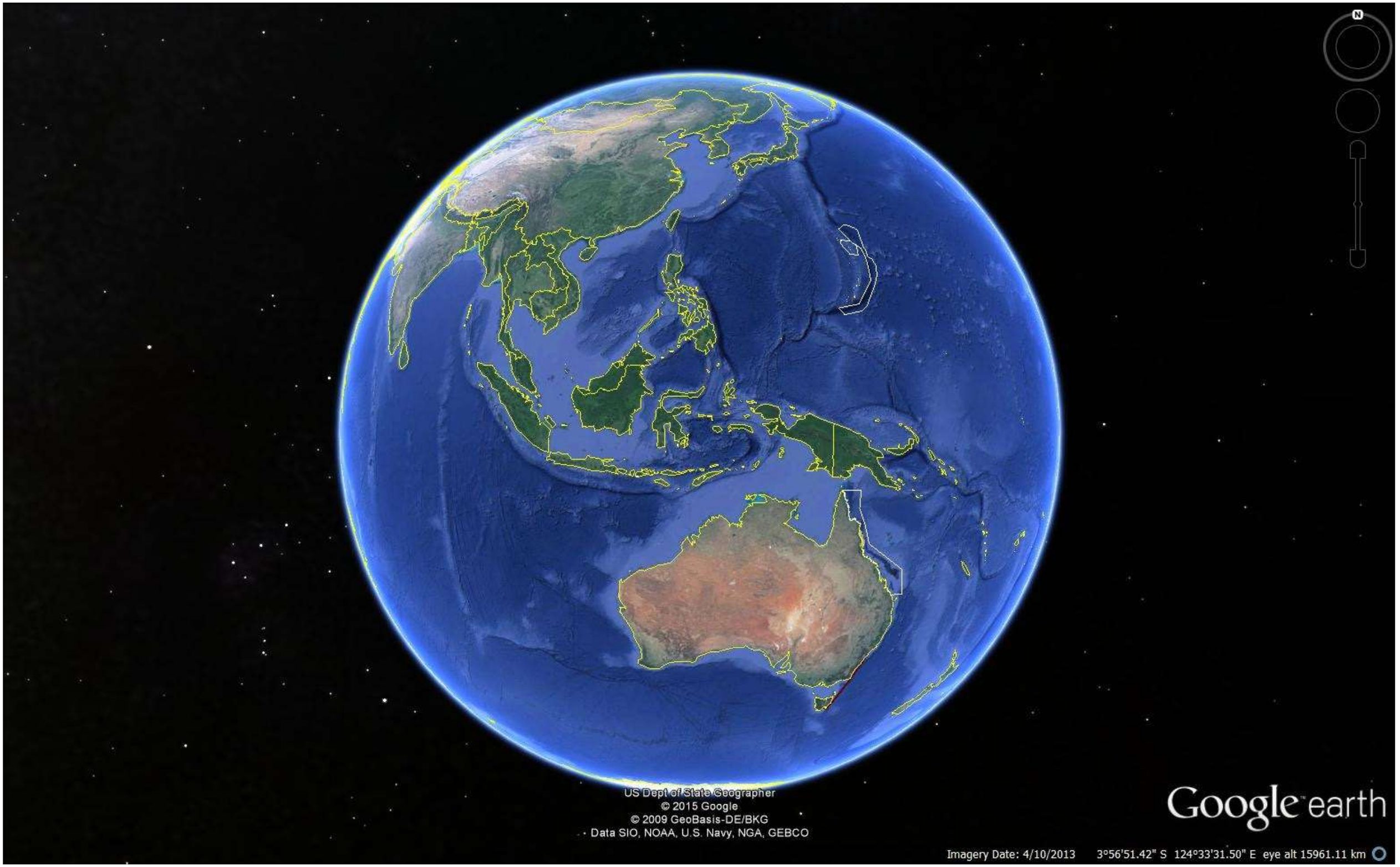
Australian Tropical Fruit R&D Update

Presented by Yan Diczbalis

Topics

- Where we are and climate
- Cacao
- Tropical fruit project (Jackfruit component)
- Cyclone (hurricane) resilience

Where are we?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US Dept of State Geographer
© 2015 Google
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google earth
Imagery Date: 4/10/2013 3°56'51.42" S 124°33'31.50" E eye alt 15961.11 km

Tropical Australia

Australian Government

Bureau of Meteorology

DARWIN
Kalumburu
Katherine
Weipa
Kowanyama
Cairns
Broome
Halls Creek
Normanton
Tennant Creek
Townsville
Port Hedland
Mount Isa
Telfer
Mackay
Longreach
Newman
Alice Springs
Giles
Rockhampton
Birdsville
Carnarvon
Charleville
Wiluna
Oodnadatta
BRISBANE
Marree
Geraldton
Bourke
Cook
Kalgoorlie-Boulder
Coffs Harbour
Port Augusta
Ceduna
Dubbo
PERTH
Mildura
ADELAIDE
SYDNEY
Esperance
Port Lincoln
CANBERRA
Albany
Horsham
MELBOURNE
Warrnambool
Orbost
Cape Grim
St. Helens
Strahan
HOBART

Climate zones

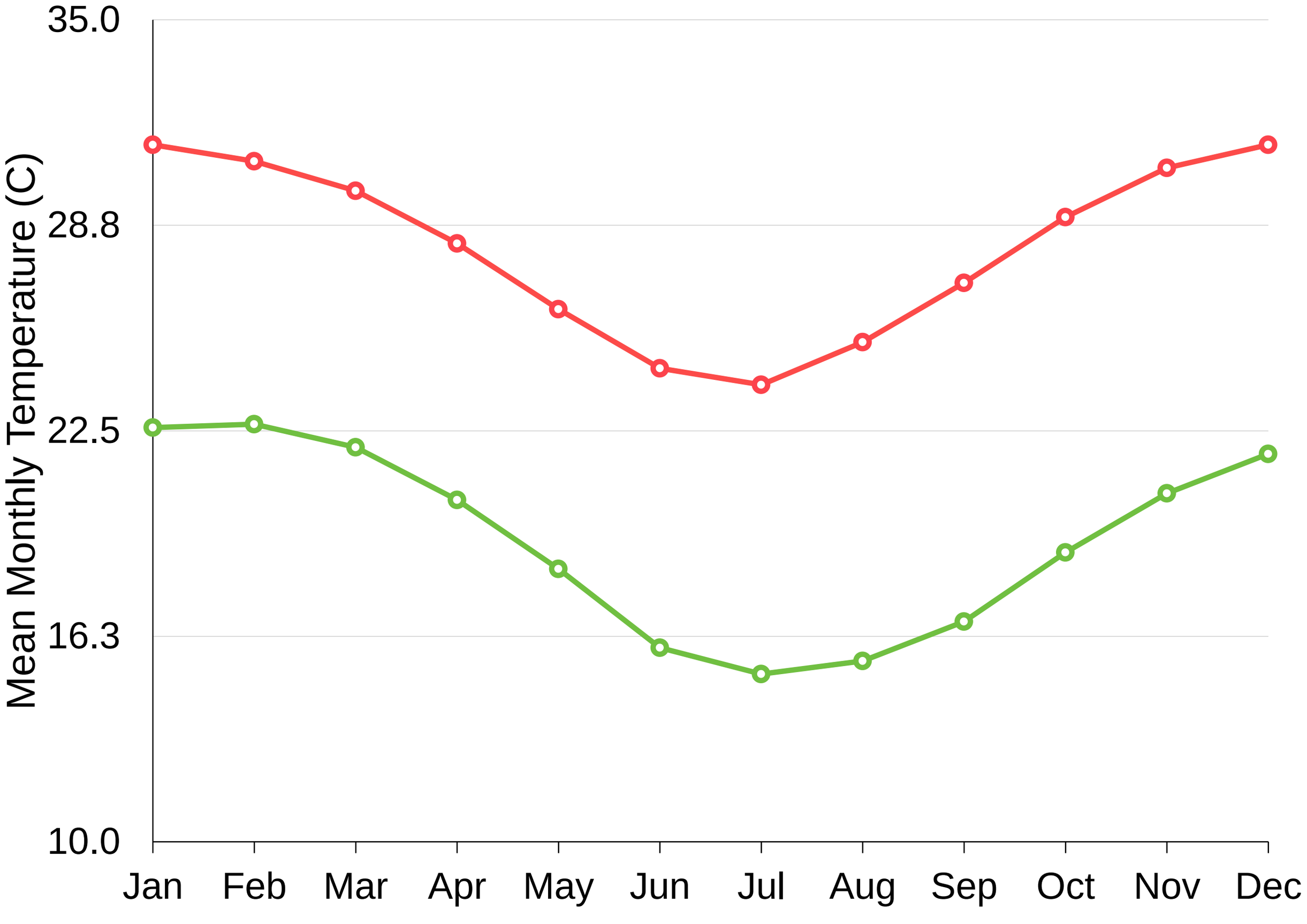
- Hot humid summer
- Warm humid summer
- Hot dry summer, mild winter
- Hot dry summer, cold winter
- Warm summer, cold winter
- Mild/warm summer, cold winter

