolate and beer are produced through fermentation but are not considered as probiotics. The term "probiotics" refers to microorganisms that, when given in sufficient amounts, contribute to enhancing human health. The two bacterial species that are most frequently seen during fermentation are regarded as probiotics*: Lactobacillus* and *Bifidobacteria* (Coelho et al., 2022) Some probiotic foods are prepared from yeast called *Saccharomyces boulardii*.

Probiotic foods

These are foods containing live microorganisms which improves and maintains gut microbiota thus providing health benefits to the consumer. People generally have this misconception that consuming live microorganisms may affect their health but probiotic foods are safe to consume and are proved to be beneficial. Some of the probiotics foods are: Bulgarian yoghurt, traditional buttermilk, sauerkraut, cheese, kefir. With the increased concern about good health, people are more inclined towards these healthy foods and there are high chances in choosing these probiotic and fermented foods. Yoghurt is one the most preferred probiotic foods across the world due to its availability throughout the year and convenience to carry. *Streptococcus thermophilus and Lactobacillus delbrueckii ssp. Bulgaricus* is starter culture used in yoghurt. Currently, the market offers a variety of yoghurts that are appropriate for various palates and conditions. The potential benefits of probiotic foods on human health and the bioactive components are summerised in Table 1.

Innovative and functional foods from Banana

The banana is itself a functional food as its rich of energy, potassium and fiber mainly due to its potential nutritional value and number of derived products from it. Likewise, there are many value-added innovation products from Banana which offers functional benefit to consumers. Due to the consumer demand for the less oil absorbed deep fry chips, banana chips with more than 25% reduction in oil percentage was produced in the presence of their hydrocolloid coating (alginate, carboxy methyl cellulose, pectin) (Singthong & Thongkaew, 2009). Green banana flour is being

used as supplement flour (upto 40%) in various foods such as spaghetti, bread, pasta, cookies, noodles and baby foods due to its ability to increase in resistant starch and phenolic content. The presence of high amounts of resistant starch and phenolic content in banana flour aids in developing low-GI foods which helps in prevention of coronary heart diseases in diabetic people

The banana stem can also be used to prepare pickle, juices, dried powder with good sensorial acceptability as it is very rich source of potassium and dietary fiber (Ranjha et al., 2022). The possibilities for using green banana flour in weaning foods are enormous. For infants, the ages of children between 6 months and 2 years, a combination of malted maize and soybean, roasted groundnut, with cooking banana (*Musa Paradisiaca L.*) may be suggested as a weaning food (Bukusuba et al., 2008; Oshaba et al., 2021). The market has a large demand for dehydrated bananas as well and are often known as banana figs (Porciuncula et al., 2016). The varieties Udhayam and Karpuravalli, which have high TSS (23°Brix), are ideal for producing figs. Banana wine with a high phenol concentration and antioxidant activity can be produced through the aerobic fermentation of clarified banana juice with *Saccharomyces cerevisiae*. Banana wine aids in ease of digestion process (Durva et al., 2020). Banana vinegar can also be produced by the anaerobic fermentation of banana wine using *Acetobacter aceti* (Akubor et al., 2003). The banana vinegar has a huge market potential due to the rising global demand for fruit vinegar due to its role in weight loss and managing blood sugar and cholesterol levels. Banana peel and stem are also largely used in Assamese cuisine (Sarma et al., 2020). The banana stem is believed to help avoid constipation and ulcers in the long run since it is packed with a good amount of insoluble fiber. A significant amount of potassium (approximately 10%) and vitamin B6 are also present in the banana stem. (Science, 2021). Hence banana stem is recommended for people with diabetes and anaemia to consume routinely in their dietary pattern. The process of weight loss is greatly aided by banana stem juice as well. By lowering hunger and cravings, the high fiber content helps people lose weight by eating less overall. The raw stem pieces can help fight obesity by lowering fat intake when eaten as salad (Konda et al., 2020). Basil seed suspended banana RTS is a drink which is getting popular especially among these new age customers due to the enormous health benefits offered by basil seeds in treating urinary tract infection (UTI) known as cystitis causes bladder discomfort (Parida, 2022).

The stem juice aids in the removal of tiny kidney stones and cleans the urinary tract and wash out impurities and is a decent diuretic beverage (Kumar et al., 2012). The stem juice includes significant amounts of iron and vitamin B6, both of which are known to raise blood levels of haemoglobin and lowers LDL cholesterol levels. Additionally, the stem lectin promotes insulin-like enzymes that control the formation of fatty cells. Due to their low glycemic index, banana stems are also excellent for diabetic individuals to consume.

Banana peel yoghurt is a great product to improve nutritional health benefits and banana peel contains a great source of nutrients which aids in yoghurt fermentation (Kabir et al., 2021). Due to its high fiber content, the plantain stem can effectively relieve constipation (Ali, 2022). In order to relieve constipation, it is highly good to consume in the form of juice. The best amounts of

fiber in the beverage should be maintained, experts advise against straining the juice. The innovative and functional food products available in the market are presented below in Table 2.

