Recent advances in tropical fruit research in India

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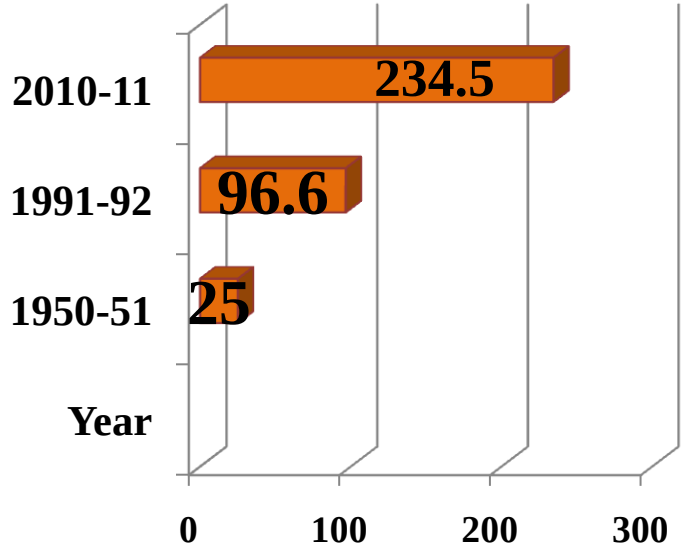
Contribution to Agricultural GDP

1950-51	• 0.5 %
1995-96	• 18 % • 6 % area
2011-12	• 30.4 % • 11 % area

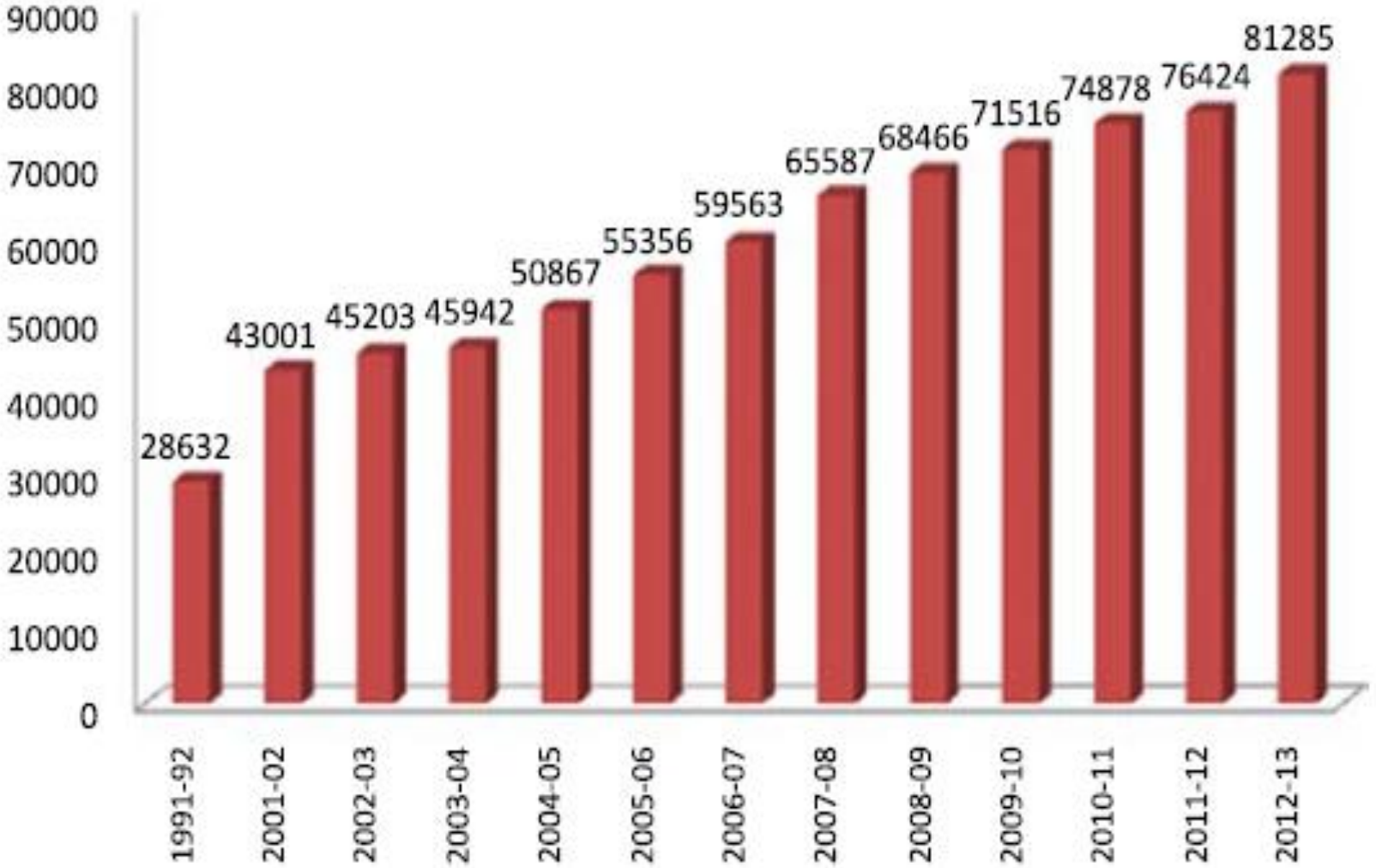
HORTICULTURAL PRODUCTION (MT)



