POMOLOGY

Evolution, Breeding History, Physiology of Production of Fruit Crops

For Quantity and Quality Of Fruit Production Of Durian, mangosteen, citrus and underutilized species
Over 230 species from over 57 families

High genetic variation in many species

Many are underutilized

..\..\..\CARP-ICRAF PROJECT\fruit trees data.xls
1. For Fresh fruits
2. Fresh fruit as raw material
3. Semi processed products
4. Processed products
5. New developments (bioprospecting-medicines, health food items)
Our fruits are gifts of diversity, not results of systematic breeding, but to unique selection events by unsung and unremembered farmers.
Growers need information that selected germplasm performs better
Seedling supply chain needs funding
APPROACH
NOW
APPROACHING
APPROACH
Once produced, only possibility is grading
# Availability of Selected Fruits

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**Season**

- **Off Season**
- **Low Season**
- **Peak Season**
New ways to look issues..
New ways to look at issues...
Durian
Identify New Species

*Durio oxleyanus* – Orange Durian

*Durio graveolens* – Red Durian
Variety improvement...

- Conventional breeding, selection from natural, induced changes (genetic engineering and mutational breeding)
- Mainly by selection of chance seedlings e.g. Hass avocado, Tommy Atkins mango, Kensington Pride mango, many more...
- Apples and strawberries conventional hybridized. New scion and rootstock varieties from East Malling (England) and Maroochy (Queensland).
- Citrus - Florida, Pineapple- Hawaii, Australia, papaya- Thailand, USA and Taiwan
- Mango from ICAR, India, IIHR, MARDI
- Tropical fruits- IPGRI, TFNet
New…

- Banana: Williams hybrid (AAA), Grande Naine (AAAA) (Cavendish types)
- Pineapple: Champaka (Hawaii), MD-2 and 3 Hawaii, Australia
- PRV resistant transgenic papaya: Hawaii
- PWV resistant transgenic passionfruit: MARDI
- Nematode resistant transgenic banana: Uganda

- Not present in Sri Lanka
FRUIT TREE IMPROVEMENT
FRUIT TREE DOMESTICATION

increase the value of tree by changing level of products and services provided by them by genetic means
Domesticating fruit trees involves accelerated and human-induced evolution to bring species into wider cultivation through a farmer-driven or market-led process. This is a science-based and iterative procedure involving the identification, production, management and adoption of high quality germplasm.
Tree Domestication Process

Increasing Social Utility

Germplasm Diffusion

Representative Sampling

Improvement (Breeding and Propagation)

Biogeographical Descriptions & Local Knowledge

Assemble Base Populations

Site/species Selection

Sustainable Use

Assessment

Environment Limitations

Threatening Processes

Germplasm Diffusion

Increasing Social Utility
Domestication Actors of fruit trees

Fruit tree

Farmers
Nursery operators
Researchers
Hort. Dev. Authorities
Extensionists
NGOs
Nutritionists
Wholesalers
Processors
Exporters
Consumers
Fruit tree domestication is not tree breeding!

whilst one still undertakes trials and selection, it is also about:

• priority setting (species & farmers’ traits)
• proactive seed/clone multiplication
• best nursery practices
• tree management
• extension messages (seed collection)
• germplasm delivery pathways
• marketing
• policies ….. and they can’t be done in isolation
Typology of Production

- wild harvest/cultivated
- low/high input
- small/medium/large-scale
- minor/major enterprise
- seasonal/a-seasonal
- assured/speculative
- clear/unclear prodn economics
Production Cycle

**Producer**
- Understand constraints/opportunities
- Enhance returns to land/labour
- Determine prospects producer associations
- Improve quality of inputs (e.g. germplasm)

**Production**
- Improve product quality
- Change timing of availability
- Reduce wastage

**Product**
- Improve recovery
- Value addition
- Extend shelf-life
- Improve efficacy (e.g. medicinals)

**Marketing**
- Analyse market chains
- Exploit/satisfy certification opportunities
- Increase premiums for quality, branding
- Elevate volume traded
- Improve consumer knowledge, promotion
- Demand forecasting

**Processing**
- Enhance product safety
- Ensure appropriate packaging
- Provide adequate labeling
- Increased graded product %

**Consumer**
- Develop market information systems
- Develop new business opportunities
- Explore subsidy, incentives to producers
- Understand scaling up needs, opportunities
- Target areas for production
SELECTION OF SPECIES/Varieties → Tree Growth → Storage

Grain/flesh/fruit/leaf/wood Characteristics → Technical/chemical Properties → USES
Fruit Domestication

- Recognition of species
- Selection of elite genotypes
- Vegetative propagation technology
- Cultivation technology
  - Pruning and training, irrigation, pollination, pest control
- Utilization
  - Storage, drying, fermentation, processing
- Dispersal of fruit crops with human migration
- Most fruit crops are closer to wild species than annual crops such as grains
Genetic Changes Associated with Domestication in Fruit Crops

Breakdown of dioecy

Fig, grape, papaya, strawberry
(unchanged, date palm, kiwifruit)

Loss of self-incompatibility

Cherry

Parthenocarpy & seedlessness

Apple & pear, banana & plantain, citrus, fig, grape, loquat, persimmon, pineapple
Allopolyploidy

Banana & plantain, blackberry & raspberry, blueberry, tart cherry, European plum, strawberry

Triploidy: banana and plantain, apple, pear

Tetraploid: tart cherry, raspberry, blackberry, blueberry, kiwifruit (Actinidia sinensis)

Hexaploid: European plums, kiwifruit (A. deliciosa)