Table 1 Effects of probiotic foods on human health

Probiotic organism	Probiotic Food	Bioactive components	Potential benefits on human health
Lactobacillus bulgaricus and *Streptococcus thermophilus*	Yoghurt	Vitamin B12, B2, Potassium, Calcium, Magnesium, Zinc	Improves gut health and immunity Increases muscle and bone strength Better cardio-metabolic health Inhibited the chances of diabetes
Lactobacillus Plantarum	Kimchi	Vitamin K and Vitamin B2	Improves digestive health
Lactobacillus rhamnosus, Enterococcus hirae, and Lactobacillus helveticus	Cheese	Peptides, Exopolysaccahrides, Fatty acids, Gamma Amino Butyric Acid (GABA)	Decrease cholesterol Enhances immune system
Leuconostoc mesenteroides, Lactobacillus brevis, Pediococcus pentosaceus, Lactobacillus plantarum	Sauerkraut	Phytochemicals like Glucosinolates and Vitamin C, Beta-Carotene, Folic acid, Tocopherol,	Reduces risk of infections and diseases like cancer and heart disease
Lactobacillus plantarum, L. brevis, Leuconostoc mesenteroides and Pediococcus cerevisiae, Pediococcus pentosaceus and Enterococcus faecalis	Pickles	Amino acids, Phenols, Antioxidants, Favonols, Sterols	Can boost intake of antioxidants Helps in fight against free radicals which are linked to problems such as heart disease and cancer.

Table 2 Functional Food Products in the market with their brand and company names

Name of the product	Functional benefit	Product category	Brand name	Company name
Innovative food products				
3 minute Instant Poha	-	Cereals	MTR	MTR Ltd
8 minute Instant Suji Halwa Jaggery	-	Cereals	Aashirvaad	ITC Ltd
3 minute Instant Pulav	-	Cereals	InstaFood	InstaFood
Biscuit and Potato 5050 Fusion	-	Snacks	Britannia	Britannia Industries
Choco Fills Ragi Bites	-	Snacks	SoulFull Smart Foods	Tata Foods

Functional food products				
Germinated Brown Rice (GABA Rice)	High in GABA, fiber and B vitamins,	Cereals	Dhatu Organics	Dhatu Organics
Probiotic Cereals	Good source of fiber and whole grains	Cereals	Happy Inside	Kellogs
Margarine	With plant sterols clinically proven to Lower Cholesterol	Fats and Oils	Flora Proactiv	Hindustan Unilever Ltd.
Real Mayonnaise Avocado Oil	Soy & Canola Free, Sugar Free	Fats and Oils	Mayo	Primal Kitchen
No Sugar Pineapple Juice and Coconut Water	No added sugar	Fruit Beverages	Dole	Dole
Innovative and functional food products of banana				
Banana Chips	Reduced oil percentage	Fruits	Dakshyn	Dakshyn Foods Ltd
Raw Banana Powder	Contains resistant starch and phenolic content	Fruits	Slurrp	Slurrp Farm
Banana Stem Pickle	Rich source of potassium and dietary fiber	Fruits	Shripoorna	Shripoorna
Banana Figs		Dehydrated Fruits	Azista	Azista Industries
Basil seed milk with Banana From Juice	High fiber content	Fruit Beverages	Rita	Rita Beverages
Banana Wine	High phenol content and antioxidant activity	Alcoholic Beverage	Daily Fruit Wine	Daily Fruit Wine
Banana Stem Extract	Rich source of potassium	Fruits	VJHerbals	VJHerbals
Banana Stem Powder	Rich source of potassium	Fruits	Saara Products	Saara Groups

Market Innovations

The food companies are marketing their products innovatively in every available platform in order to reach more potential customers by understanding their preference patterns. The social media marketing, content marketing, guerrilla marketing, affluent marketing and holistic marketing are few of the marketing methods adopted by the companies in order to increase their consumer base. For instance, companies are adopting the influencer marketing strategy by marketing their product with the most influential person/celebrities/sportspersons. Companies are marketing themselves in social media to reach more potential consumers. Similarly, there are many innovative strategies which companies are following. These innovations in both the product as well as different packaging designs have been successful in attracting more customers (Majid, 2018). Placing the

oxygen, carbon dioxide, ethylene scavengers, bioactive packaging, vacuum packaging, freshness indicators outside the packaging, flavor and odor absorbers/ releasers, zero wastage packaging are some of the latest packaging techniques that exist in the market (Lee & Han, 2011). The trend for this has been proven just not a fad but the design for the future generations. Packaging materials have been designed innovatively to meet ecofriendly requirements. Lactose-based packaging, zero-waste packaging are some of those packaging innovations. Various marketing techniques have been employed across different companies by packing the food products with different colors which can attract different potential customers based on their demographics such as age, gender, education, income, and ethnicity (Vogl et al., 2015). For instance, Lays marketed by PepsiCo sells more spicy flavored products in India compared to America. Marketing innovations based on size of the package can be commonly observed in super markets. Large packets of food products are to attract affluent consumers whereas the one serve sachets are used to attract the below premium consumers. Some of the innovative marketing strategies are discussed below:

Guerrilla marketing

Guerrilla marketing is an advertising method in which a business employs unexpected and/or unusual interactions to market a good or service. Guerrilla marketing makes use of a variety of strategies and tactics to get in touch with potential customers directly. The ultimate goal of marketing is to get people to remember items or brands in a way that differs from how they may be used to remembering them. One of the objectives of this engagement is to elicit an emotional response in the customers. It is relatively cheap and emphasizes reach over frequency. Businesses typically don't need to spend a lot of money on guerilla marketing efforts, but they do need creativity, passion, and time. Guerrilla marketing therefore has the potential to be successful for small enterprises, especially if they are up against larger corporations.