Estimated requirement 2016-17 – 345 MT

Trend of Fruit Crops in India

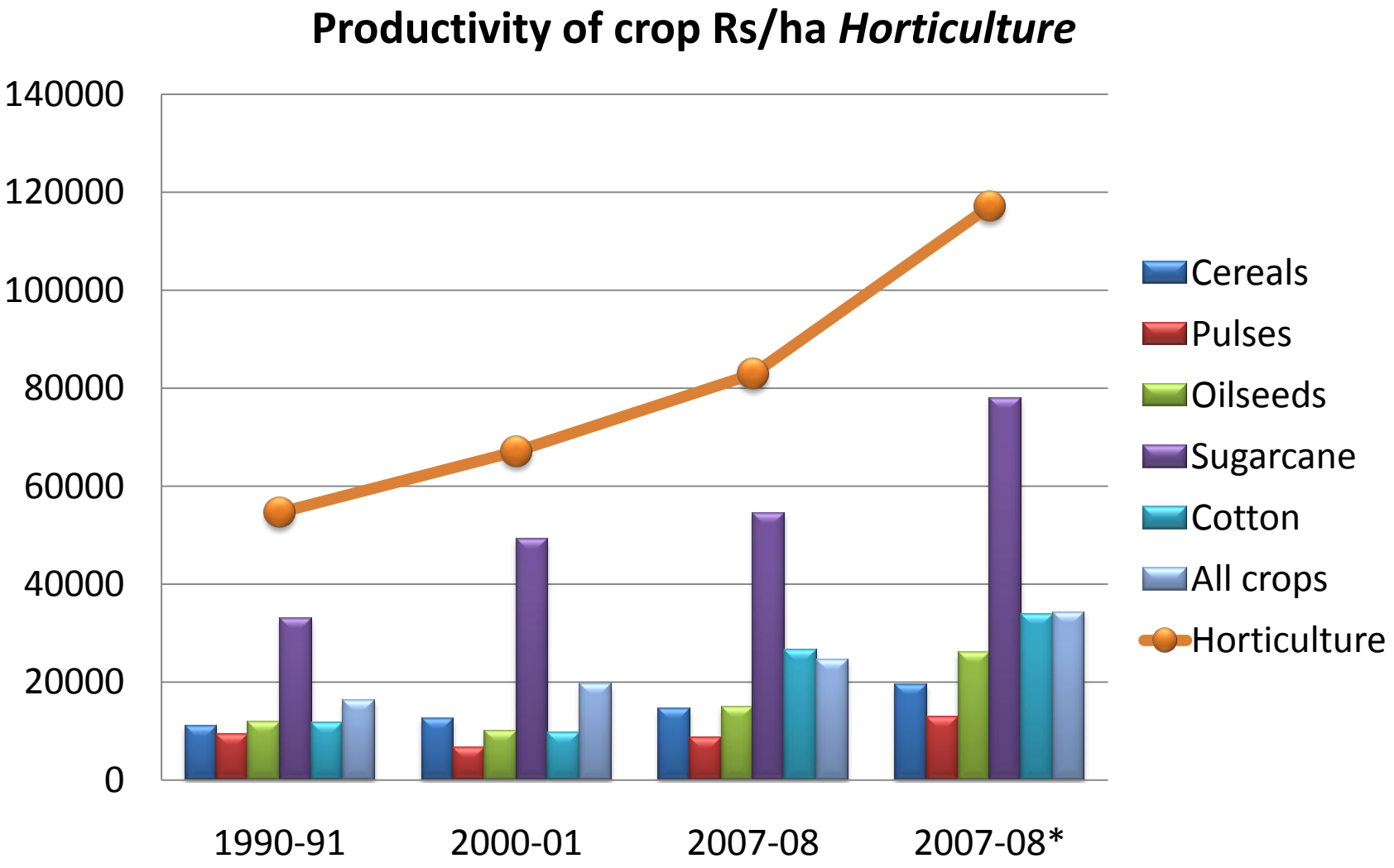
All India Production of Fruits At A Glance (in thousand MT)



India in the world
Productivity comparison of Fruits-2012-13 (t/ha)