Climate zones based on temperature and humidity

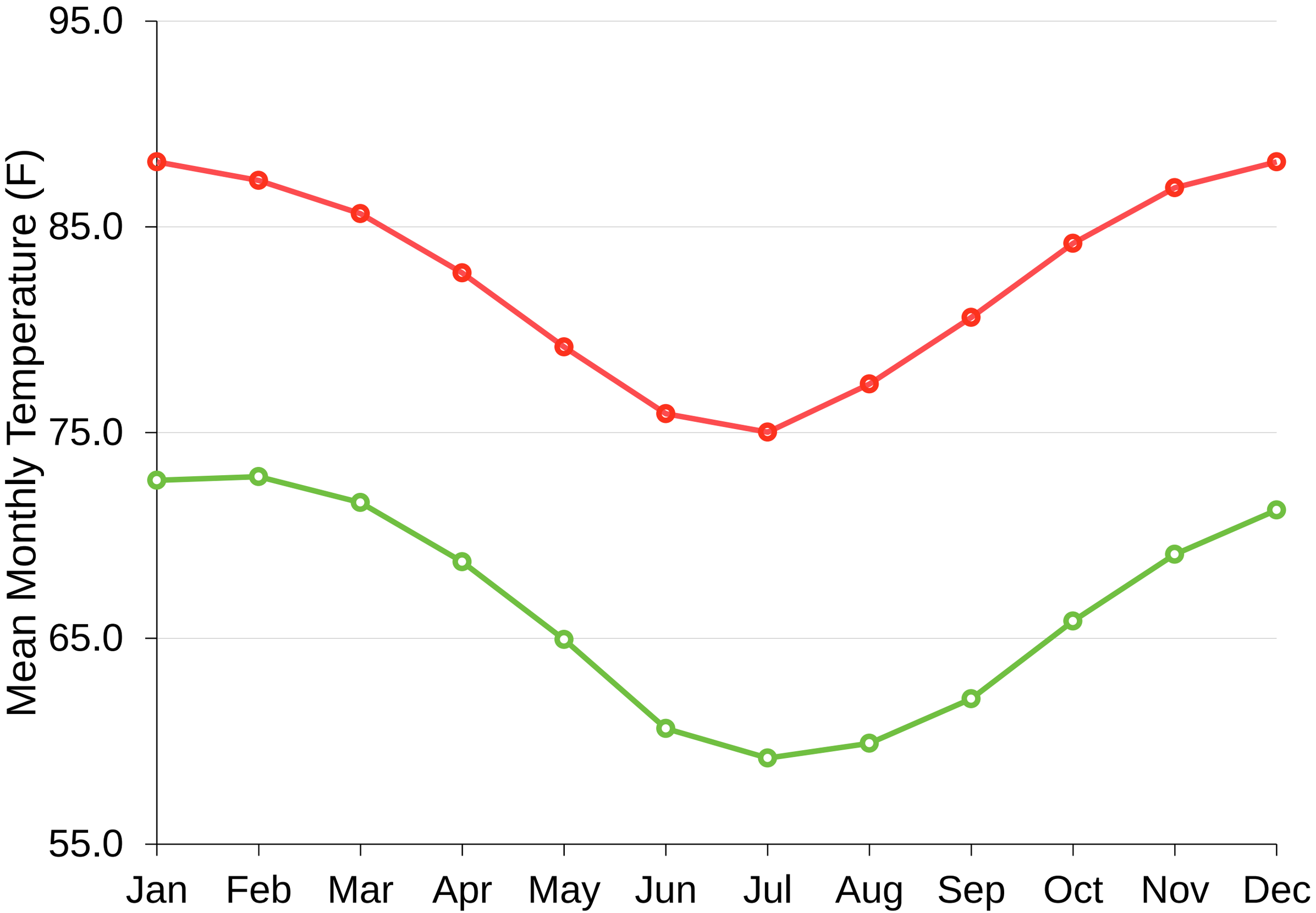
Projection: Lambert conformal with standard parallels 10°S, 40°S.

Based on a standard 30-year climatology (1961-1990)

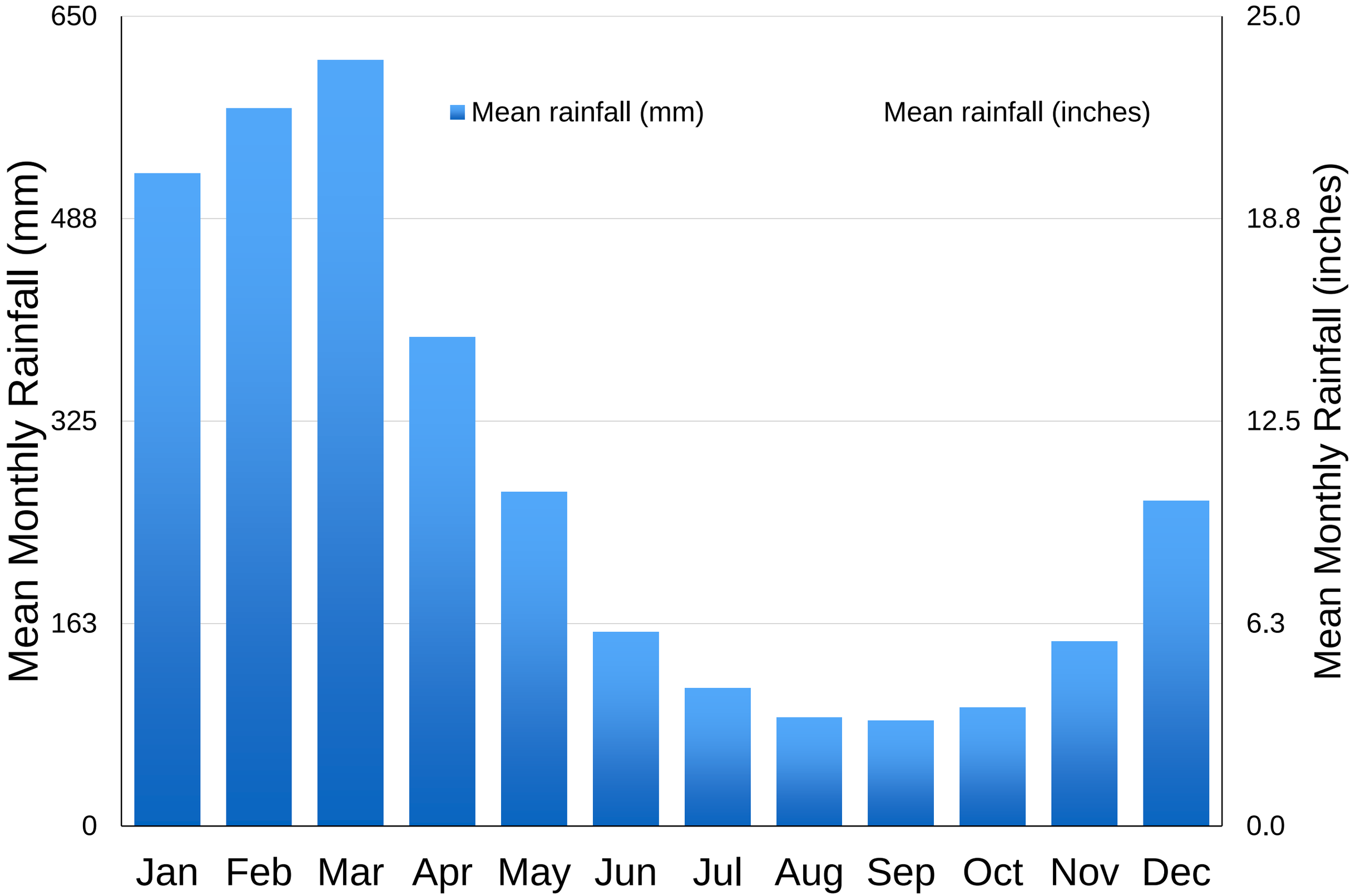
South Johnstone



South Johnstone



South Johnstone



Cacao

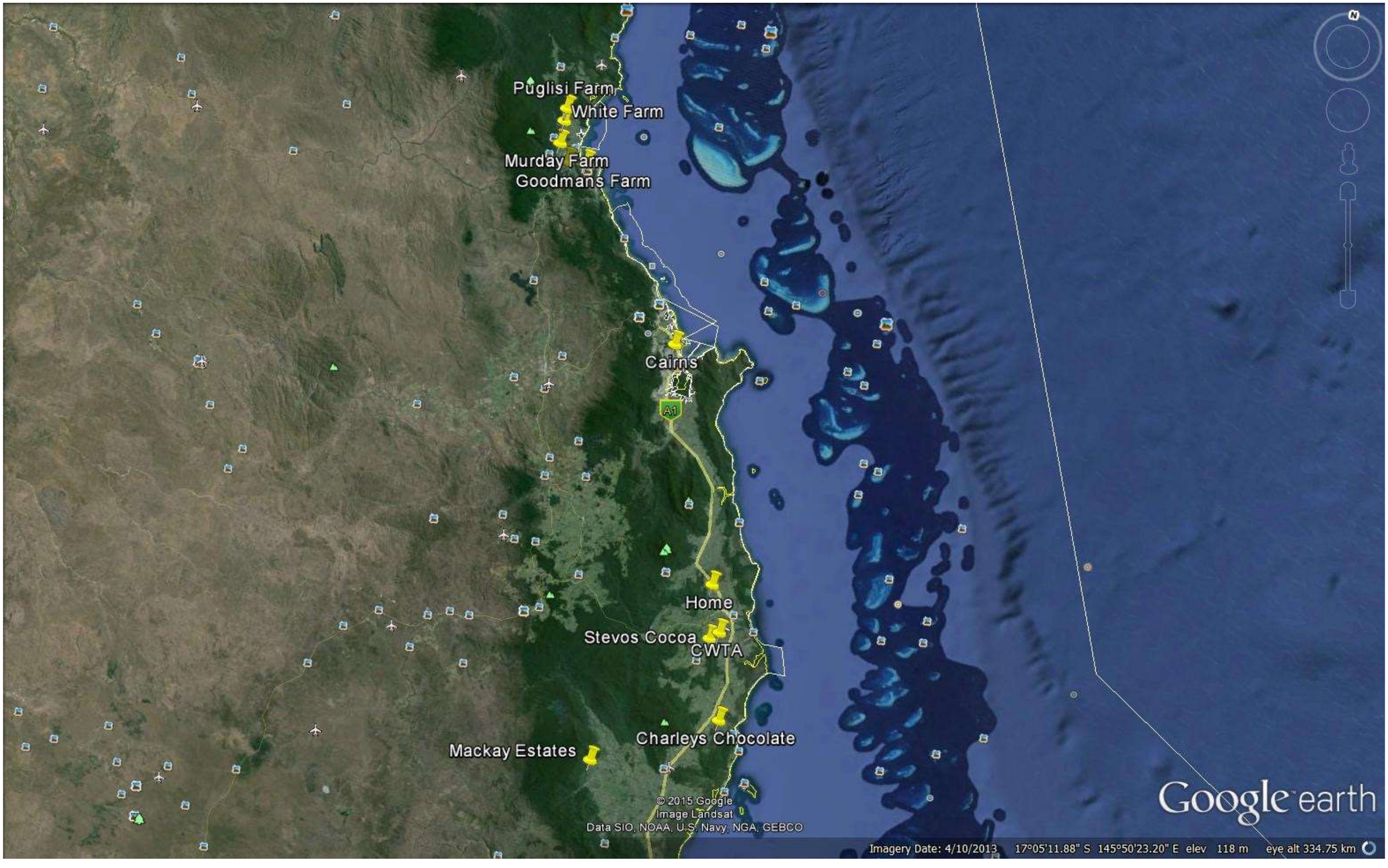
Research and Development

- Research feasibility study – 1999 to 2006
  - Funded by RIRDC, Cadbury, Qld, NT and WA Departments
  - RIRDC Report – **Producing Cocoa in Northern Australia**
- Cocoa Commercialisation – 2007 to 2012
  - Funded by RIRDC, Cadbury/Mondelēz, DAF
  - RIRDC Report – **Commercialising cocoa growing in north Queensland**
- Eradication of Cocoa Pod Borer: Qld DAF - BioSecurity
- Support/advice to new and existing growers where requested.

Current Industry status

- Cocoa producers
  - Mossman region (5 - contacts)
    - Area – approx. 6 ha
  - Cairns region (1 – contact)
    - Area – approx. 2 ha?
  - Innisfail/Tully region (3 – contacts)
    - Area – approx. 8 ha
- **Two** producer associations (ACC and QCIDA)
- Planting Material
  - PNG SG2 hybrids
  - seedlings of hybrids (concern!)