Content marketing

Creating, publishing, and disseminating material for a specific audience online is the emphasis of the marketing strategy known as content marketing. It is followed by companies to increase brand awareness and credibility of the product. It helps in creating brand loyalty among consumers. Content marketing starts with identifying the customer's needs and requires content to be delivered continuously.

Social media marketing

Social media marketing refers to the use of websites and social media platforms to advertise a good or service. It can be done in the platforms like Google, Facebook, Instagram, Youtube. These social media platforms allow businesses to interact with their customers in order to develop their brands, boost sales, and enhance website traffic. This type of marketing is especially useful for startups who wants to reduce their initial advertising costs by reach more potential consumer base.

Conclusion

Hence innovative and functional food products are the current trend in food market. It is also envisaged that there is huge potential for market innovations in banana to attract new age consumers with very many convenient and value added products. The marketing tools and the packaging designs are major determinant which attracts the millennial consumers who are trendsetters of market in recent times.

Annexure - I
Agencies involved in export of Banana

Annexure - I

Agencies involved in export of Banana

Government Agencies

S. No	Name & Address	Contact details
1.	Agriculture Production Commissioner Agricultural Production Commissioner and Secretary to Government	Thiru C. Samayamoorthy, IAS., agrisec@tn.gov.in 044 - 25670073
2.	Directorate of Agriculture Department, Chennai Tamil Nadu Walajah Road,, Navalar Nagar, Chepauk, Chennai-600006	Th. A. Annadurai.,IAS diragri@nic.in 04428524894
3.	Tamil Nadu Horticulture Development Agency (TANHODA) Department 3rd Floor, Agriculture Complex, Ezhilagam, Chepauk, Chennai- 600 005.	Mrs. R. Brindha devi, IAS Director, dirhortitn@yahoo.com
4.	Department of Agricultural Marketing and Agri-business, 116, 100 Feet Rd, Guindy Industrial Estate, SIDCO Industrial Estate, Guindy, Chennai, Tamil Nadu 600032.	Mr. Natarajan 044 2225 3885 ceotansamb@gmail.com / agrimarkbusiness@gmail.com
5.	Agricultural and Processed Food Products Export Development Authority 3rd Floor, NCUI Building 3, Siri Institutional Area, August Kranti Marg, (Opp. Asiad Village), New Delhi - 110 016, India	91-11-41486013, 20863919, 20867008, 20867007 headq@apeda.gov.in
6.	Directorate General of Foreign Trade (Headquarters), Udyog Bhawan, New Delhi Directorate General of Foreign Trade (DGFT) Udyog Bhawan, H-wing, Gate No-02, Maulana Azad Road, New Delhi - 110011	1800-572-1550 1800-111-550 dgftedi@nic.in
7.	ICAR - Indian Institute of Horticulture Research, Hessaraghatta Lake Post, Bengaluru-560 089	Dr S. K. Singh, Director director.iihr@icar.gov.in 080-28466471/080-28466353
8.	ICAR - National Research Centre for Banana Thogamalai Road, Thayanur Post, Tiruchirapalli - 620 102. Tamil Nadu, India.	Dr. R. Selvarajan, Director, director.nrcb@icar.gov.in 0431-2618125

9.	ICAR-National Institute of Natural Fibre Engineering and Technology 12, Composite Housing Estate, Regent Park, Kolkata, West Bengal 700040	Dr. Alok Nath Roy 033-2421 2116 director.nirjaft@icar.gov.in
10.	Ministry of micro, small & medium enterprises (MSME) The Joint Director & Head of Office, MSME Development & Facilitation Office, Ministry of MSME, Govt. of India, MSME Bhawan, 65/1, GST Road, Guindy, Chennai, Tamil Nadu, India - 600032	Shri S Suresh Babuji, IEDS, Joint Director & Head of Office dcdichennai@dcmsme.gov.in 044-22501011, 12, 13,
11.	Indian Institute of Packaging (IIP), Plot no. 169, Industrial Estate, 2nd Main Road, Burma Colony Perungudi, Chennai - 600096	Mr. Ponkumar, Deputy Director iipchennai@iip-in.com Mobile : 9382199089
12.	National Plant Protection Organization (NPPO) Regional Plant Quarantine Station, G.S.T. Road, Near Trident Hotel,	Dr. Subhash Kumar, Joint Director (WS) rpqfsc@nic.in
	Neenambakkam Chennai- 600 027	
13.	The National Institute of Food Technology, Entrepreneurship and Management – Thanjavur (NIFTEM-T) Pudukkottai Road, Tamil Nadu, Thanjavur- 613005	Dr. M. Loganathan, Director i/c hod.dtd@iifpt.edu.in director@iifpt.edu.in
14.	Tamil Nadu Agricultural University, Coimbatore TNAU, Lawley road, Coimbatore- 641003	Dr. V. Geethalakshmi Vice- Chancellor, TNAU 0422-6611200
15.	Directorate of Agri Business Development (DABD), TNAU DABD, Tamil Nadu Agricultural University, Coimbatore- 641 003	Dr. E. Somasundaram Ph.D Director (ABD) business@tnau.ac.in 91-422-6611310
16.	Technology Business Incubator(TBI), TNAU DABD, Tamil Nadu Agricultural University, Coimbatore- 641 003	Mr.A.V. Gnanasambantham, Chief Executive Officer, TBI 7598134908 tbi-abis@tnau.ac.in
17.	National Bank for Agriculture and Rural Development, (NABARD) Nabard address – No. 48, High Road, Nungabakkam Road, Nungabakkam, Chennai, Tamil Nadu-600034	Shri.T. Venkatakrishna, Chief General Manager chennai@nabard.org 044-2827 6088