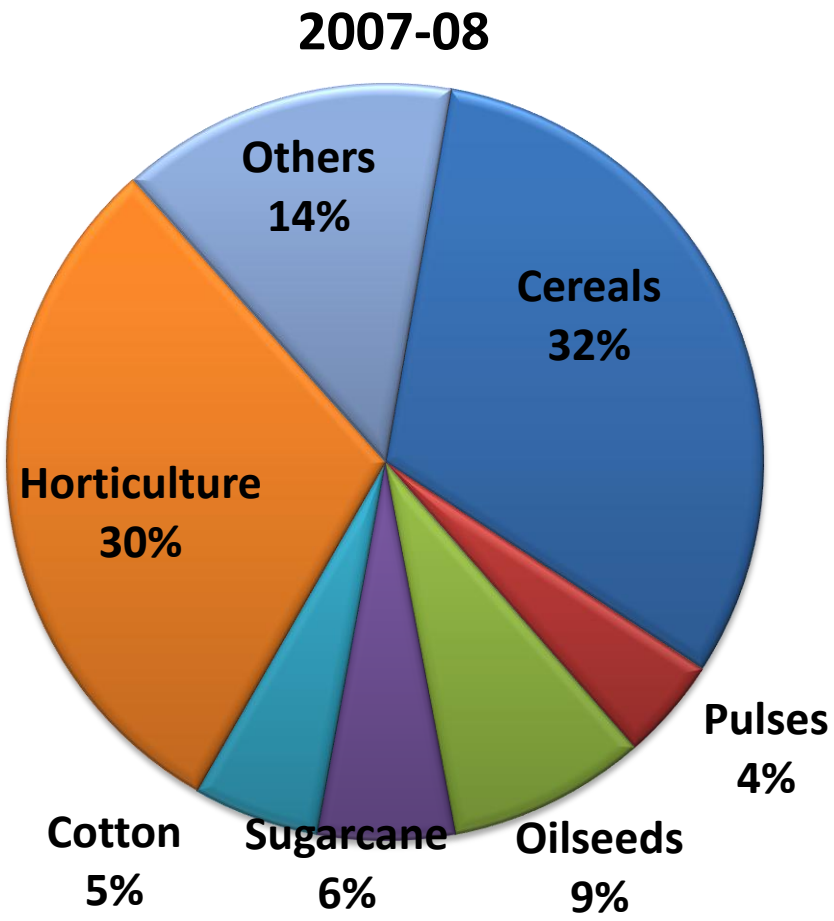
Fruits	India	World	Highest
Banana	**34.2**	**20.7**	**1.Indonesia (58.9)** 2.Guatemal (40.9) , 3.India (34.2) 4.Ecuador (33.3) 5.Mexico (30.3)
Grapes	**21.1**	**9.8**	**1.India (21.1)** 2.U.S.A (17.1) 3.China (16.0) 4.Chile (15.7) 5.Argentina (12.7)
Mango	**7.2**	**7.7**	**1.Brazil (15.8)** 2.Pakistan (10.7) 3.Indonesia (9.7) 4.China (9.4) 5.Mexico (9.3)
Orange	**9.3**	**18.2**	1.Turkey (36.3) 2. South Africa (35.8) 3.USA (32.6) 4. Brazil (24.7) 5. Egypt (23.5)
Papaya	**40.7**	**28.9**	1. Dominican Republic (312.7) 2.Guatemala (89.8) 3.Indonesia (86.7) 4. China, Taiwan province of (58.4) 5.Mexico (50.1)
Pineapple	**14.9**	**23.2**	1.Indonesia (124.5) 2.Costa Rica (59.2) 3.Mexico (42.9) 4.Philipines (41.0), 5.Brazil (40.9)
All fruits	**11.6**	**11.3**	**1.Indonesia (22.3)** 2.U.S.A (23.3) 3.Brazil (16.5) 4. Turkey (13.6) 5.Philipines (13.2)

Changes in land Productivity through Diversification



Gross returns from per hectare at 1999-00 prices * indicates at current prices

How role of Horticulture has changed ?
Contribution of Crop Groups in Production (Value)



9% area contribute 30.4 % Value at constant prices and 30.73 at current prices

Institutional support to address the challenges

Research ICAR

- 11 Institutes
- 6 Directorates
- 6 NRC's
- 14 AICRP's
- 251 Research Centres
- Dept. of Hort. in 35 SAU's

INSTITUTES (11)

- IIHR, Bangalore
- IIVR, Varanasi
- IISR, Calicut
- CISH, Lucknow
- CITH, Srinagar
- CIAH, Bikaner
- CTCRI, Trivandrum
- CPRI, Shimla
- CPCRI, Kasargod
- CIARI, Portblair
- CRIC Nagpur

DIRECTORATES (6)

- Medicinal & Aromatic plants
- Onion & Garlic
- Oil Palm
- Mushrooms
- Cashew
- Floriculture

NATIONAL RESEARCH CENTRES (6)

- NRC Grapes
- NRC Banana
- NRC Litchi
- NRC Seed Spices
- NRC Orchids
- NRC Pomegranate

Varieties for specific purpose

Mango	Pusa Arunima (Export quality) Pusa Surya (Long self life) Arunika (Anthracnose resistant) Ambika (bright yellow with dark red blush, firm with scanty fibre)
Guava	Lalit (Pink pulp)
Grape	Pusa Navrang (Red pigmentation, juice making)
Papaya	Arka Prabhat (Gynodioecious - table fruit) CO-8 (Red pulp- table)
Citrus	Phule Sharbati, Balaji acid lime
Jackfruit	Less gum type

Arka Prabhath

- Fruit wt : 1200 to 1500g
- Yield : 135 t/ha
- TSS : 13-14° Brix
- Cavity index : 28 - 32 %

Papaya CO.8

- Attractive red pulped dioecious variety
- No of fruits /tree : 75-80
- Average fruit weight : 2.20 kg.
- Highly suitable for processing and papain extraction
- Dec 2011; Undergoing MLT in AICRP centres

Evaluation of intergeneric hybrid progenies of papaya for PRSV tolerance

Parents : Arka Surya x *V.Cauliflora*
Number of progenies under evaluation (F5) :640

Field view of inter-generic progenies evaluated

Evaluation of intergeneric hybrid progenies of papaya for PRSV tolerance

Fruit weight :600-800 g

TSS:11.5 to 12.5^{o} B

Pulp thickness: 2.95 -3.05 cm

Pulp colour: orange

Fruits/tree :55-60

Selected progenies under evaluation for PRSV tolerance coupled with fair fruit quality

Acid lime

Phule Sharbati

- High summer crop (25%)
- Round fruit, thin rind
- Less incidence of canker and tristeza
- Yield (180 kg/tree)

Balaji acid lime

- High yielding (115 – 120 kg/tree)
- Canker tolerant
- Large and round fruit

H-531

- Resistant to nematode & *Fusarium* wilt
- Resembles Poovan
- Yield 13-15 kg/bunch

Kovvur Bontha Selection

- High yielding cooking type
- 35 kg / bunch

Clonal Selection of Nendran

(Manjeri Nendran II)

- Higher bunch weight (14-15kg-potential even up to 25kg as against local Nendra 10 kg)
- Suitable for annual cropping
- Tolerant to Sigatoka leaf Spot & pseudostem borer

Jackfruit

Promising type

Selection G-11a

- Medium latex exudation
- Coppery red flakes of 44g/flake
- Medium sized fruits (9.5-10 kg)
- Thick flakes (1.1 cm)
- Fake to Fruit ratio of 0.48
- High TSS (23°B)
- Acidity of 0.4%
- High carotenoids (3.5 mg/100g)