FNQ Cocoa sites (16.5S-18.0S)



Issues – Planting Material

- Continued availability of hybrid seed from PNG?

Issues – Pod Borer

Issues – Low commercial yields

Issues – Flush Eating Beetles

- Cocoa seedlings/juvenile phase and Rhyparida beetle

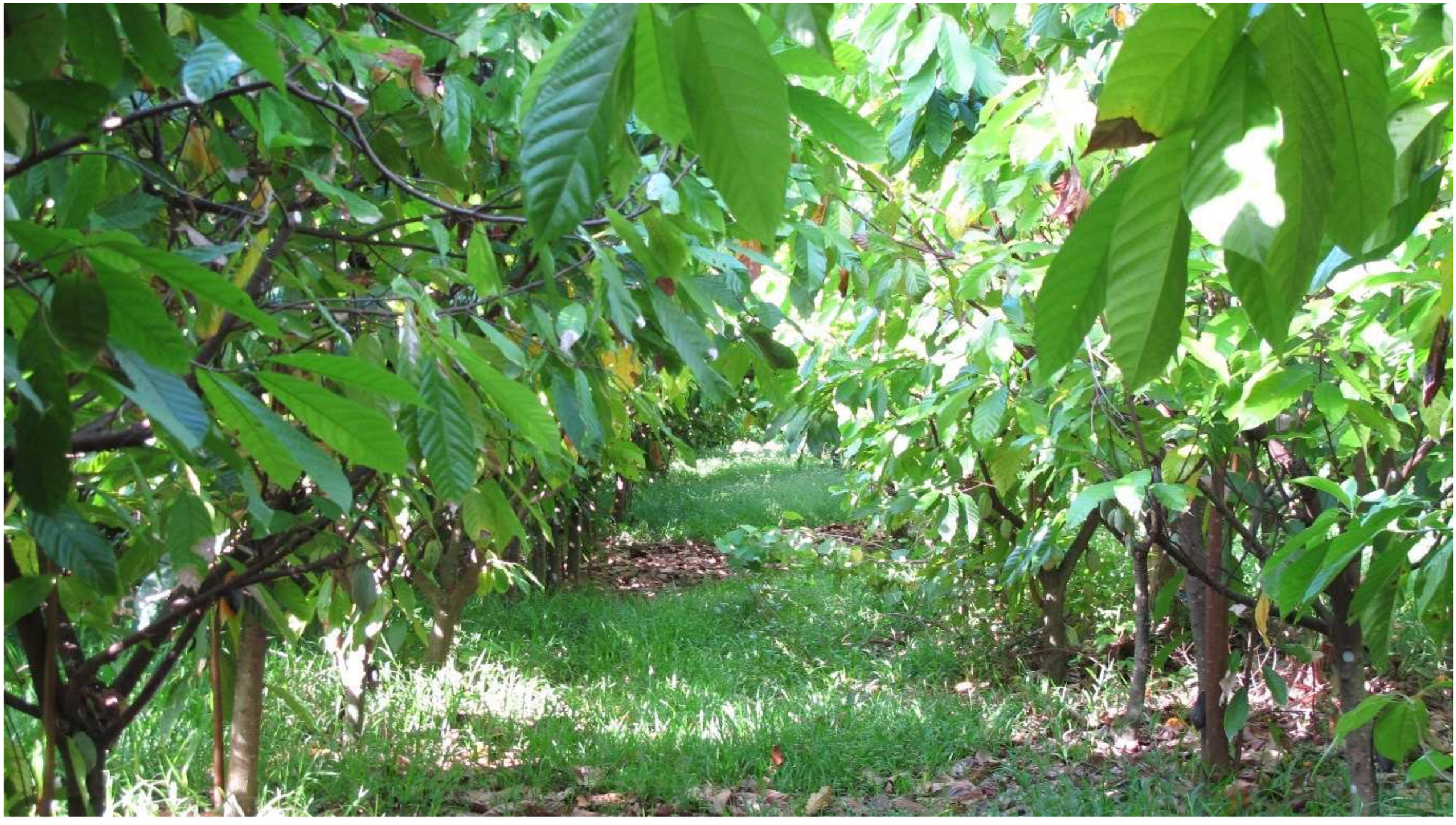
Issues – Exposure/Wind/Cyclones

Issues - Consistency of fermentation and drying

Issues – Trellising challenge

Ex Trial Site

12 April 2011

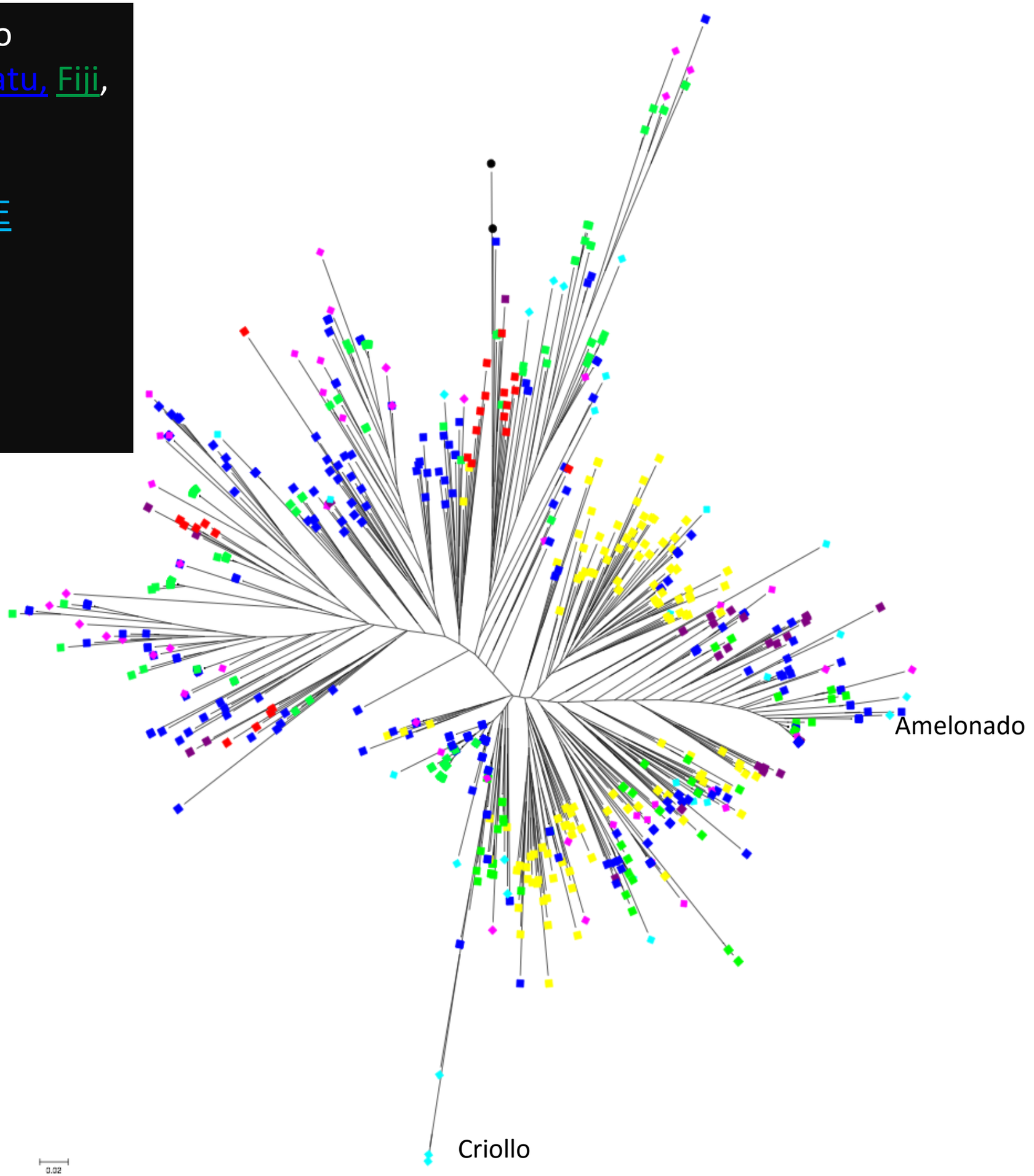


Future for FNQ cocoa?

Current projects

- ACIAR – Small Research Development Activity - **Evaluation of molecular marker technology for identification of elite cocoa germplasm in the South Pacific.** Dillon, Hucks and Diczbalis
  - **Solomon Islands**
  - **Vanuatu**
  - **Fiji**
  - **Samoa**
  - **North Queensland**

Genetic diversity of all 608 cacao accessions collected from Vanuatu, Fiji, Samoa, Solomon Islands, and Australia.
Reference clones from the CATIE and Trinidad collections are included. Two related cacao accessions were also included in the analysis, *T. bicolor* and *T. grandiflorum*.



Current projects

- ACIAR – Full Proposal submitted - **Aligning genetic resources, production and post-harvest systems to market opportunities for Pacific island cocoa**
  - Objective 3. To evaluate and deploy methods of intensifying cocoa production systems in response to market opportunities. ***NQ - Trellising***
  - Objective 4. To develop and deploy improved post-harvest handling systems (especially fermentation, drying and quality controls) to deliver higher quality and better returns to producers. ***Fermentation/drying and organoleptic quality***

Future R&D

- Where is the Qld industry heading?
  - Boutique?
  - Origin?
  - Commodity?
- Level of input will depend on target?
- In the interim the origin market is potentially feasible if commercial yields can be raised to 3-4 t/ha.


Roasted
COCOA
BEANS
Raw
COCOA NIB
Samoa's favourite drink
KOKO
SAMOA
'Raw Chocolate'
STEVO'S
SUPER
CHOCOLATE
DARK

North Qld Cocoa R&D Requirements

Production

Clonal selection

Genotyping (cold tolerance yield and quality)

Conventional versus trellising
- Density
- Light interception
- Pruning management
- Productivity/economics

Effect of rootstock
- Dwarfing/vigour control
- Productivity

Nutrition management
- Soil health/mulching
- Yield versus vigour control
- Heavy metal analysis

Harvesting & processing

Harvesting
- Conventional versus robotic harvesting
- Pod handling systems

Pod Splitting/bean removal
- Mobile unit
- Engineering tender

Fermentation
- Pod storage & bean moisture
- Controlled fermentation (inoculation, microbiology, temperature, modified atmosphere chamber)

Drying
- Rate of drying, heat pump technology
- Combination (sun/solar/heat pump units)

Sensory evaluation

P&D management

Chemical permits
- Insect/disease control and residue data
- APVMA application

Bio control options
- Rhyparida
- Fruit spotting bug
- Helopeltis

Cocoa Pod Borer Vigilance

Effect of lichen/moss on flowering

Priority issues -


409


Black Pepper
Cinnamon
Vanilla
Coffee
Spicy
Floral
Earthy
Citrus
Berry
Cherry
Apricot
Peach
Apple
Tree Fruit
Pineapple
Banana
Tropical Fruit
Fruity
Dried Fruit
Fruit Preserve
Raisin
Prune
Fig
Other
Artificial
Hazelnut
Walnut
Almond
Peanut
Nutty
Spicy
Nutty
Caramel
Vegetative
Fresh
Cooked
Dried
Grass
Eucalyptus
Mint
Asparagus
Green Olive
Black Olive
Hay/Straw
Tea
Tobacco
Honey
Butterscotch
Butter
Milk
Molasses
Caramel

HORT/2012/095. Tropical tree fruit research and development in the Philippines and northern Australia to increase productivity, resilience and profitability.