18.	Directorate General of Foreign Trade (DGFT), Chennai No. 26, Shastri Bhavan, Haddows Road, 4th & 5th Floor, Chennai-600006	chennai-dgft@nic.in 044-28283404
19.	ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Adenwala road, Matunga, Mumbai, Maharastra- 400 019	Director 022 - 24127273, 022-24184275 director.circot@icar.gov.in
20.	Confederation of Indian Industry, The Mantosh Sondhi Centre 23, Institutional Area, Lodi Road, New Delhi - 110 003	Mr. Anantha Krishnan 98428 16200 ciitrichyzone@cii.in
21.	Central Silk Technological Research Institute (CSTRI), WJ8C+F8M, Dr Puneeth Rajkumar Rd, Madiwala, Stage 2, BTM Layout, Bengaluru, Karnataka - 560068	Dr. Subhas V. Naik 080-26685238; 26282190 cstriban.csb@nic.in naikcstri@yahoo.co.in
22.	The South India Textile Research Association (SITRA), 13, 37, Avinashi Rd, TNHB Colony, Civil Aerodrome Post, Nehru Nagar West, Coimbatore, Tamil Nadu 641014.	Dr. Prakash Vasudevan 0422 257 4367 info@sitra.org.in director@sitra.org.in
23.	National Institute of Technology, Tiruchirappalli. Tanjore Main Road, National Highway 67, Near BHEL Trichy, Thuvakudi, Tiruchirappalli – 620015	Dr. Aghila Director, 0431 250 3000 director@nitt.edu;

Exporters

S. No.	Name/Address	Contact details
1.	Desai Agri Foods Private Limited Plot No 49, At & Post Amadpore, N.H. No 8, Ta & Dist Navasi, Gujarat.	Mr. Hiren Tanna 9099070002 bharat.patel@desaiagrifoods.com
2.	INI Farms Private Limited 1st Flr -A102 Boomerang Main , Chandivali, Farm Rd, Yadav Nagar,	Mr. Pankaj Khandelwal 7506712535 subsidy@inifarms.com

	Chandivali, Andheri East, Mumbai.	
3.	SMV Export, Karumaripuram, Kamayagoundanpatti-625521, Theni Dist	9363272316 infosmvexports@gmail.com
4.	Greeneers Agro Products India Pvt.Ltd, No. 11, Padmini ,Garden 4th Street Kangayam Road ,Tirupur Coimbatore TN 641604	Mr. Ezhilan Kave 9003939092 ezhilankave@gmail.com
5.	Three Star Exports, No. 6D, Jangal Patti Road Poomalaikundu PO, Theni-625520, Tamil Nadu, India	Mr. Paneer Selvam, Managing Director, 9698119991
6.	Purogreen Exports, 29A, Masakkalipalayam Main Road, Thanthai Periyar Nagar, Sowripalayam, Coimbatore-641 028	Mr. Ragul, 9047557055 ; 9865633331; 8124251981 info@purogreenexports.com
7.	Dharsini Exports A-31, Tnhb, Vellakinar, Coimbatore, Tamil Nadu - 641029, India	Mr. J. Ganesh, 989469676 dharsiniexports@gmail.com info@dharsiniexports.co.in sales@dharsiniexports.co.in
8.	Tidal Imports And Exports 6th Cross West, Kumaran Complex, Vignesh Nagar, Kattur, Trichy,	Mr. J, Venkataraman, info@tidalimpex.com 9843689062,
	Tamil Nadu, India - 620019.	
9.	Geewin Exim, No.14,Sonaiyar Kovil Street Narimedu, Madurai, Tamil Nadu.	Mr. Govindaraja N info@geewinexim.com 9626188777
10	Yuvaraju Agro Impex, No.44/45, Villakkadi Kovil Street, Near Rangaswamy Kulam, Kanchipuram, Tamil Nadu.	Mr. Yuvaraj yuvarajuagroimpex@gmail.com 9626993222
11.	VKS Foods Private Limited, No.31, Subramaniam Road, R.S.Puram, Coimbatore, Tamil Nadu.	Mr. R. Ramesh Kannan, info@vksfoods.in 9840990676
12.	Universal (India) Exports, 4/70/2, Muthammal colony, 3rd street extension, Tuticorin, Tamil Nadu.	Mr. A. Subash subashfernando2013@gmail.com 9894197727
13.	Greeneers Agro Products India Private Limited, No.11, Padmini Garden, 4th Street, Kangayam Road, Tirupur, Tamil Nadu.	Mr. Lakshmi Srinivasan 9003939092 greeneersagroproductsindia@gmail.com
14.	ABC Fruits On Chennai - Bangalore Highway Road, Ankinayanapalli Village And Post, Krishnagiri.	Mr. G. Vjayan 9443248391 info@abcfruits.net

