Transforming Mango Crop Productivity

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Why do we need change ?

- Mango yields are lower than other tree crops
- Yields are biennial and irregular
- Production costs are high
- Production efficiency is low
- Labour costs are high
- Fruit quality is inconsistent and unpredictable

What is the potential for improving productivity in mango ?

Annual energy in fruits crops

	Energy in fruit (10^9 J t^{-1})	Highest commercial yields (t ha^{-1})	Annual energy in fruit (10^9 J ha^{-1} $year^{-1}$)	Relative yield based on energy capture
Orange	2.6	100	260	1.0
Apple	2.2	100	220	0.85
Avocado	6.7	38.3	257	0.99
Mango	2.7	28	76	0.29
Custard Apple	3.1	14.7	46	0.17
Macadamia kernel	30.0	2.5	75	0.29

(Chapman and Stephenson, unpublished)

The evolution of apple planting systems in Queensland

Era	Pre 1980	1980-90	1990-2000	2000 -
Tree density	280	280-1000	1000-1250	2000 +
Irrigated	No	No/Yes	Yes	Yes
Rootstock	Vigorous	Vigorous	Semi-vigorous	Semi-dwarfing/dwarfing
Pruning/training	Vase	Vase-central leader	Central leader	Central leader
Yield (t/ha)	10-15	10-20	30-40	60-100+
Time to full production	10 (5-6)	7-10 (3-6)	6-7 (3-4)	5 (2-3)

(Wilkie, unpublished)

The old and the new

The Small Tree High Productivity Initiative

Researching the Shape of Future Mango Orchards

HIAL AI 13004 Transforming subtropical/ tropical tree crop productivity

Undertake long-term research to transform the productivity and profitability of subtropical/ tropical tree crops By developing high density and high productivity orchard systems

Benefits of smaller trees

- Increased productivity per hectare
- Reach max orchard productivity earlier
- Increase access to tree and fruit for
  - Harvesting
  - Pruning
  - Fruit manipulations
  - Spray applications
  - Disease and pest monitoring and management
- Early canopy closure - weed control
- Decreased pruning

The Small Tree High Productivity Initiative

Focusing on four key components of productivity

Vigour management

How to effectively manage the tree's vegetative vigour using rootstocks, pruning strategies for canopy manipulation and growth regulators.

Canopy architecture

To understanding patterns of vegetative growth, flowering and fruiting and the potential to manipulate these through pruning and/or training to optimise the orchard light environment.

The Small Tree High Productivity Initiative

Focusing on four key components of productivity

Canopy light relations

To understand the role of sunlight in tree growth, flowering and fruiting and the effects of canopy pruning and training on light interception and distribution

Crop load

To understanding of the physiology of crop load and it's management through flowering and fruit set and subsequent management to maximise yields

Vigour management

Rootstocks

Screening 90 rootstocks for vigour reduction of scions

- Identify rootstock genetics that reduce tree vigour and increase productivity
- Investigate mechanisms behind vigour control in rootstocks
- Breeding for low vigour scions

Canopy training

Pruning and training induced vigour control

- Investigate the influence of pruning and training systems on vigour control

Rootstock Discovery

- Screen 90 mango RS for vigour reduction in scions
- Testing two scions NMBP 1243 and 4069
- Rootstock/scion combinations will be observed for vigour and architecture controlling attributes
- Vigour controlling RS will be tested on a wider group of scions
- Investigate mechanisms behind vigour control in rootstocks

Canopy Architecture




- **Canopy training and tree density systems field trial**
- **Functional and structural canopy modelling**
- **Mapping gene activity of annual growth cycles**

Planting systems field experiment

To: study vigour, light, yield, responses to plant density and canopy training

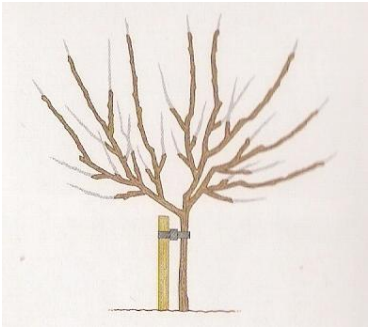
Three varieties – Keitt, NMBP-1243 and Calypso