Australian Government

Australian Centre for International Agricultural Research

Queensland Government

Northern Territory Government

Visayas State University

Department of Agriculture 1898

One Dost

Team - Philippines

- Philippines Team
  - VSU
    - Prof. Othello Capuno – Philippines Project coordinator
    - Dr's Lucia Borines & Elsie Salamat, Enrico Virrey– Pathology
    - Dr's Roberta Lauzon & Lorina Galvez, Kent – Processing
    - Dr Dario Lina - Horticulture
  - DA
    - Dr Carlos De la Cruz – team leader
    - Jimmy Palma/Alice Bulawan – Nursery management
    - Dr Francisco Dayap/Joel Cantoneros – Physiology/Agronomy
  - BPI-Davao
    - Dr Virgilio Loquias – Nursery Hygiene/Agronomy
    - Mr Albert Fuentes – Pathology Nursery Hygiene

Team - Australia

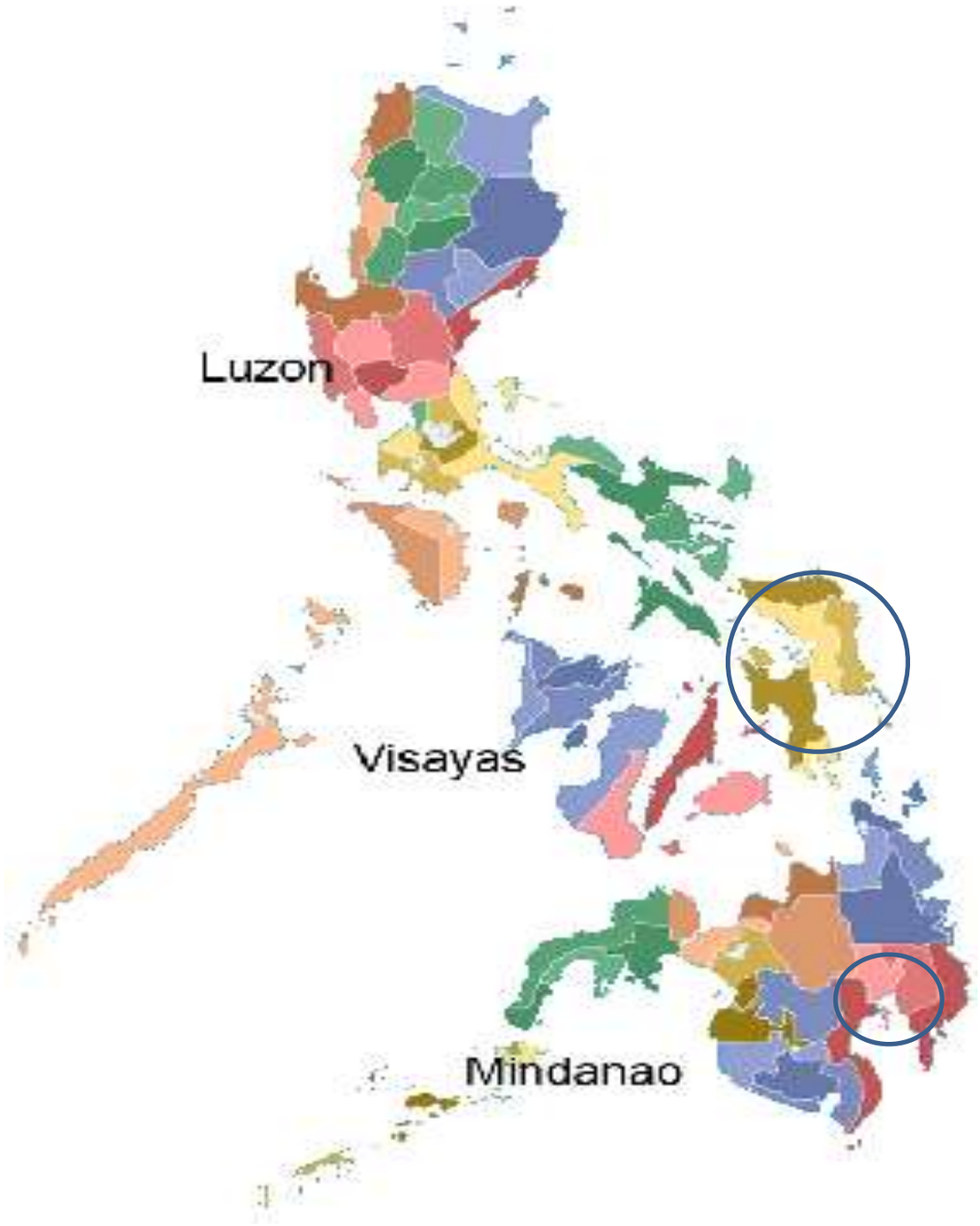
- Queensland Department of Agriculture, Fisheries and Forestry
  - Yan Diczbalis – project leader/agronomy
  - Dr Kent Fanning - processing
  - Dr Natalie Dillon – genotyping of jackfruit selections and relationships between Artocarpus species
- NT Department of Primary Industry and Fisheries
  - Mark Hoult and Mark Traynor – propagation/agronomy/selection

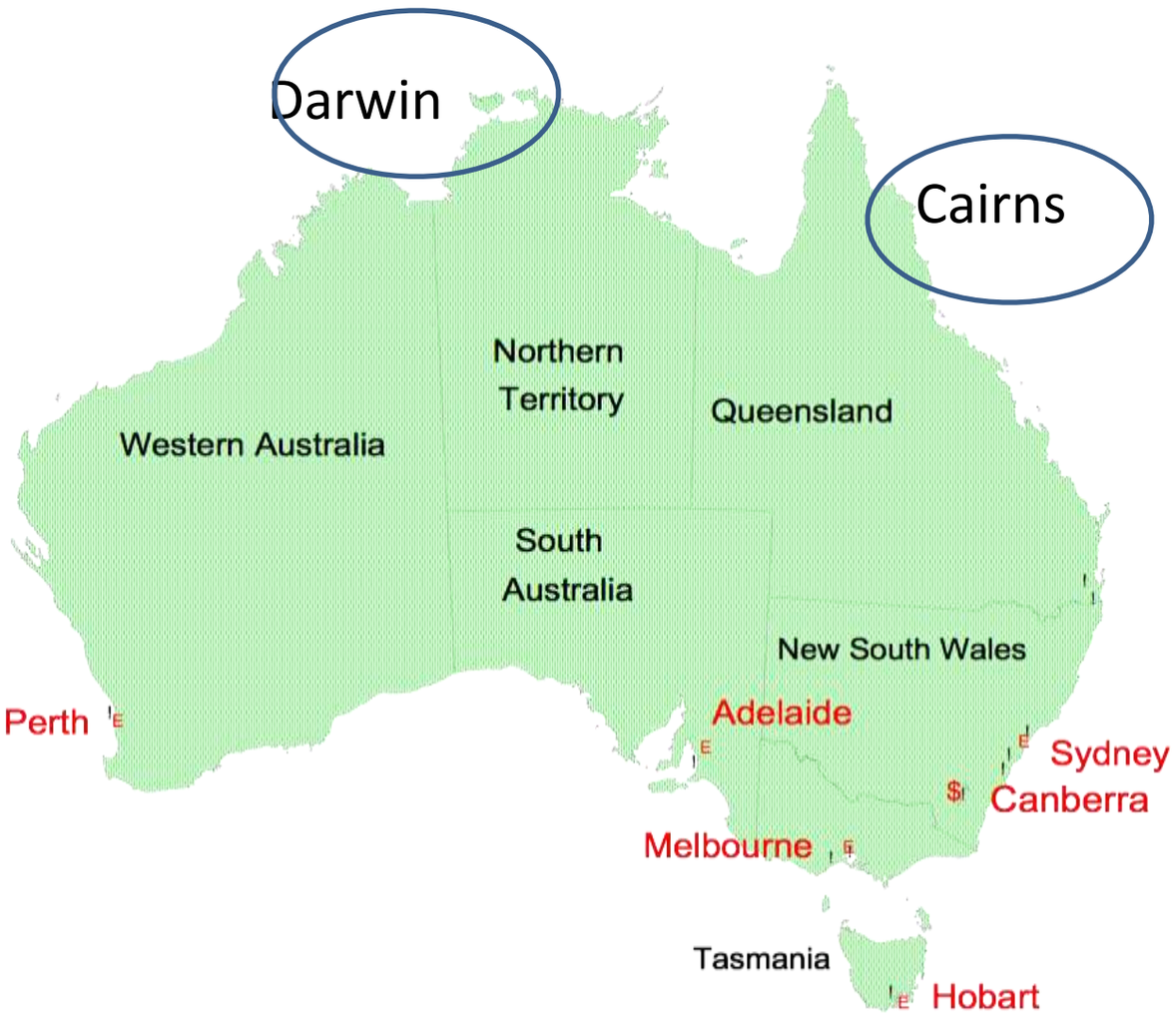









Luzon
Visayas
Mindanao


Darwin
Cairns
Northern Territory
Queensland
Western Australia
South Australia
New South Wales
Perth
Adelaide
Sydney
Canberra
Melbourne
Tasmania
Hobart

General Objective

- developing a range of production management technologies and processing options which will enhance production and marketing options.
- improve the livelihood of smallholder tropical fruit farmers in the Southern Philippines
- enhance new industry development in tropical Australia