Octaploid: strawberry
Loss of toxic substances

“Sweet” seed: almond

Non-astrigency: apple & pear, persimmon, pomegranate

Ease of vegetative propagation

Offshoots: date palm

Rooting: apple (rootstock)

Nucellar embryony: citrus, mango

Loss of spines, thorns, or pubescence

Apple, brambles, citrus, peach, pear, pineapple
FRUIT TREE IMPROVEMENT
TREE DOMESTICATION

increase the value of tree by
changing level of products and
services provided by them

by

genetic means
Fruit Tree Improvement

Objectives
  Short term
  Long term

Biological, technical and financial requirements

Simplicity, efficiency, flexibility and delivery of gain

Biology, genetics and economics
Fruit Tree Improvement

Why genetic improvement

Once change, it is relatively permanent
GV is available
Increase survival
Increase products and services
Increase adaptation
Problems with tree genetics
1. Large size
2. Long juvenility
3. High heterogenity
4. Apomictic, seedlessness
5. Polyploidy
6. Outcrossing /self incompatible
7. Wild plants with no information
8. Process requirement from nursery to harvesting
9. Level of domestication
10. Long term investment
Tree product volume at 15 years

\[ \Delta G = i \times \delta p \times h^2 \]

\[ \Delta G = 3.96 \times 0.18 \times 0.27 \]

\[ \Delta G = 19.2\% \]

Seln intensity

1 in 10,000

\[ i = 3.96 \]

\[ P_1 \]

1.192 m³

\[ P_0 \]

1.0 m³
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<td>Spp 2</td>
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Fruit yield per plot (kg) at 18 months
Height (m) at 12 months for 3 (of 30) families of Fruit tree

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<td>0.6</td>
<td>11</td>
<td>0.8</td>
<td>21</td>
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<td>02</td>
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<td>12</td>
<td>1.3</td>
<td>22</td>
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<td>03</td>
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Overall mean = 1.0, mean of three = 1.4
Genetic gain – for a selected trait

\[ \Delta G = i h^2 \sigma_p \]

- \( \Delta G \) = genetic gain
- \( i \) = selection intensity
- \( h^2 \) = heritability of the trait
- \( \sigma_p \) = phenotypic standard deviation
- Above parameters need to be estimated through a genetic analysis
Use Breeding Cycle to Identify the Problems of the Species

Base population

Breeding population

Selection

Mating

Selection

Infusion population

Breeding population

Multiplication population

Production population
APPRAOCH

Identification anthropogenic and natural base populations and their morphological variation;

Basic information on reproductive biology of the species;

Collection, characterization and evaluation of germplasm using chemicals and DNA markers;

Selection and evaluation of plus trees;

Development of rapid multiplication systems;

Identification of harvesting package;

development of value added products

dissemination of relevant technical information
Select from existing population
Introduce from outside (different species or varieties)
Make crosses and selection for desirable characteristics.
Genetic manipulation (mutation, gene transfer, marker-assisted selection, etc.)
Fruit Breeding Programme and Strategies
Fruit Production is the Science of Process Management in Orchards

1. Site selection and management
2. Selection and management of environment
3. Selection of species and their varieties
4. Propagation
5. Sexual system and flowering requirements
6. Establishment of orchards
7. Plant growth and development requirements
8. Training and pruning of plants
9. Fertilizer and moisture management
10. Pest and diseases management
11. Pollination requirements and management
12. Breeding and mating system (incompatibility, pre and post zygotic selection)
13. Maturity indices
14. Harvesting
15. Postharvest handling
Establish a mother plant orchard

Develop a nursery

Produce planting materials

Train the nursery raisers on production of quality PM according to the local species (trainers trained are conducting this)
Creation of a cultivar

*Earlier fruiting, smaller trees and uniform quality*

*Dacryodes edulis*
Mangosteen
A double root-stocked mangosteen graft (18 months old)
Fruit Crop Ecology & Management
Understanding the System –
The Fruit Enterprise and Its Environment
Fruit Crop Ecology & Management

Agricultural Ecosystem

Questions to ask

1. How do climate and natural ecosystems influence farms? (the natural environment, climate and weather, climatological limitation to horticulture)

2. How can I make my fruit plant efficiently use ecosystem resources? (surrounding ecosystems and natural biodiversity)

3. How can a more biologically active soil benefit sustainable fruit production? (soil and its management)

4. How does biodiversity promotes the health of my farm
The Fruit Plant: The fruit plant is constantly evolving factory that utilizes ecosystem resources to produce fruits. Understand how this factory works and which factors can be controlled to achieve the best plant performance with the highest quality fruits.
Rehabilitation of old, unproductive fruit trees and orchards

The balance between vegetative growth and cropping is heavily influenced by pruning, nitrogen and crop load.
1. Identification of species
2. Identification of correct methods
3. Correct time
AGRONDONY – TRAINING/PRUNING
Mango Propagation
Mangosteen
A double root-stocked mangosteen graft (18 months old)
Organic Fruit Production

Organic: refers to the farming system and products described in the organic standards.
Organic Fruit Production

Organic products: a product that is produced, processed and handled in compliance with accepted organic standards.
Assignment

1. Identify an underutilized fruit tree species of your choice

2. Describe the process of production of quality fruits from the species

3. List critical steps in the management

4. Submit to me via email ngpkumara63@gmail.com
Durian
Mangosteen
Galsiyambala
Katu anoda
Weli anoda
Seeni Artha
Pini jambu
Jambu
Uguressa
Weralu
Lovi
Lavulu
Gaduguda
Karamba
Naminang
Karawala kebilla
Dan
Kon
Jambola
Naran
Grapefruit
Masan
Carambola
Madan
Mora
Woodapple
Nelli
Beli