Jackfruit

Selection G-65

- Low latex exudation
- Medium sized fruits (8.65 - 13.2 kg)
- Good crispy flakes
- TSS of 24 – 29 °B

Osmo-dried jackfruit slices of different types

Sapota

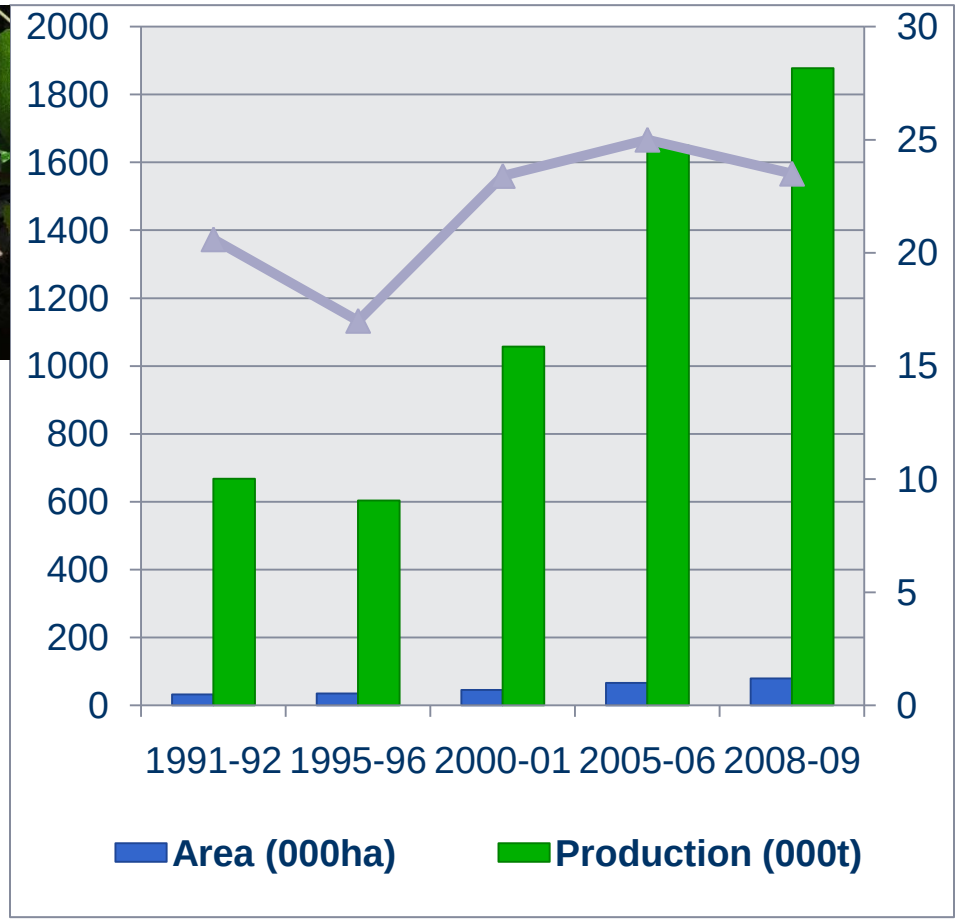
- Dwarf statured
- Fruits are oval in shape
- High yield (65-75 kg/tree/year)
- Medium size fruits

- Compact tree canopy
- Suitable for high density planting
- High yielder (100.4 Kg/tree/year; 20.08 t/ha)
- Spindle shaped fruits in clusters
- Attractive pulp with honey brown colour

Rootstock research

- **Root which impart better vigour and productivity of soil even under adverse situation and provides required architecture**
- **Used in most of the perennial fruit trees**
- **Use of rootstock is success story**
  - **Grape: Dogridge and 110R (drought and salinity tolerance)**
  - **Citrus: Alemow**
  - **Mango: 13-1**
  - **Guava: Interspecific wilt resistant rootstock (*P. molle x P guajava*)**

Using root stock revolutionized grape production



Rootstock, plant architecture management & use of hormones made grape successful in tropics with highest global yield

Root stock technology alone revolutionized grape cultivation with 10 % yield and quality advantage fetched additional revenue of 129 Million USD