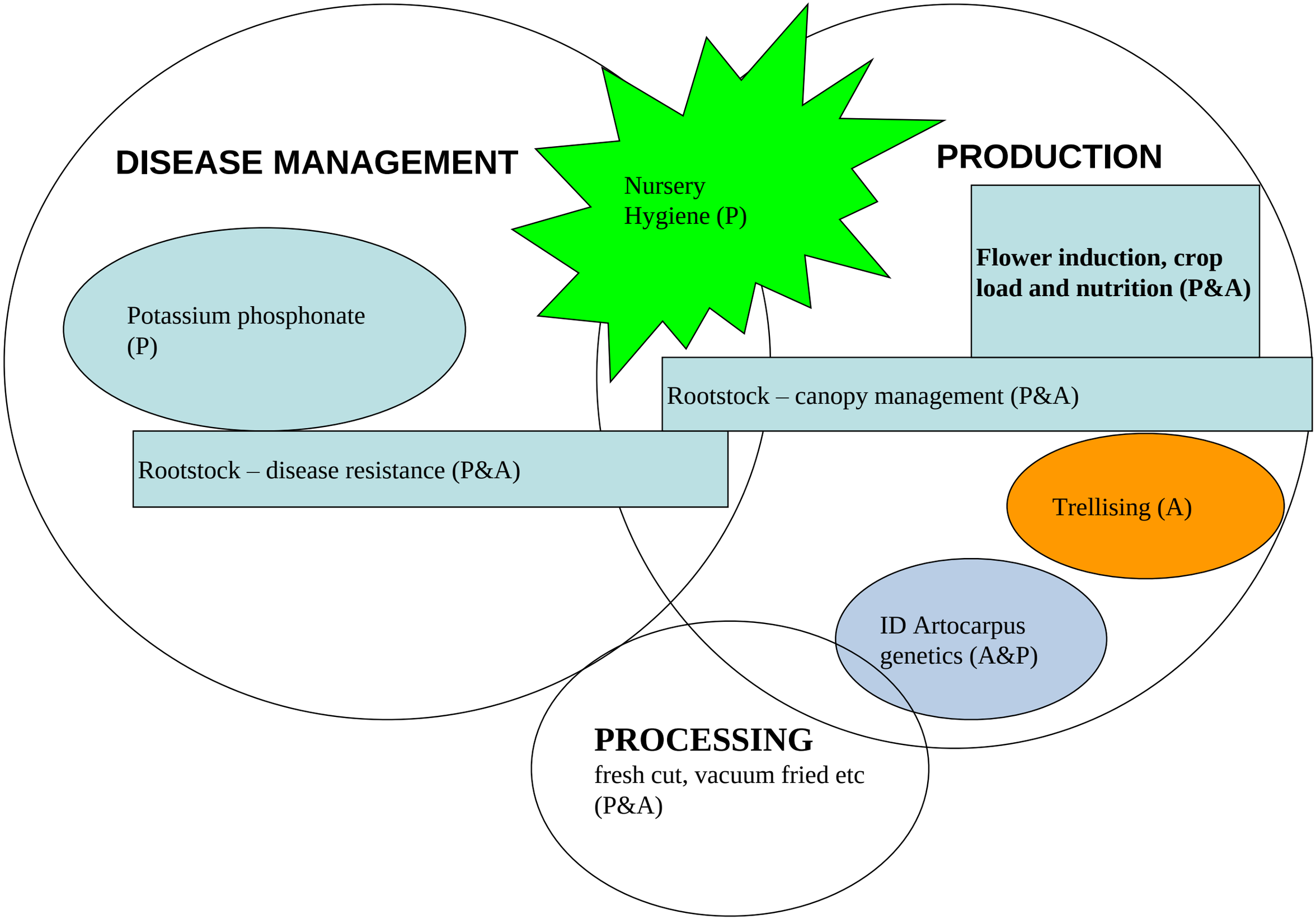
Jackfruit

Jackfruit is an emerging industry in the Philippines and is being targeted for further research and development to assist its development and export potential.

Jackfruit decline caused by *Phytophthora palmivora* was identified as one of the main constraint to jackfruit.

Poor nursery practices, lack of chemical for disease control and a range of production problems are hindrances to industry development for jackfruit.

What are we doing?



Obj 1. To develop and implement Integrated disease management solutions to diseases affecting jackfruit.

a. Research support for registration and availability of potassium phosphonate (PC).
b. Demonstration “best practice” nurseries (PC).
c. Workshops to promote nursery hygiene regimes to Philippine fruit tree nurseries using information transfer from Australia and Philippine demonstration nurseries (PC).
d. Confirm benefits of nursery hygiene protocols by measuring comparative disease loads in the new and conventional system (PC).
e. Initiate work to measure the effect of Artocarpus spp. rootstock/scion combinations for disease resistance (PC).

Field trials
2 - locations
Fertiliser (0.5, 1, 1.5 DA inorganic recommended rates) and organic
±Phosphonate
±Fruit regulation

Identification of Possible Sources of Phytophthora in the Nursery

Collection of soil and water sample in selected site

Confirmation using *Phytopthora* diagnostic kit.

Baiting with Periwinkle flower

Microscopic Examination

Effect of Air-Filled Porosity of Potting Media on Seedling Health

Preparation of potting media

Planting of jackfruit seedlings

Inoculum preparation

Inoculation

Wilting and yellowing of infected seedlings

Qld agronomy team.

- Pot trial

Tolerance of different Artocarpus species to *Phytophthora palmivora*

Mean length of *Phytophthora* lesion on stem of different *Artocarpus* species 3 weeks after inoculation.

SPECIES AND SOURCE	LESION LENGTH (cm)
Champedak (Abuyog)	***31.90 a***
Jackfruit (Abuyog)	***2.58 cd***
Camansi (Foodtech, VSU)	***4.70 b***
Marang (Abuyog)	***0.00 e***
Tipolo (Brgy. Gabas)	***2.17 d***
Tugop (San Jorge, Samar)	***3.87 bc***

OBJ 2. To develop and implement crop management options which improve productivity and fruit quality in jackfruit.

a. Investigate scion – rootstock combinations and evaluate effects on canopy growth and productivity (PC and A)
b. Evaluate tools to manipulate flowering patterns to spread crop production (PC).
c. Improve crop production by developing crop load and nutrient management techniques (PC).
d. Assess the feasibility of trellising jackfruit, durian and rambutan for cyclone (typhoon) resilience and improved crop production (A).

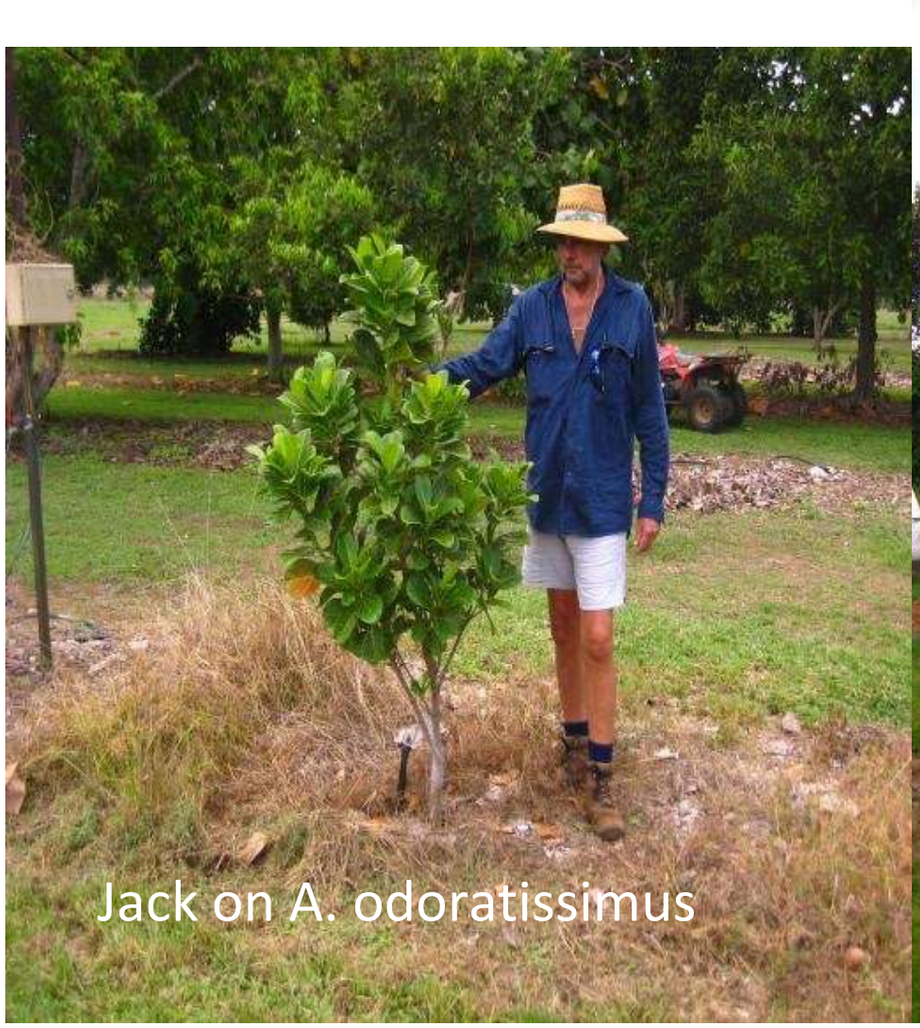
Rootstock compatibility

Genomic sampling

A. heterophyllus	70
A. altilis	29
A. integer	10
A. anisophyllus	4
A. hypargyreus	3
A. odoratissimus	11
A. rigidus	5
A. species	11
A. sarawakensis	1
A. heterophyllus x A. rigidus	1
A. sericicarpus	3
A. kemando	1
A. glaucus	1
Morus nigra	2
A. camansi	10
A. blancoi	3
A. elasticus	3
A. lakoocha	1

Rootstock scion combinations for yield

- Influence of stock on canopy development and size
  - Can we improve yield per canopy area?


Jack on A. odoratissimus


Jack on A.rigidus


Jack on A. heterophyllus

Jack on A. odoratissimus

Jack on A. blancoi


TIPO K


KAMANSI


Early grafting trials

- scion - A. heterophyllus
- stocks - A. heterophyllus; odoratissimus; A. blancoi; A. elasticus
- suggest A. odoratissimus has a strong dwarfing effect on jackfruit scion

Crop load and nutrient management

Trellising for cyclone/typhoon resilience

OBJ 3. To develop improved processing options for jackfruit

a. Refine the current vacuum fried and alternative product produced in the Philippines and evaluate processed products through consumer testing (PC).
b. Investigate ‘fresh cut” processing option and evaluate processed products through consumer testing (A and potentially PC).

Why processing?