Training systems – conventional, hedge, single leader, single leader on trellis

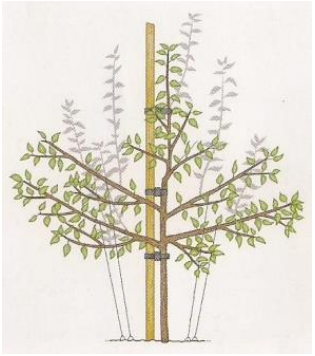
Three plant densities

- 8 X 6 m (208 trees ha^{-1})
- 6 X 4 m (417 trees ha^{-1})
- 4 X 2 m (1250 trees ha^{-1})

Training Canopy Architecture

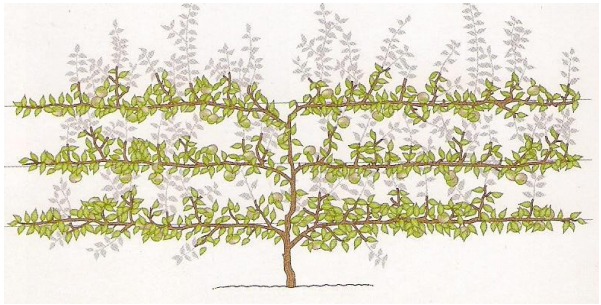


Conventional training and pruning



Single leader training

Maintain a single leader with apical dominance removing up-growing branches
Allow 2 growth units per branch then prune
2-5 main branches main frame on lower scaffold tied horizontal
Prune secondary branches to downward or outward facing nodes tie to horizontal

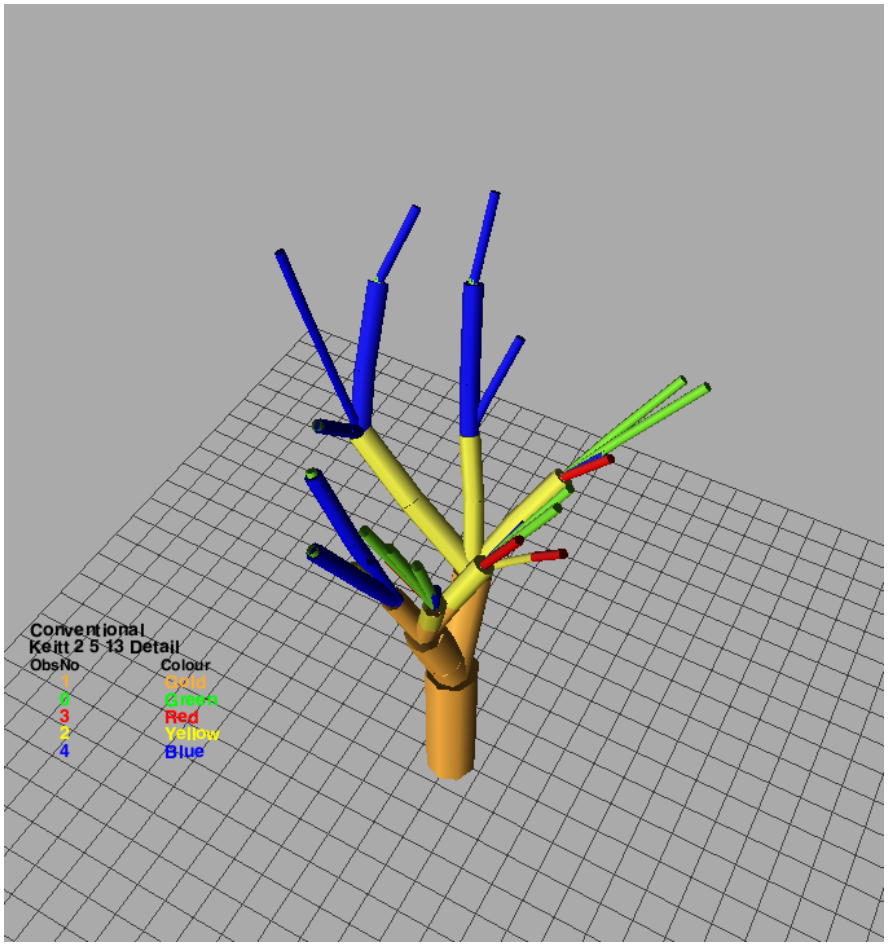


Source: Buckingham 2011

Single leader trellis

on 2-5 main branches main frame on lower scaffold tied horizontal
Prune secondary branches to downward or outward facing nodes tie to horizontal