15.	Vashini Exports, Shri Ramvijaya Hyyde Park, B ,Block, 303, Duraisamy layout, Peelemedu, Coimbatore, Tamil Nadu.	Mr. V. N. Muruganandam 9842290222 info@vashiniexports.com
16.	CPS Exports, 4/114, Chinna peelamedu, Sundakkampalayam Po, Sathy Via, Gobichettipalayam Tk, Erode, Nambiyur Tamil Nadu	Mr. Sridhar 8754312402 cpsexports123@gmail.com
17.	Fresh Farms Exim Private Limited, 90/2, Madakulam Nadu Main Street, Madakulam, Ponmeni, Madurai, Tamil Nadu.	Mr. M. Boobalakrishnan, 8939688814 krishna@freshfarmsexim.com

Cold chain service providers

S. No	Name & Address	Contact details
1	Blue Star, KRM Plaza, No 2, Harrington Road, Chetpet, Chennai – 600 031	+91 4442444000
2	Natural Storage Solutions	+91 9909958891 info@nsspl.in
	Pvt Ltd, Plot No. 3 / 4 / 5, Survey No. 164, SIDC Road, Veraval (Shapar), Rajkot, Gujarat.	
3	Rinac Cold Chain Solutions, No. 5, Saraswathi Nivas, Main Chennai Road, Ulsoor, Bangalore - 560008, Karnataka.	91 9916042420 ; 1800 4191166 rilco@rinac.com
4	Coldman 4th Floor, Rupa Sapphire, Plot No. 12, Sector 18, Opposite Sanpada Railway station on Sion-Panvel Highway, Vashi, Navi , Mumbai - 400705	022 - 41581800 info@coldman.in
5	Uni-ref Balagi Blessing – 01, D-125, Narayan Vihar, Jaipur, Rajasthan – 302006	+91 7222001000 unirefindia@gmail.com
6	SBP Cold Storage Private Limited, 63/3,Cauvery Nagar, Behind Sindhi College Madhiravedu Noombal Village,	9444033575 ; 9600099115 sbpcoldstorage@yahoo.com ; mail@sbpcoldstorage.com

	Poonamallee High Rd, Velappanchavadi, Cheannai, Tamil Nadu - 600077.	
7	Way Cool Foods and Products Pvt. Ltd, Old Number 1, New Number 105 Central Warehousing Corporation, Arcot Rd, Compartments III, C and D, Virugambakkam, Chennai, Tamil Nadu 600092.	+91 9500168299 info@waycool.in
8	Ninjacart, WeWork Vaishnavi Signature, No. 78/9, Outer Ring Road, Bellandur Village, Varthur Hobli, Bengaluru, Karnataka – 560103	+91 8069155666 queries@ninjacart.com
9	Siddartha Reddy S Siddartha Warehouse and Cold storage, Tadipatri, A.P.	9985173731 siddu3699@gmail.com
10	MS & Co. Cold Storages (Ripening Chamber) , Annaikatti Street,	Mr. M. Singaravelu msandco.wholesale@gmail.com 9487543465 ; 9443143465
11	Mr. Krishna	9500065867 Nagahari@danfoss.com
	Danfoss Industries Pvt Ltd.	

Logistics Companies for export

S. No.	Name	Contact Details
1	Maersk Line India Private Limited 3rd Floor, Prestige Palladium Bayan, Greams Road, Thousand Lights West, Chennai - 600006	+91 4466588366 in.import@maersk.com ; in.export@maersk.com
2	Jaya Jha Reefer Sales Manager, Tower 9A, 6th Floor, DLF Cyber City - Phase III, Gurgaon - 122002	91 1246135687 ; 91 8420009578 Jaya.Jha@maersk.com
3	Hapag-Lloyd India Pvt. Ltd. Venkatnarayana towers, 1ST Floor, NO. 60, Venkatnarayana Road, T.Nagar, Chennai – 600017	+91 4443930700 Manoj.Madhavan@hlag.com
4	PGS Global Forwarding India Pvt Ltd, Spaces, 621,640/6th Floor, Whites Road, Royapettah, Chennai.-600014	+91 4466282234 Ind-south@parisigs.com

Insurance Agencies

S. No.	Name	Contact Details
1	Export Insurance and Weather based crop Insurance Corporate Solutions Group Alliance Insurance Brokers Pvt.Ltd, 210, Workafella	C .A. Srinivasan, Vice President 8291027991 / 9444928388/9444928388