Fresh market fruit
excess to demand

Cracked/damaged fruit


Hey Hah
TROPICAL FRUIT SNACK
Jackfruit Chips
PRODUCT OF THAILAND
Net Wt. 30g


jsweet
Jackfruit
Dehydrated
NATURAL
Product of Thailand


Q JACKFRUIT
50.00
0.320
16.00
Q JACKFRUIT
19.75


NANGKA SLICED
43/kg

Research focus

- Dehydrated
- Vacuum fried
- Fresh cut


YOUR SAY
Amber 22.2.2015


88 DAYS


RI. 26/2. 5°c.
1629
RI. 2/2. 10°c.
1719

Conclusion

- Work is well underway on all objectives
  - Integrated disease management
  - Crop management
  - improved processing options
- Highlight outcomes to date include
  - Improved understanding of the nursery environment as a source of disease
  - Interspecies grating with the possibility of improved disease resistance and canopy productivity
  - Effect of fruit maturity on fresh and processed product quality

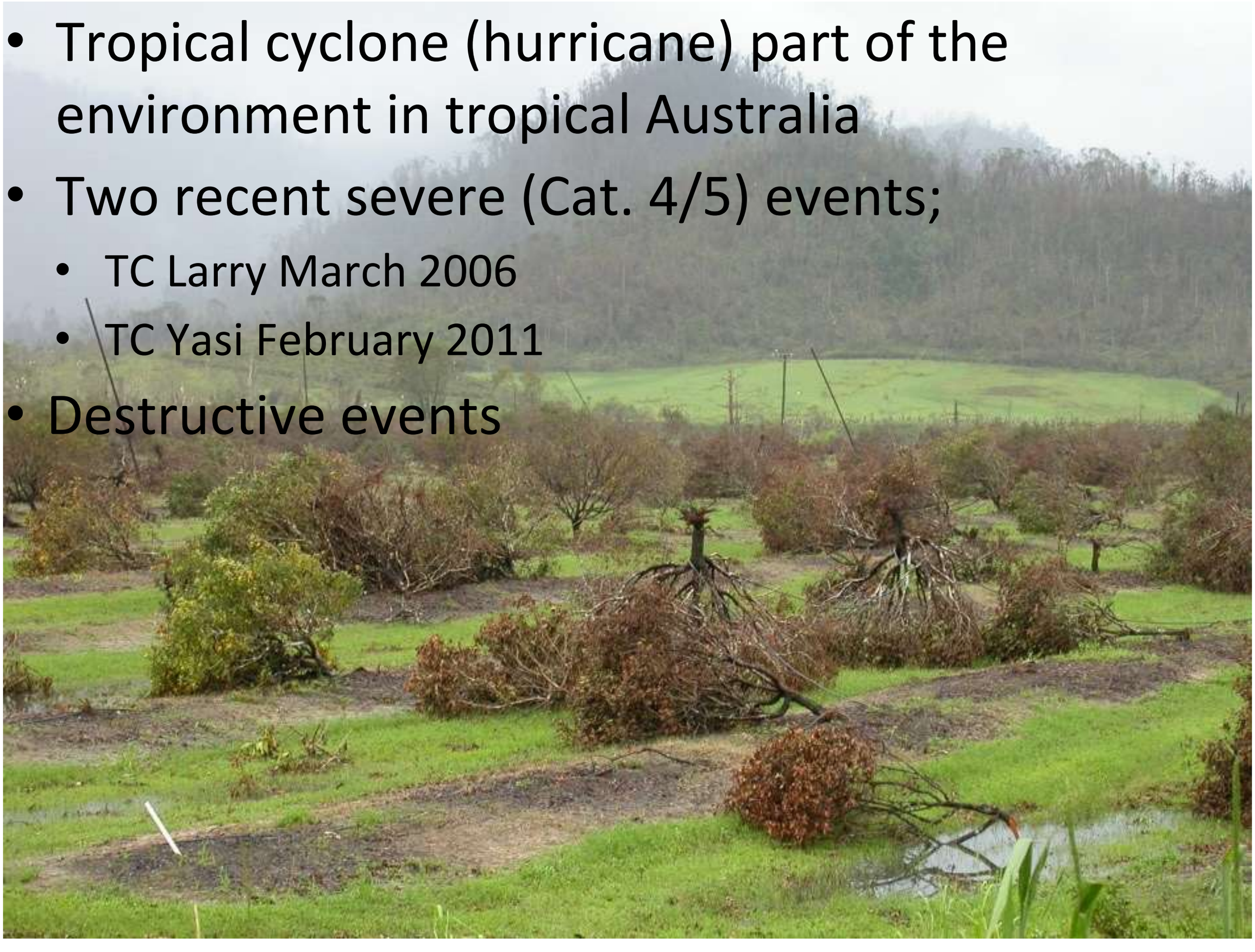



Cyclone resilience project

- Project Team - Dr James Drinnan, Yan Diczbalis, Neil Wiltshire
- Project areas
  - Production and economics of trellising tropical tree fruits
  - Emergency defoliants
  - Propagation

Funded by Rural Industries Research and Development Corporation (RIRDC) and Queensland Government

- Tropical cyclone (hurricane) part of the environment in tropical Australia
- Two recent severe (Cat. 4/5) events;
  - TC Larry March 2006
  - TC Yasi February 2011
- Destructive events

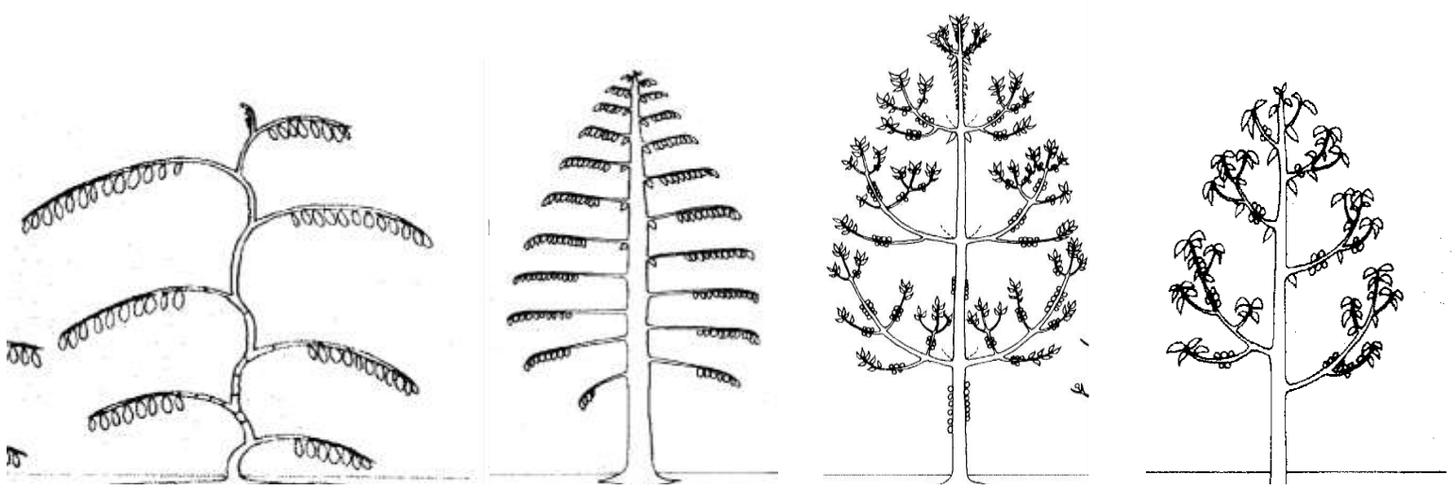


Project areas

- Nursery management - propagation techniques, potting, hygiene - to develop stronger plants
- Trellising techniques (Growers & DAF, Literature Review)
- Windbreak species selection
- Emergency defoliation to reduce wind resistance
- Insurance issues relating to these changed production practices
- Cost/benefit analysis

Tree architecture and trellising

- Trellising fruit trees is a suggested solution to improving cyclone resilience – INSURANCE!
- Trees grow and develop differently
  - Branch architecture
  - Flowering position
- This will impact on “trellis-ability”
- Recommend growers consider the architecture of the species they wish to trellis



Tree architecture

- 23 architectural models - Dr Francis Hallé, Roelof Oldeman and Philip Tomlinson

Attributes used to develop architecture models

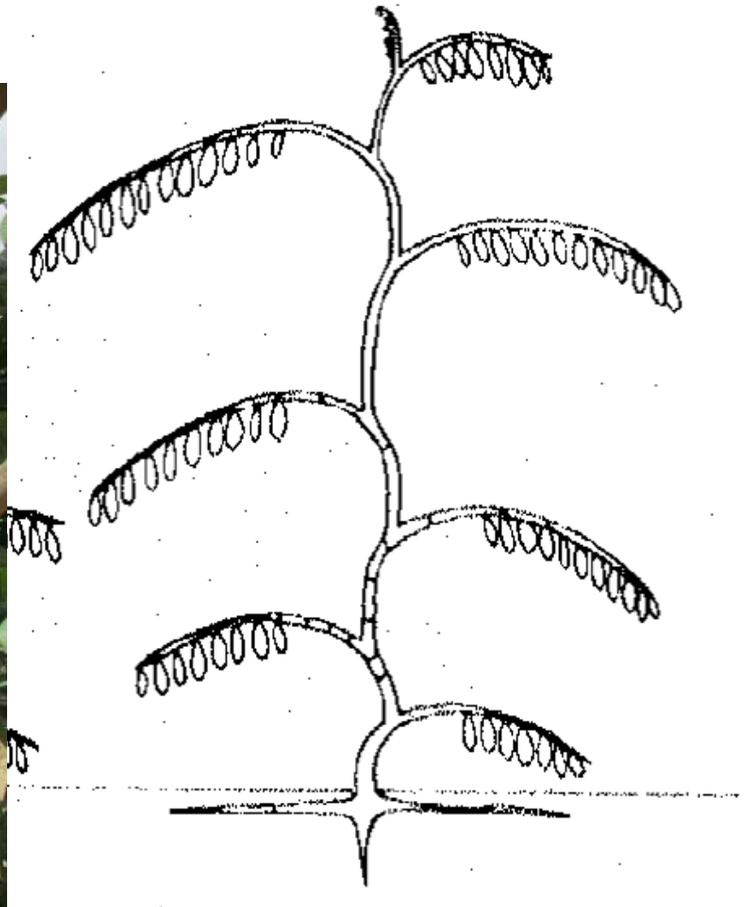
- Unbranched vs Branched

Basic Tree architecture

- Shoot Orientation
  - Plagiotropic (horizontal/oblique) shoots - where leaves are produced on the same plane
  - Orthotropic (vertical) shoots - where leaves are produced spirally around a shoot.