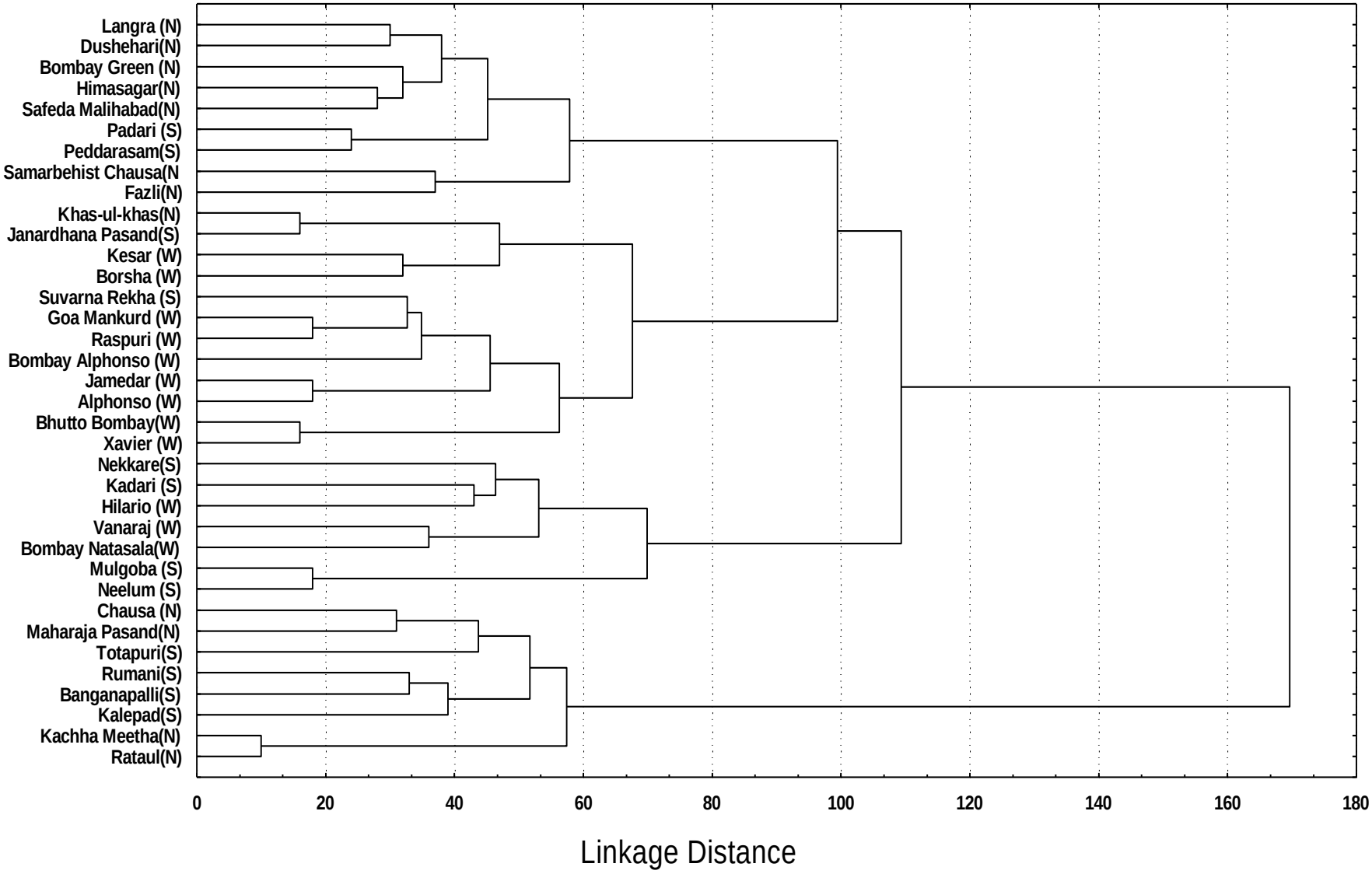
Citrus rootstock Alemow : Resistant to *Phytophthora* (root rot & gummosis)

Two times increased yield

Nagpur mandarin (>21 t/ha)

Acid lime (> 13t/ha)

Cluster analysis of RAPD markers generated for 36 mango cultivars grown in different regions of India



High Density Planting in banana

- Paired row system at 1.2x1.2x2.0m
- 5208 plants/ha

- 3 plants/ Hill at 1.8 x 3.6m
- 4630 plants/ha

Nutrient requirement under HDP in banana

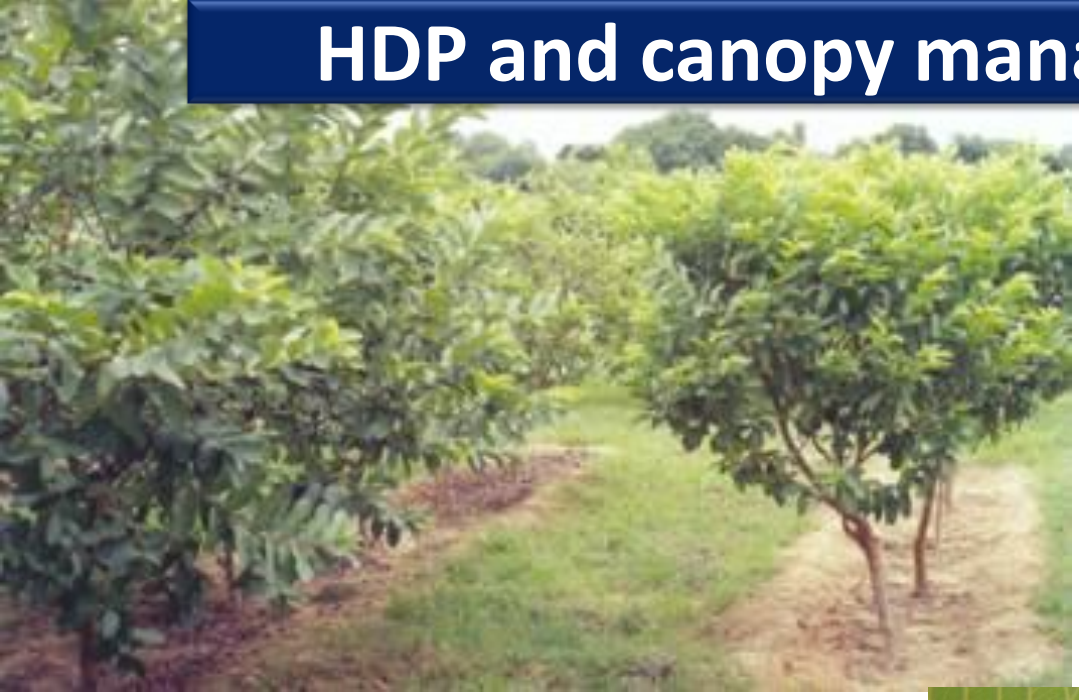
Density	RDF (%)	Centre/variety
4650 to 5000 plants/ha	50	Rajapuri at Arabhavi
	75	Alpan (Pusa), Robusta (Kovvur), Martaman (Mohanpur) and Grand Naine (Gandevi)
	100	Borjahji (Jorhat) and Nendran (Kannara)