	Business Centre, No.10, Nungambakkam High Road, Chennai - 600034.	srinivasan@allianceinsurance.in
2.	Agriculture Crop Insurance Company of India Limited Office Block-1, 5th Floor, Plate-B & C, East Kidwai Nagar, Ring Road, New Delhi-110023	011 - 24604444 aicho@aicofindia.com
3.	IFFCO Tokio general insurance co. ltd. IFFCO Tower ,Plot No. 3 , Sector 29 , Gurgaon - 122001,Haryana(India)	1800 103 5499 cgo@iffcotokio.co.in
4.	National Insurance Company Limited National Insurance Co. Ltd.3 , Middleton Street , Kolkata -700071,West Bengal.	18002007710 customer.relations@nic.co.in

Certification Agencies

S. No	Name & Address	Contact details
1.	Global Sustainability Consulting Services, Rohini Chandrasekaran, Samyukthas 247 / 12 W.Kottur, Theni - 625534	6380377157 globalsustainconsulting@gmail.com
2.	TQ Cert Services Private Limited SBU Quality Services, Splendid Tower, 6th Floor, H No. 1-8-364, 437, 438 and 445, S P Road, Begumpet, Hyderabad -500016, Telangana, India.	040-6725 8800, tq@tqcert.in

Farmer Producer Organizations

S. No	Name	Contact No
1	Banana Grower Association of India At. Nimbol, PO.- Vitwa the Raver, DisttJalgaon, Maharashtra	B. V. Patil, President, 02584-271091,271094,250036 9373410350, 09403382858
2	Tamil Nadu Banana Growers Federation, 22, Bharathi Nilayam, Thottiyam PO, Trichy - 621 215	Thiru. G. Ajeethan, Managing Director - 9443714352; Mr.AP.Karuppiah – 80125 79999, 8637423268; ajeethkisan@gmail.com; apkarrupiah@gmail.com
3.	Tamil Nadu Hill Banana Growing Association, Theni	Mr. Shaker Nagarajan President 9842125652
4.	Trichy District Banana Growers' Association Trichy.	Mr. Gopaladesikan, Vice President 04323- 222188
5.	Srirangam Banana Farmer Producer Company Limited, 1/72 West street, Taluk, Srirangam, Tiruchirappalli,	Mr. Natarajan, Chief Executive officer 8680809984

6.	M/s Ameliorate Bioenergy Farmer Producer Co. Ltd, Kushinagar - 274 402, Uttar Pradesh.	Ameliorate.befpcl.kushinagar@gmail.com 9839431549;8756994311
7.	M/s Surachita Agro Producer Company Ltd, Karkamb (Post), Pandharpur (Taluk), Solapur (Dt) Maharashtra - 413302	Mr. Ratnadeep Mohan More surachitaagro@gmail.com 9423594407

ICAR - NRCB Entrepreneurs

S. No	Name	Contact No
1.	M/S. Abhay Natural Food Processing Unit, Mr. Naveen Kumar H.M No.110/1, Rathanapuri village, Aspatrekavel Gram Panchayath, Hunsur, Mysuru, Karnataka - 571189.	naveen.ibs@gmail.com 9008005521
2.	Arivumani. C, 13 - A, Maniammai illam, 3rd Cross Bharathi Nagar, Puthur, Trichy - 620007	c.arivumani@gmail.com imayamarketingtry@gmail.com 95785 86667
3.	Althash Hussain, P.A., Parikunnath House, Chalissery Post, Palakkad District - 679536, Kerala	althash1234@gmail.com 7907755900
4.	Stay Health Tech culture Pvt Ltd, 53, Alagu Nagar, 4th Street, Saravanampatti, Coimbatore - 641035	Janarthanan. P, janabits@gmail.com 9442510845
5.	S. Devipriyadharshini, 2/15 North Street, Mudivaithanendhal Pudur, Thoothukudi – 628102, Tamil Nadu.	devisankar203@gmail.com ; agathiyaorganic@gmail.com 9942680776
6.	M/s Cake Bee Deli Fresh Private Limited, 25/B, 2nd Main Road, Kalyanasundaram Nagar,Karumandapam , Trichy - 620001, Tamil Nadu.	Mr. SP. Sethu Subbiah admin@cakebee.in 9842932242
7.	Mr. Jose Joseph Mathew, Varickamakkal House, Pindimana Post, Kothamangalam, Kerala - 686 692	josevarickamackal@gmail.com 9843430055
8.	Mr. Ashif. K.K Kammattiyerikunnu, Chungam, Thamarassery (Po), Calicut, Kerala.	ashif2293@gmail.com

9.	M/s AFAS Foods, 9/65, Velankattu Thottam Anjanur Post Nambiyur (Taluk) Erode - 638462	Mr. A. K. Soundararajan akssoundararajan@gmail.com 8072041560
10.	M/s Viyan Health World Plot no 23, 4th cross street, Devi Eswari Nagar main road Thendral Nagar East, Thirumullaivayil, Chennai - 600 062	M. Gurunathan viyanhealth2017@gmail.com 7397492555