Functional structural modelling



Dr Neil White DAF ids the major contributor of this work

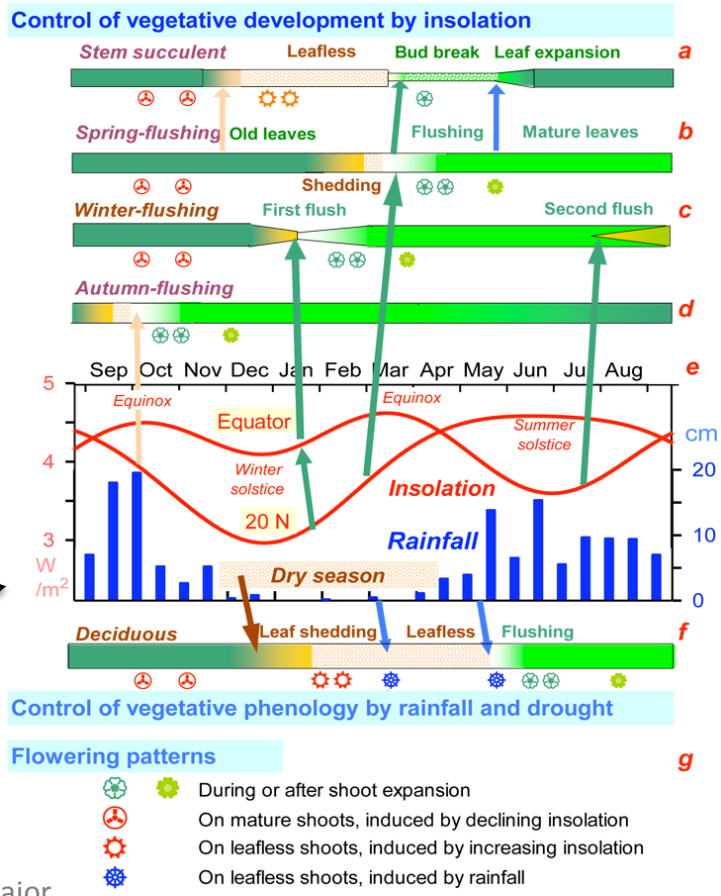
Molecular Phenology

Which genes are active and when during annual growth and cropping cycle

Physiological Map

To identify <u>where</u>, <u>when</u> and <u>which</u> key architectural and flowering genes are expressed?

Need to create or identify charts like this



Prof Christine Beverage, Plant Physiologist, QAAFI and Dr Natalie Dillon, DAF are the major contributor to this work

Light Environment

Baseline studies in commercial cultivars:

– Relationship between light interception, canopy volume and yield

Pruning and training induced light environment

– Investigate the influence of pruning and training systems on light environment
– Optimizing light environment in the orchard
– Modelling of the light environment and productivity