3 suckers /hill 1.8x 3.6m= 4600 plants/ha

3 suckers /hill 2x3m = 5000 plants/ha

HDP in guava

HDP and canopy management in guava



Early shoot management for better canopy and production

Enhancement of flowering through shoot pruning

HDP and canopy management in guava Contd…

Initial canopy management to maximize fruiting under high density planting

Heavy fruiting after 7 years of planting

High density orcharding in mango

- **400 trees/ha in case of Alphonso facilitated through vigour regulating practices - enhancing productivity in early years of mango orchard**

High density planting of mango

Alphonso - 3m x 3m

Alphonso variety on Vellaikolumban

PLANTS LOADED WITH FRUITS UNDER HIGH DENSITY PLANTING

HIGH DENSITY PLANTATION

NORMAL SPACING PLANTATION

PRUNING AND TRAINING

New approach for induction of flowering in mango

Stems must be in rest for sufficient time

generally about four to five months to induce the flower in the absence of chilling temperatures

Rhizosphere of mango plants

- **Microbial inoculum (*Trichoderma* and *Pseudomonas*) +**
- **Ethylene precursors - Methionine + $FeSO_4$**

highest ethylene levels in leaves during flowering and highest percentage of shoots flowered

(Reddy and Singh, 2010; Pulla Reddy et al., 2010)









Quality planting material

- **Micro-propagation techniques for various fruits**
  - ***Success story in banana***
- **Cleaning of infected materials**
  - ***Shoot tip grafting in Citrus***
- ***In vitro* propagation for Quality assurance**
- **Quality seed and planting material-health management**

New propagation techniques

- Wedge/ softwood/epicotyle grafting in mango
- Wedge grafting in guava, jackfruit, aonla & jamun
- Shoot tip and Mini-crown grafting in citrus

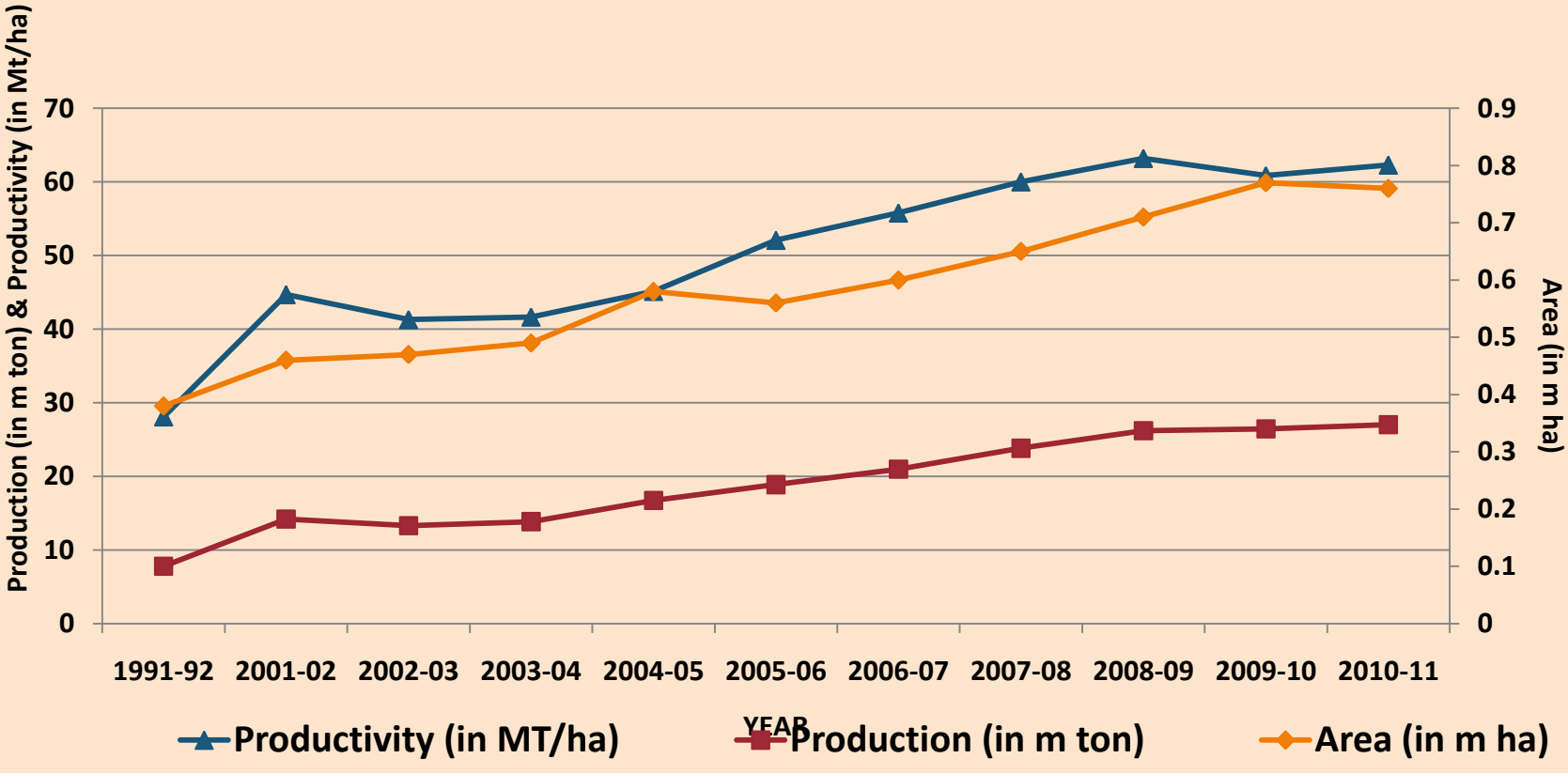
Wedge grafting in guava

Why micro-propagation ?