Material Suppliers

S. No	Name	Contact No
1.	M/s. Kovai Plastics 925, Raja Streets, Five Corners, Opp To Chandransteels, Coimbatore - 641 001.	kovaiplastics72@gmail.com info@kovaiplastics.com +91 98945 99770 ; +91 90955 99770
2.	M/s. Nilkamal 77/78, Nilkamal House, 14th Street, MIDC Road, Andheri (East), Mumbai - 400 093.	furniture.enquiry@nilkamal.com
3.	Sri Kamakshi Enterprises H. R. Complex, New No. 939, Old No. 482, P. H. Road, Near Panchaliamman Koil, Arumbakkam, Chennai – 600106.	8048967154
4.	Jenani Commercials, 5/151, Shenbagam Colony, Satchiyapuram, Sivakasi - 626 124. India.	+91 9677399230, +91 944 344 1374 sales@jenanicorrugatedbox.com
5.	VVM Carton Industries, Chinnanainthan Vilai, Nagercoil – 629501, Kanyakumari Dist, Tamil Nadu.	+91- 7904935038, 04652 287350 info@vvmcartons.com

Annexure - II
Committees

ICAR – NATIONAL RESEARCH CENTER FOR BANANA

TRICHY

No. ICAR-NRCB/Export Consultative Workshop/2022 Date: 09.12.2022

CIRCULAR

The ICAR-NRCB, Trichy is conducting **Consultative workshop on "Export of GI and Traditional bananas: Present Scenario, Trade Opportunities and Way Forward" on 21st and 22nd December, 2022 (Wednesday and Thursday)**.

For successful conduct of the event, various committees have been formed and is attached herewith. In addition, wherever required, the help of RA/SRF/Contractual staff may be utilized with intimation to the undersigned. All concerned Chairperson of the Committees are requested to initiate necessary action immediately concerned to their assignment for the successful conduct of the event.

(R. Selvarajan)
Director

Distribution to :-

1. All the Scientific / Technical / Administrative staff
2. Notice Boards(s)

ICAR – NATIONAL RESEARCH CENTER FOR BANANA, TRICHY

Consultative Workshop on Export of GI & Traditional Bananas

21-22 December 2022

REGISTRATION / RECEPTION COMMITTEE

Chairperson	Dr. S. Backiyarani, Pr. Scientist
Co-chairperson	Dr. K.J. Jeyabaskaran, Principal Scientist
Member	Mrs. Anitha Sree, STO
Member	Mrs. CS. Jacqueline, STO
Member	Mrs. AV. Suja, UDC
Member	Mrs. K. Mariammal, SSS
Convener	Dr. C. Anuradha, Sr. Scientist

PROGRAMME PLANNING COMMITTEE

Chairperson	Dr. M.S. Saraswathi, Principal Scientist
Member	Dr. P. Suresh Kumar, Principal Scientist
Member	Dr. M. Loganathan, Pr. Scientist
Member	Shri D. Ramachandramurthy, CO
Convener	Dr. A. Mohanasundaram, Sr. Scientist

VIP COORDINATION COMMITTEE

Chairperson	Dr. S. Uma, Pr. Scientist
Co-chairperson	Dr. M. Mayilvaganan, Pr. Scientist
Member	Dr. I. Ravi, Pr. Scientist
Member	Dr. A. Mohanasundaram, Sr. Scientist
Member	Shri T. Sekar, TO
Member	Dr. P. Durai, ACTO
Convener	Dr. M. Loganathan, Pr. Scientist

MEMENTOS AND CERTIFICATE ARRANGEMENT COMMITTEE

Chairperson	Dr. M. Loganathan, Pr. Scientist
Member	Dr. P. Suresh Kumar, Pr. Scientist
Member	Mrs. T. Anithasree, ACTO
Member	Shri RNMS. Kannan, PS
Member	Mrs. S. Durgawathi, Asst.
Convener	Dr. M.S. Saraswathi, Pr. Scientist

PUBLICATION COMMITTEE

Chairperson	Dr. J. Poorani, Pr. Scientist
Member	Dr. M.S. Saraswathi, Pr. Scientist
Member	Dr. K.N. Shiva, Pr. Scientist
Member	Dr. P. Suresh Kumar, Pr. Scientist
Member	Dr. P. Ravichamy, ACTO
Member	Shri K. Kamaraju, STO
Convener	Dr. P. Giribabu, Sr. Scientist

FARMERS / FPO'S/ GUESTS COORDINATION COMMITTEE

Chairperson	Dr. R. Thangavelu, Pr. Scientist
Member	Dr. C. Karpagam, Pr. Scientist
Member	Dr. P. Durai, ACTO
Member	Shri N.Marimuthu, TO
Member	Shri R. Pitchaimuthu, TO
Convenor	Dr. K.J. Jeyabaskaran, Pr. Scientist

MEDIA AND PUBLICITY COMMITTEE

Chairperson	Dr. C. Karpagam, Pr. Scientist
Member	Dr. M. Loganathan, Pr. Scientist
Member	Dr. P. Giri Babu, Sr.Scientist
Member	Dr. P. Ravichamy, ACTO
Member	Dr. C. Palanichamy, ACTO
Convener	Dr. A. Mohanasundaram, Sr. Scientist

HOSPITALITY AND REFRESHMENT COMMITTEE

Chairperson	Dr. I. Ravi, Principal Scientist
Member	Dr. C. Anuradha, Sr. Scientist
Member	Shri R. Sridhar, AAO
Member	Shri P. Kamaraju, TO
Member	Shri R. Mohan Raj LDC
Member	Shri M. Bathrinath, TO
Member	Shri A. Kaspar, SSS
Convener	Dr. D. Ramajeyam, Pr. Scientist