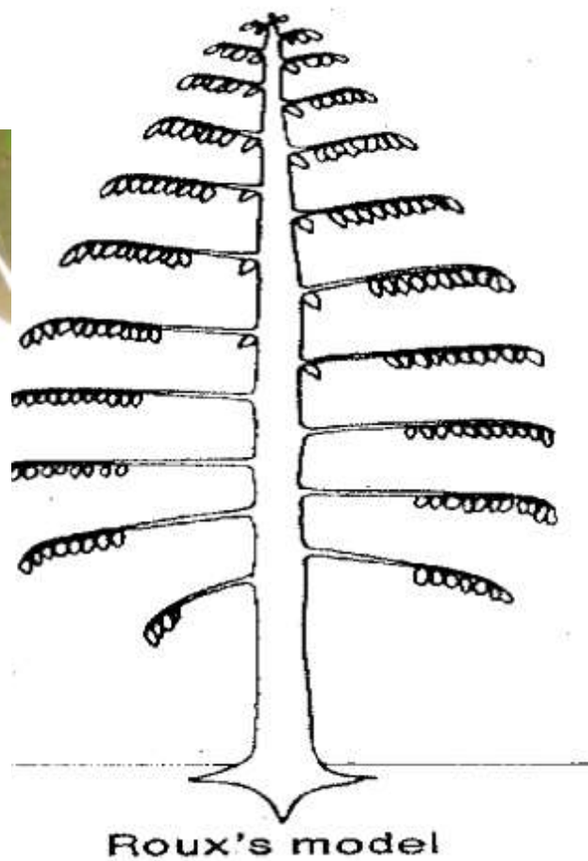
Tree Architecture Models – 7/23

- Troll
  - Axes all plagiotropic
    - Custard Apple (Annona sp.)
    - Carambola (Averrhoa carambola)
    - Star Apple (Chrysophyllum cainito)
    - Guava (Pisidium guajava)



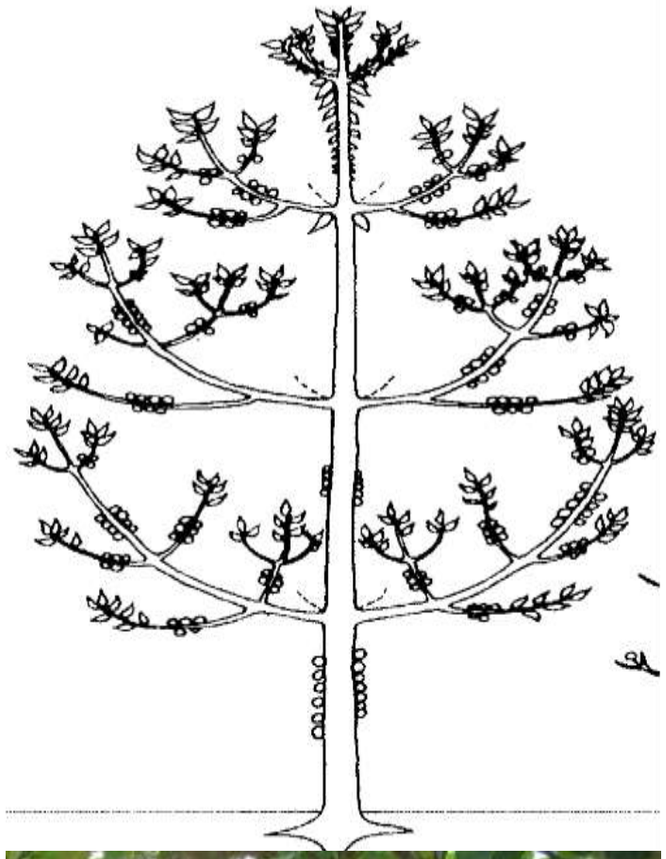
Tree Architecture Models

- Roux
  - Monopodial trunk grows continuously orthotropic with monopodial plagiotropic branches
    - Durian (Durio zibethinus)
    - Coffee (Coffea arabica)



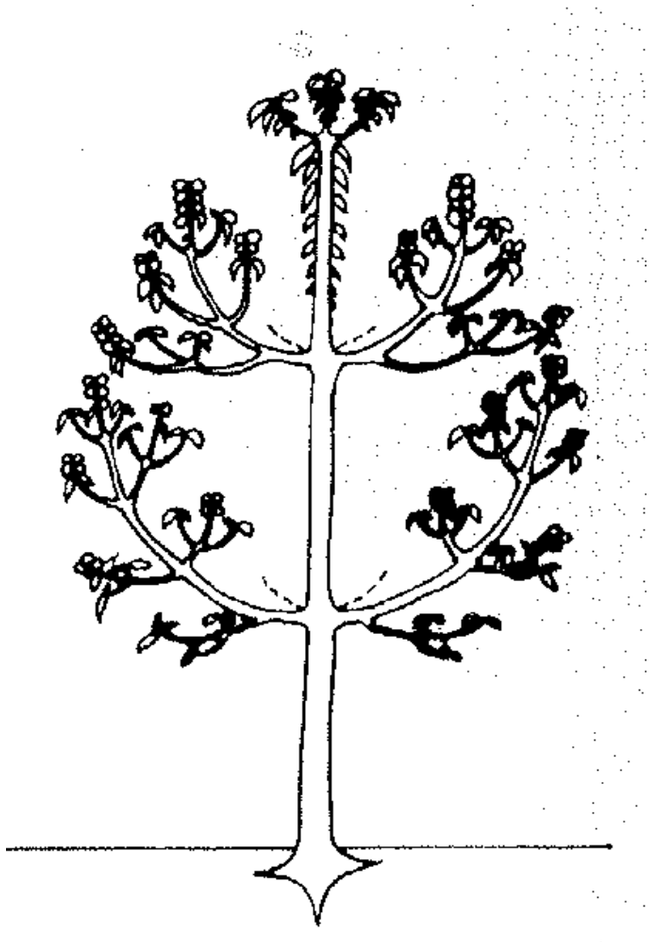
Tree Architecture Models

- Rauh
  - Monopodial trunk growing rhythmically. Monopodial branches orthotropic
  - Temperate species
    - Apple (Malus domestica)
    - Pear (Pyrus communis)
    - Walnut (Juglans regia)
    - Cherry (Prunus spp.)
    - Peach (Prunus persica)
    - Langsat/duku (Lansium domesticum)
    - Avocado (Persia americana)
    - Jackfruit (Artocarpus hyterophyllus)



Tree Architecture Models

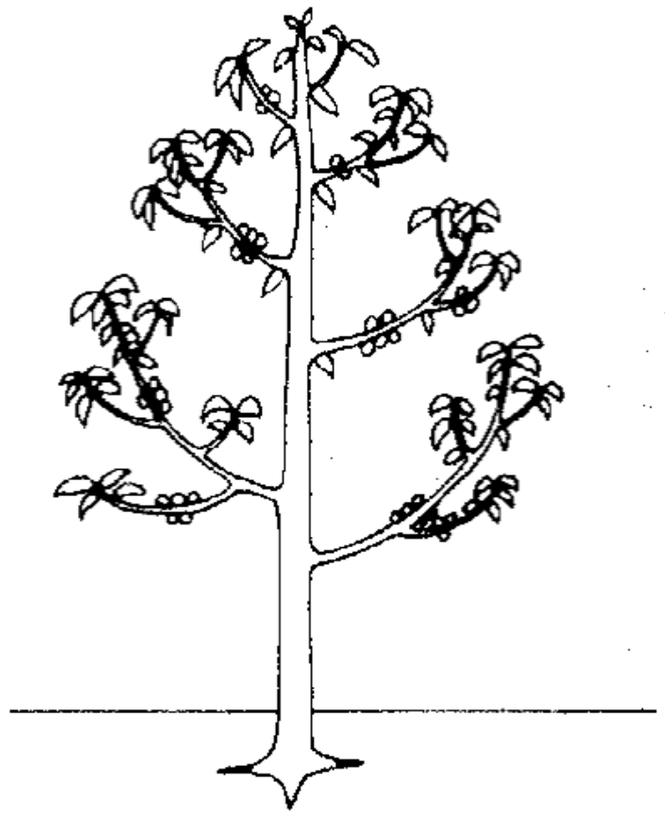
- Scarrone
  - Monopodial trunk growing rhythmically. Branches orthotropic and sympodial
    - Mango (Mangifera indica)
    - Rambutan (Nephellium lappaceum)
    - Longan (Dimocarpus longan)
    - Lychee (Litchi sinensis)
    - Hogs Plum (Spondias mombin)
    - Cashew (Anacardium occidentale)



Scarrone's model

Tree Architecture Models

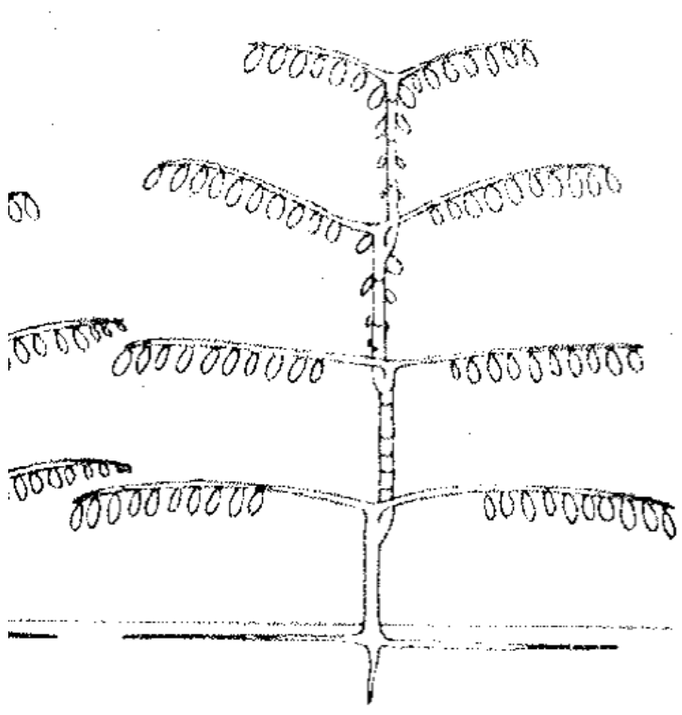
- Attim
  - Monopodial trunk growing continuously. Monopodial branches orthotropic
    - Mangosteen (Garcinia mangostana)



Attims's model

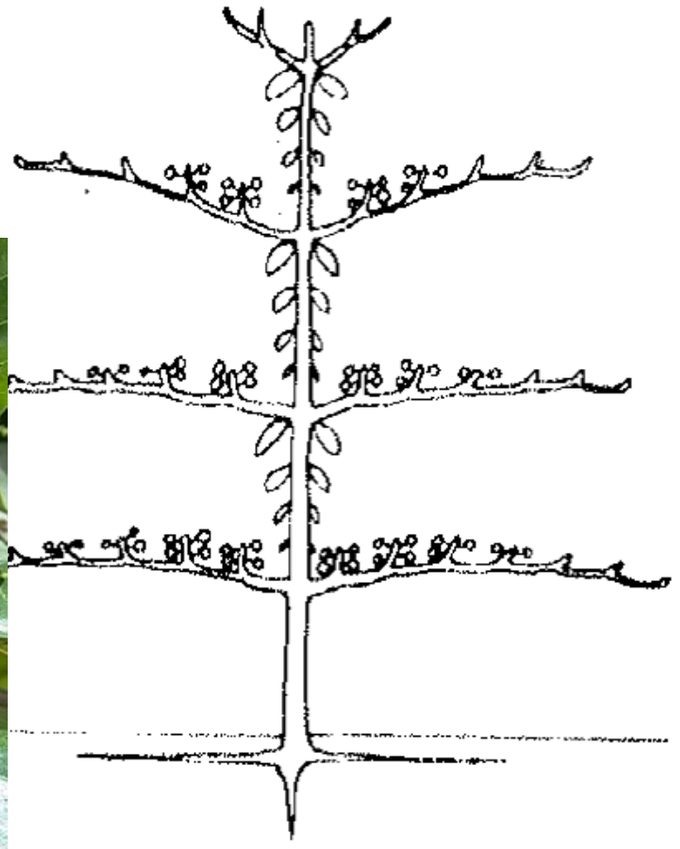
Tree Architecture Models

- Nozeran
  - Trunk a sympodium of orthotropic branches. Branches at distal end are plagiotropic retaining their character as cuttings.
    - Cacao (Theobroma cacao)



Tree Architecture Models

- Auberville
  - Monopodial trunk, growing rhythmically. Branches plagiotropic by apposition (ie. Composed of intermediate sympodial units).
    - Sapodilla (Manilkara zapota)
    - Saba Nut (Pachira aquatica)
    - Sea Almond (Terminalia catappa)



Tree Flowering

Terminal Flowering

Determinant

Mango

Rambutan

Lychee

Longan

Indeterminant

Avocado

Cauliflorous Flowering

Cacao

Jackfruit?