- Development of disease-free planting material
- Development of micro-propagation protocols for recalcitrant crops
- Mass multiplication of vegetatively propagated plants
- Safe exchange for disease safety

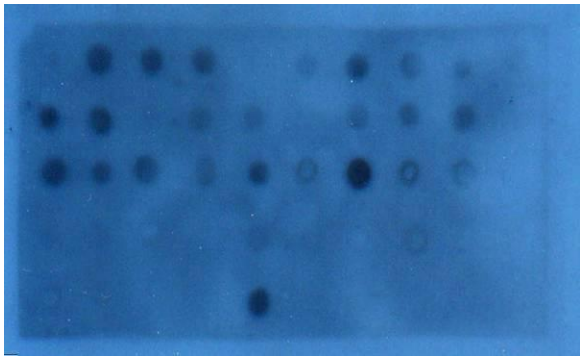
Micro-propagation success story in banana

Revolutionized the banana production

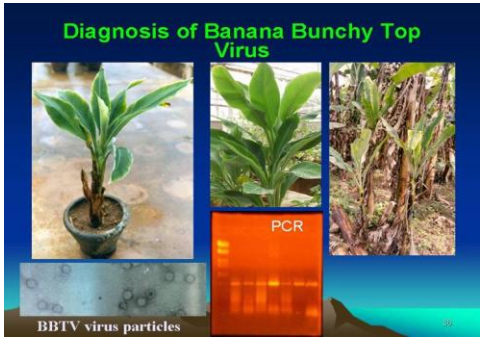


Diagnostics development

- **ELISA Kit** - Banana bunchy top
  - Banana mosaic
  - Citrus tristeza virus
- **PCR based** Banana bunchy top
  - Banana streak virus
- **NASH based detection** - Banana bunchy top/streak
- **RT - PCR based detection**
  - Banana bract mosaic
  - Banana mosaic caused by CMV



NASH based detection of banana streak virus (BSV)



Diagnostics developed for banana and citrus

Crop Protection Technologies

Standardised the region-specific control measures for the management of insect pests, nematodes and diseases using chemicals, botanicals and bio-agents

Bio-agents

- *Mallada boninensis* (4-6 eggs per shoot) for black fly in citrus
- *Paecilomyces lilacinus* and *Pseudomonas fluorescens* for nematodes in banana
- *Trichoderma viride, T. harzianum, Pseudomonas fluorescens* for *Phytophthora* in citrus.
- *Pseudomonas fluorescens* for nematodes/Sigatoka leaf spot in banana.
- Bt for citrus butterfly

Botanicals

- Neem oil for leaf folder and fruit sucking moth in citrus.
- NSKE for citrus leaf miner & canker.
- Neemazal for pseudostem borer of banana
- Neem cake for nematodes of banana and citrus
- Pongamia oil for blackfly

Biological Control of Papaya Mealy Bug using Exotic Parasitoid Acerophagus papaye

Paracoccus marginatus, an invasive mealy bug, Which cannot be controlled by insecticides

Release of parasitoid results in complete control of mealy bug in 3-4 months

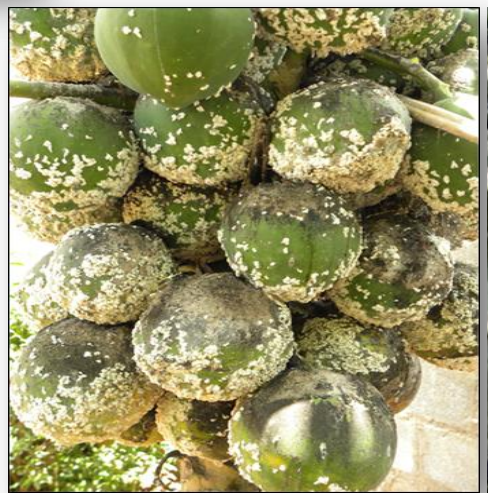
Healthy plant after release of parasitoid

IPM & CBC

Complete suppression of papaya mealy bug through, deploying three exotic insect parasitoids, in seven states, saving 245 m USD worth of starch, papain and silk in cassava, papaya and mulberry crops