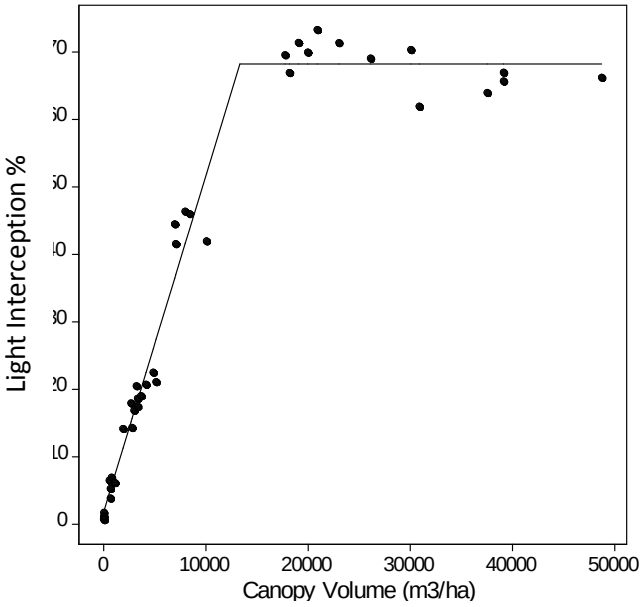
Light interception experiment

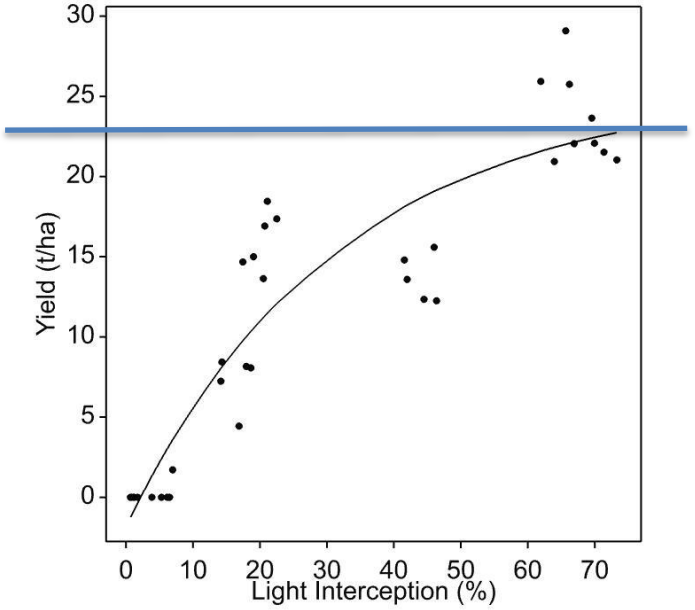
Light interception of mango trees as trees age

Light interception

Baseline study early findings

Relationship between light interception and yield Kensington pride, showing maximum yields are reached at about 68% light interception.





Dr Paula Ibell and Mr Ram Kolala, DAF are the major contributors to this work

Crop Load Research

Baseline studies commercial cultivars

– Relationship between flowering density and fruit set, yield, vegetative growth and tree performance in the following year

Pruning and training crop load

– Investigate the influence of pruning and training systems on development patterns, flowering and fruiting

- **Crop load modelling**

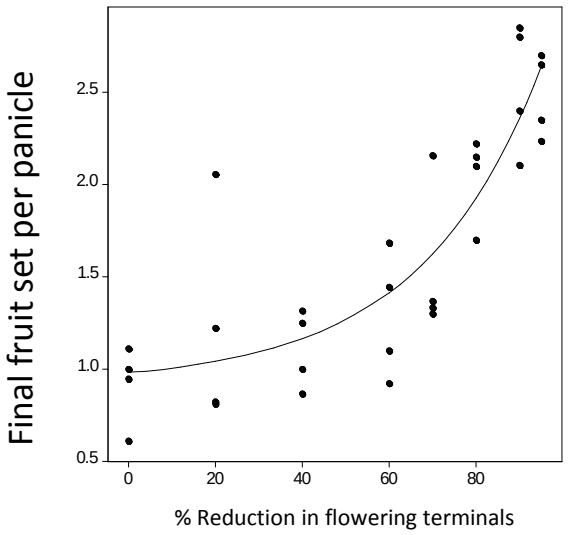
– Application of crop load relationships with canopy training, pruning, density, flowering and light interception will be added to the mango model.

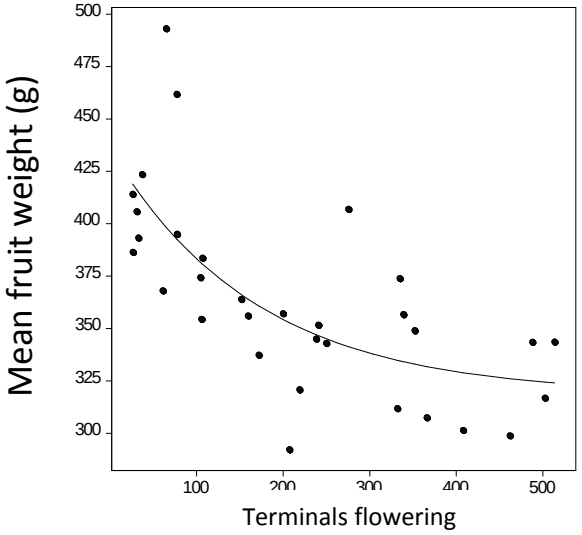
Crop load experiment

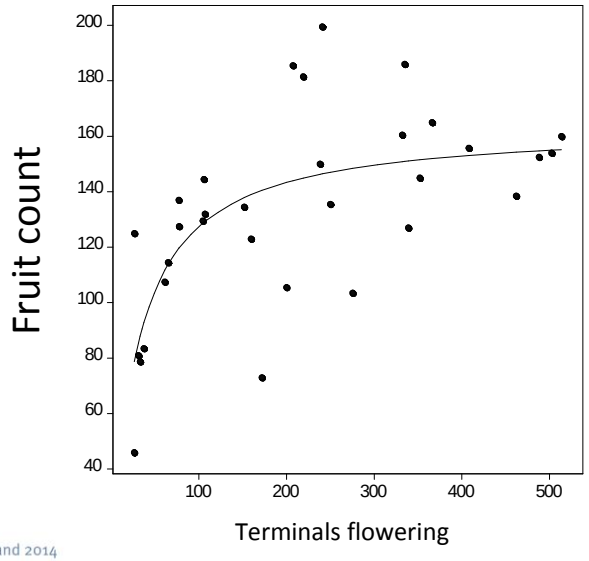
Investigating effect of Inflorescence density In Calypso on:

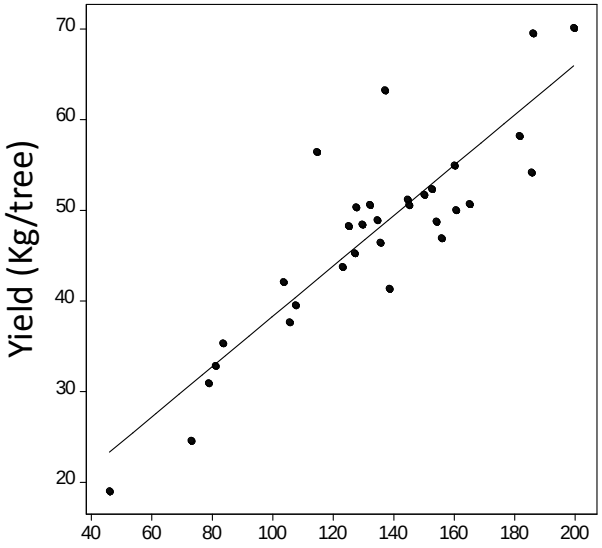
- Fruit set and retention,
- Yield (tree and orchard),
- Fruit quality,
- Tree yields,
- Biennial bearing,
- Vegetative growth, and
- Stem carbohydrates.

Crop load

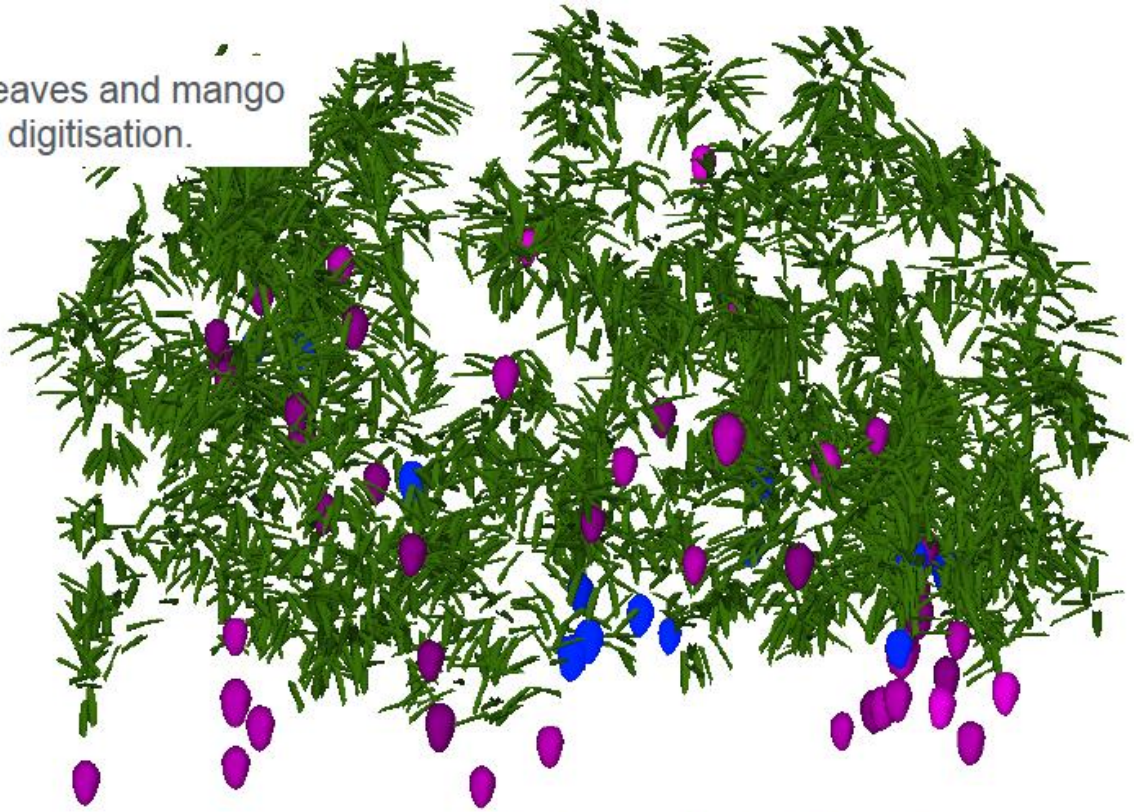






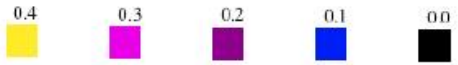


Modelling Light Interception



Static mapping of leaves and mango fruits from 3D digitisation.