FINANCE COMMITTEE

Chairperson	Director
Co-chairperson	Dr. S. Uma, Pr. Scientist
Member	Mrs. C. Gomathi, FAO
Member	Shri. P. Murugan AAO
Member	Shri R. Sridhar, AAO
Convenor	Dr. P. Suresh Kumar Pr. Scientist

EXHIBITION COMMITTEE

Chairperson	Dr. V. Kumar, Pr. Scientist
Member	Dr. K.N. Shiva, Pr. Scientist
Member	Dr. S. Backiyarani, Pr. Scientist
Member	Dr. P. Durai, ACTO
Member	Shri K. Kamaraju, STO
Member	Shri M. Bathrinath, TO
Convener	Shri D. Ramachandramurthy, CO

TRANSPORT COMMITTEE

Chairperson	Dr. K.N. Shiva, Pr. Scientist
Member	Dr. S. Palanichamy, ACTO
Member	Shri V. Selvaraj, STO
Member	Shri N. Marimuthu, TO
Member	Shri R. Mohan Raj LDC
Member	Shri R. Pitchaimuthu, TO
Convener	Dr. P. Giribabu, Sr. Scientist

FIELD VISIT COMMITTEE

Chairperson	Dr. D. Ramajeyam, Pr. Scientist
Member	Dr. S. Backiyarani, Pr. Scientist
Member	Dr. P. Durai, ACTO
Member	Shri V. Selvaraj, STO
Member	Shri N. Marimuthu, TO
Member	Mr. V. Ganesan , SSS
Convener	Dr. V. Kumar, Pr. Scientist

ACCOMMODATION COMMITTEE

Chairperson	Dr. M. Mayilvaganan, Pr. Scientist
Member	Dr. V. Kumar, Pr. Scientist
Member	Mr. N. Marimuthu, T.O.
Member	Mr. T. Sekar, T.O.
Member	Mr. V. Thangaraju, LDC
Convener	Dr. K.N.Shiva, Pr. Scientist

TECHNICAL SESSIONS: GI and Traditional Bananas

Chairperson	Dr. P. Suresh Kumar, Pr. Scientist
Member	Dr. R. Thangavelu, Pr. Scientist
Member	Dr. V. Kumar, Pr. Scientist
Member	Dr. KN. Shiva, Pr. Scientist
Member	Dr. D. Ramajeyam, Pr. Scientist
Convener	Dr. M.S. Saraswathi, Pr.Scientist

TECHNICAL SESSION: PPV & FRA

Chairperson	Dr. S. Backiyarani, Pr. Scientist
Member	Dr. M.S. Saraswathi, Pr.Scientist
Member	Dr. D. Ramajeyam, Pr. Scientist
Convener	Dr. P. Durai, STO
Convener	Dr. C. Anuradha, Sr. Scientist

===

ICAR – NATIONAL RESEARCH CENTER FOR BANANA
TRICHY

No. ICAR-NRCB/Export Consultative Workshop/2022 Date: 15 .12.2022

CIRCULAR

The following committees are formed in addition to the existing committees for the conduct of the **Consultative workshop on "Export of GI and Traditional bananas: Present Scenario, Trade Opportunities and Way Forward" on 21st and 22nd December, 2022 (Wednesday and Thursday).**

Secretariat

Member	Mrs.C.Gomathi, FAO
Member	Mr.R.Sridhar, AAO
Member	Mr.R.N.M.S.Kannan, PA
Member	Mrs.R.Arthi, SPA
Member	Mr.A.Chandrasekar, SPA
Member	Ms.T,Subrajha, SRF
Member	Dr.C.Sivanand, RA
Member	Dr.C.Karthi, YP-II
Member	Mr.G.Jhony, JPA

EXHIBITION COMMITTEE (Additional members)

Co-Chairman	Dr.C.Karpagam, Pr. Scientist
Member	Dr..P.Ravichamy, ACTO

PHOTOGRAPHY

Chairman	Dr.C.Karpagam, Pr. Scientist
Member	Mr.S.Ajit Kumar, Research Assistant
Member	Mr.H.Nelson, YP-I
Member	Mr.R.Gopi, YP-II
Member	M. Balasubramanian, YP-I
Convenor	Dr.P.Ravichamy, ACTO

15/12

(R.Selvarajan)
Director

To

All Staff of the Centre

Notice Board (s)

स्वच्छ भारत
एक कदम स्वच्छता की ओर

G20
भारत 2023 INDIA

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

Sponsors

PPVFRA

NABARD

एपीडा
APEDA

राष्ट्रीय बागवानी बोर्ड
NATIONAL HORTICULTURE BOARD
Ministry of Agriculture & Farmers Welfare, Government of India

ICAR - National Research Centre for Banana
Sardar Patel Outstanding ICAR Institute - 2020
(ISO 9001:2015 Certified Institute)
Thayanur Post, Thogamalai Road, Tiruchirappalli - 620 102, Tamil Nadu, India.
Phone : 0431 2618125, Email - director.nrcb@icar.gov.in,Web - https://nrcb.icar.gov.in

9 789357 684699