Acerophagus papayae

Pseudleptomastix mexicana



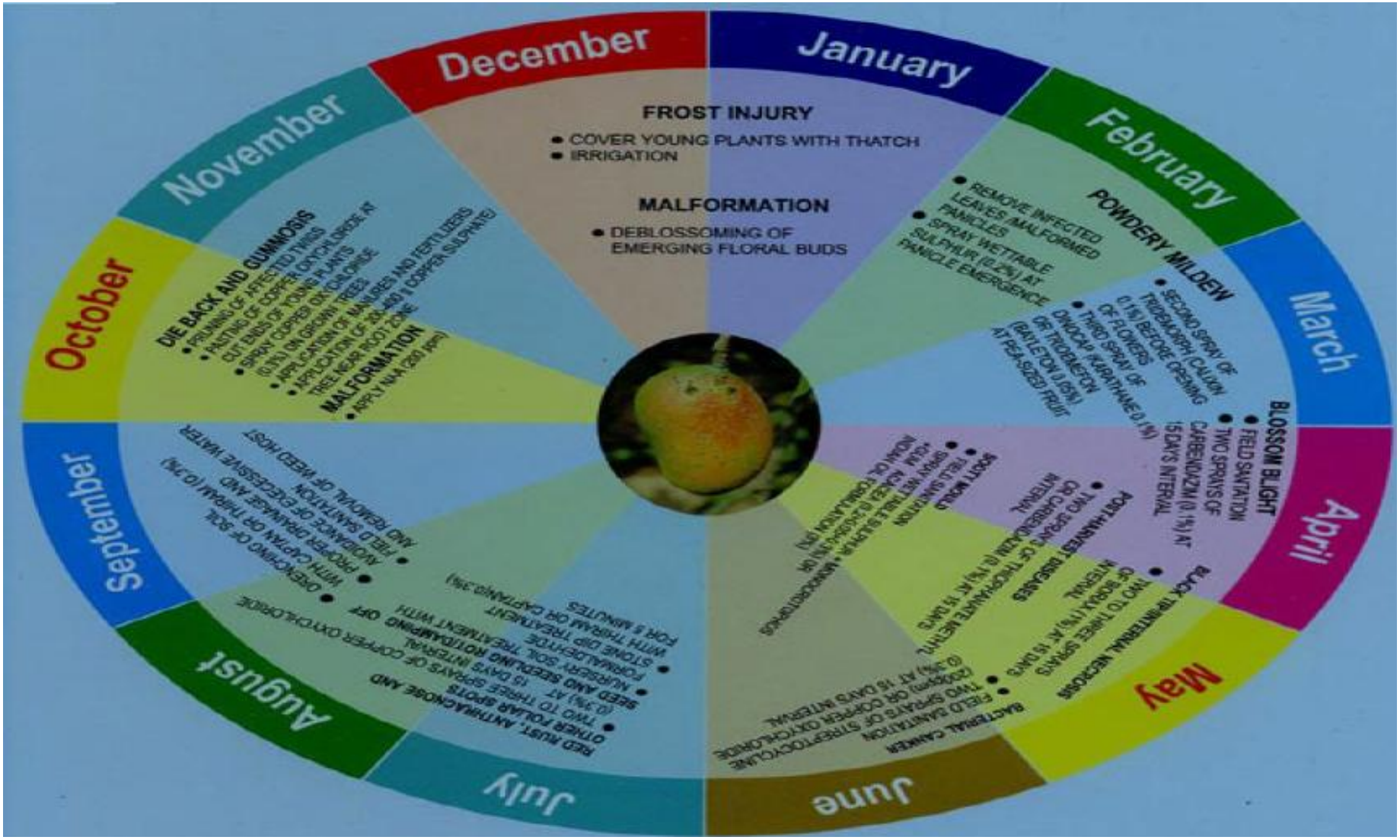
Management of Mango Stem Borer using Sealer-cum-Healer

- Neglected orchards more prone to stem borer attack to the tune of 15-20% of trees
- Application of sealer-cum-healer will control the borer infestation and rejuvenate the affected trees

Important Protection Technologies

IPM in mango

Integrated Diseases Management in Mango



Management of fruit rots in mango

Pre-harvest application - Azoxystrobin (0.1%) **+**

Post-harvest application - Neem leaf extract (5%) or Azoxystrobin (0.1%) or Chitosan (0.1%) or hot water treatment (10 minutes 52^{o}C)

Post harvest technology

Hot water treatment plant

- Capacity :1 ton/hour
- Anthracnose control :52°C for 5 minutes
- Fruit fly control :46°C for 65 minutes

Biological control of guava wilt

Biological control of guava wilt was achieved with *Aspergillus niger* and *Trichoderma* sp. Technique for its multiplication in FYM was developed


Fresh Mangoes From CISH Garden
Fresh Mangoes From CISH Garden


D-955 FILM


Fresh Guava From
GISH Garden
GISH
Export Quality


GUAVA SLICES
GUAVA NECTAR
GUAVA PULP
GUAVA PULP
GUAVA NECTAR


Mango Squash
Mango Squash
Mango Squash
Mango Squash
Mango Squash
Mango Squash


Guava RTS


Guava
Cider

Pre as well as Post NAIP Value Chain Scenario for Kesar Mango and Ahllabad Safeda guava

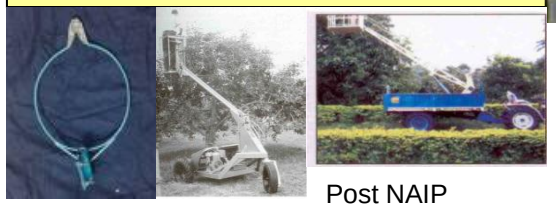
Pre NAIP

Intervention of NAU

Pre NAIP

Intervention of NAU

Harvesting, post harvest handling and management

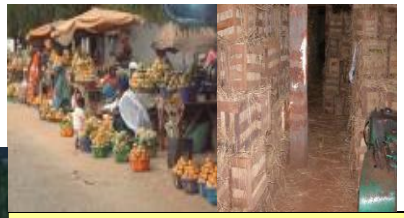


Post NAIP

Production system of mango and guava

Post NAIP

Pre NAIP



Consumer Satisfaction and Benefit to Growers

Intervention of NAU

Marketing of fresh fruits or value added products

Pre NAIP

Consumption

Post NAIP

Processing of fruits

Intervention of NAU

What we have Achieved ?

- Enriched Genetic Resources: 2300 (total: 79600) accessions
- New Varieties/hybrids: 240 (total 1870)
- Plant architectural engineering and management for enhancing efficiency
- Crop management system - water & nutrients
- Plant health management - IPM & Bio-control
- Technology for reducing losses
- Post harvest technology & value addition

Research priorities

- Development of hybrids - genes for higher yield and resistance to biotic and abiotic stress which respond to climate change
- Improved production technology for mitigating problematic soil
- Enabling efficient use of water, nutrients and solar energ
- Technology for safe management of insect pests and diseases
- Reduction in post-harvest losses and value addition
- New areas
  - organic farming
  - precision farming
  - protected cultivation
  - biotechnology

Thank You