Durian

Jaboticaba

Axillary Flowering

New growth

Custard Apple

Soursop

Orange, lime, etc.

Guava

Breadfruit

1st year wood

Coffee

1st, 2nd & older wood

Macadamia

Carambola

Terminal Flowering

Trellis Mango – Estimated Productivity
Spacing 3 x 4 m = 833 trees/ha; 550g/fruit
9 terminals = 4.1 Mt/ha
33 terminals = 15.1 Mt/ha
49 terminals = 22.4 Mt/ha

Conventional; 476 trees/ha; 13.3 - 16.6 Mt/ha

Cauliflorous Flowering

Trellis Cacao (V) – Estimated Productivity
Density = 2000 trees/ha
40 pods = 3.2 Mt dried bean/ha
60 pods = 4.8 Mt dried bean/ha
70 pods = 5.6 Mt dried bean/ha

Axial Flowering

Guava – recorded yields

Hawaii commercial – 250 trees/ha; 27 t/ha

Hawaii experimental – 200 trees/h; 50 t/ha

Taiwan commercial – 700 trees/ha; 60 t/ha

Estimated Productivity (based on 3 month data)

V trellis - 1334 trees/ha; 39 t/ha/year

Free – 667 trees/ha; 23 t/ha/year


Summary

- To trellis or not to trellis?
  - Consider the risk!!!
  - Consider the tree architecture!
  - Where does the tree flower?
  - What triggers flowering?
  - Estimate yield and compare to conventional orchard!
  - Is there another way to achieve a similar end result?
  - Still needs to be profitable!
  - Each species/variety likely to need its own pruning solution.

- Thanks to our funding agencies and growers;

RURAL INDUSTRIES
Research & Development Corporation

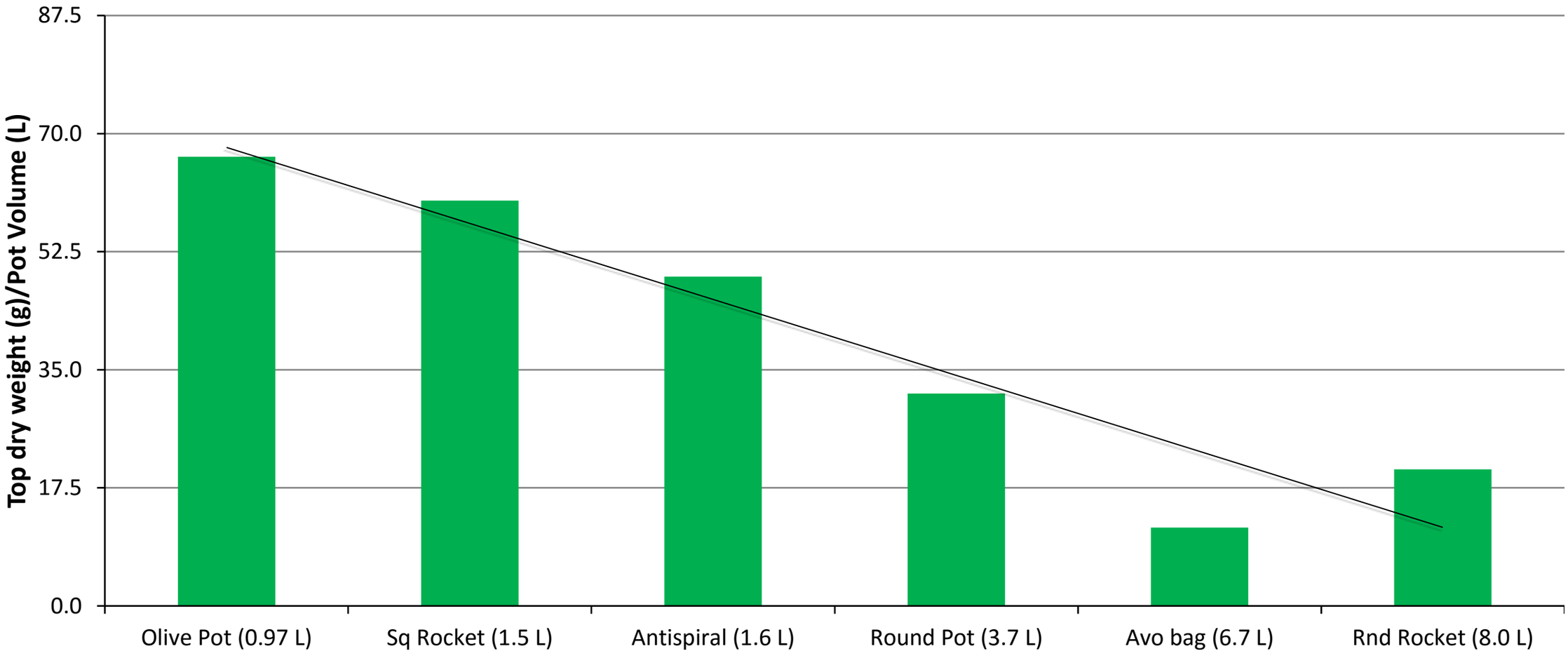
Nursery/propagation Environment

- Often not ideal
  - Grafted trees in pots for 2+ years
  - Marcotts can lead to root turning
  - Small/short pots lead to root spiralling

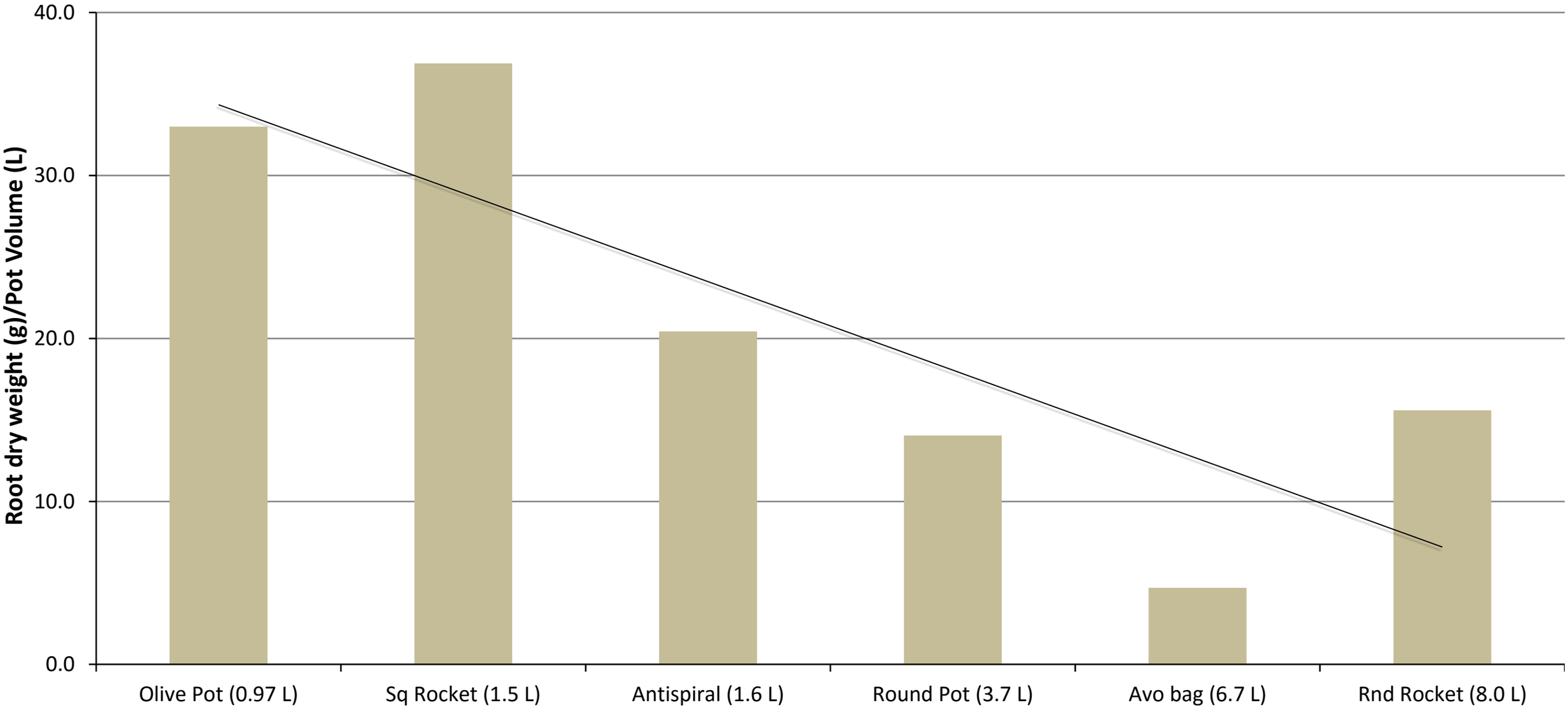
Pot trial

- Experiment details
  - Seedling jackfruit
  - Planted: 15 Nov 2013
  - 6 pot types
  - 7 replicates of each pot
  - Sampling: Mar & Sep 14; Mar 15 (4, 10, 16 months)
- Pots
  - Olive pot – 0.97 L
  - Square Rocket – 1.5 L
  - Antispiral - 1.6 L
  - Round/Citrus – 3.7 L
  - Avo polybag – 6.7 L
  - Round Rocket – 8.0 L
- Mix – Commercial Searles Premium

Ratio Top dry weight (g)/Pot Vol (L)



Ratio - Root dry wt (g):PotVol (L)



Olive pot

Avocado bag

Anti spiral

Square rocket

Round rocket

Round/citrus

Field Planting

Recommendations

1. For trees requiring 2+ years in the nursery – select a larger pot
2. Avoid plastic poly bags if you can. They are cheap but can result in poor root growth.
3. Use pots which are designed to avoid/reduce root spiralling
4. Ensure you are using a clean, well aerated mix
5. Maintain good watering and fertiliser practices, appropriate to pot size

The nursery stage is the foundation stone for the development of your trees - Ignore this stage at your peril!

Thank you

- **HTFA**
- **Funding institutions**
- **Project colleagues**
- **Cooperating growers**