Modelling of light interception by canopy and the amount of light reaching fruit using path tracing



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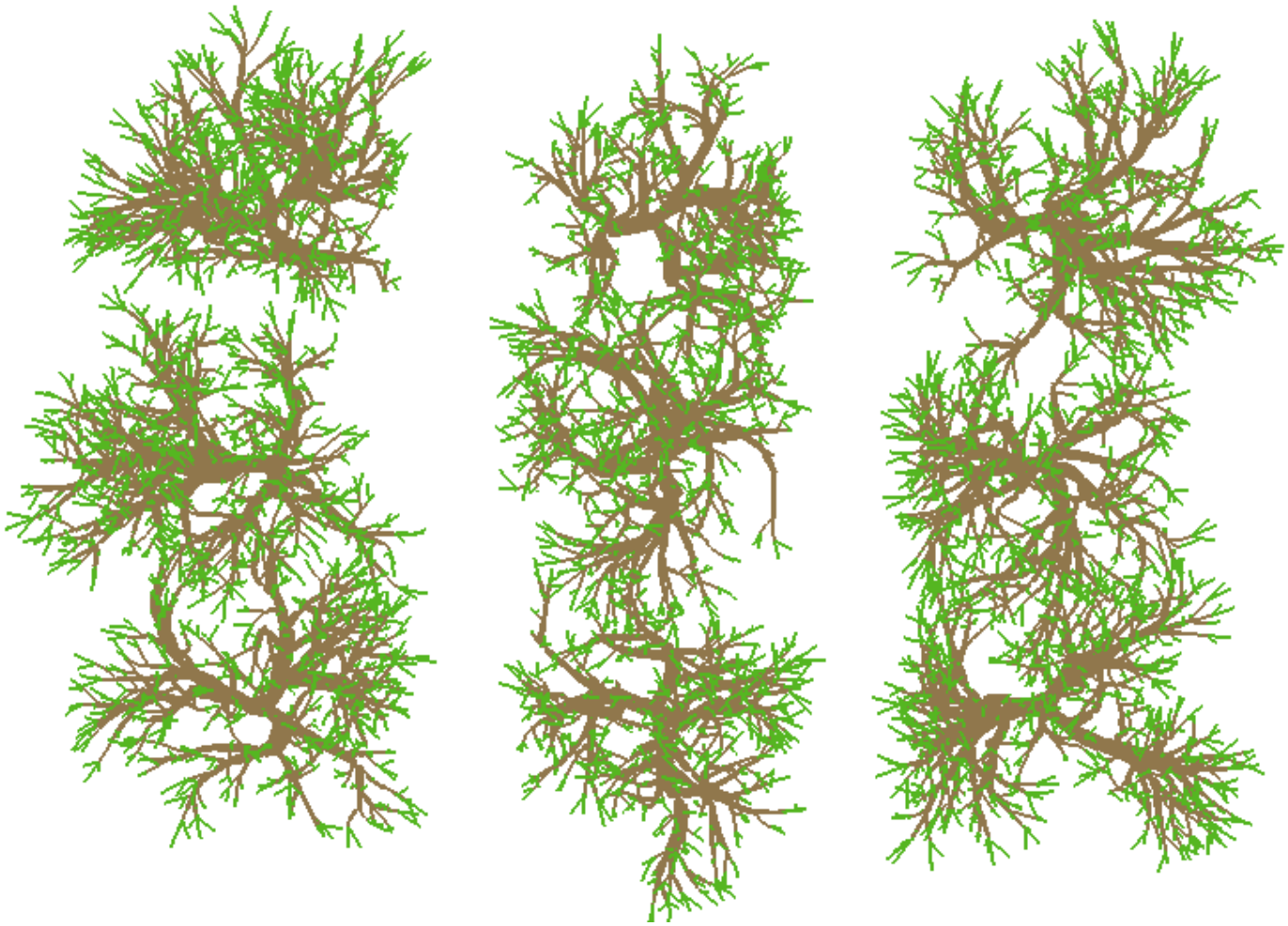
Orchard Level Modelling



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