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PROBLEMS AND OPPORTUNITIES IN TROPICAL FRUIT TREE PROPAGATION

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INTRODUCTION

Tropical fruit tree propagation as referred to in this paper is largely confined to those species of tropical or subtropical origin which are not major industries in northern Australia. However a few more established crops (e.g. mango and lychee) are included in the context of developments and problems associated with plant quarantine introduction and propagation.

There has been little innovative research in propagation of the "emerging" tropical tree fruits in terms of support from government institutions in Australia. This is perhaps justified in the order of research priorities. However, as varietal screening and market development proceed, the few fruits with sustained market prospects will be identified.

Developments in propagation techniques to date have largely arisen from the initiatives of individual nurserymen, and trial and error in quarantine facilities where problems in establishing importations have arisen.

For most species, relevant propagation techniques have been developed overseas (particularly in Asia). However, in Australia problems have arisen due to climatic differences, shortage of parent stock (stock and scions), and operation costs. We have nursery stock costs which, at the purchaser level, are currently limiting industry development. *In-vitro* culture and juvenile stock propagation are desirable prospects for the future despite the fact that for most species such development appears difficult at this stage.

HISTORICAL ASPECTS OF NORTHERN AUSTRALIA TREE FRUIT INTRODUCTION

Queensland already has an enormous diversity of deciduous, subtropical, and tropical fruit tree species. Efforts to increase the range have been prompted by collectors (South America and Asia in particular), exotic fruit study groups (e.g. R.F.C.), and grower interest in supplying domestic, ethnic, and export markets.

In the 1890's Kamerunga was established as the State's tropical crop introduction station. In addition to sugarcane, rubber, coffee, cocoa, palm oil, and most standard tropical fruits, the introductions also included mangosteen, rambutan, lychee, longan, wampi, etc. Many of the tropical exotics did not thrive due to inadequate irrigation and lack of management understanding. Further, all material was of seedling origin and resultant crops were often of poor quality.

In the early 1970's renewed interest in tropical fruit species arose and importation of clonal material of tropical fruit tree species started in earnest. The Horticulture branch of the Queensland Department of Primary Industries has been a major importer. Importation through quarantine reached a peak between 1978 and 1982 and has now tapered off due to the shortage of new cultivars.

Table 1 summarises the species and number of cultivars successfully brought through Kamerunga since 1970, and, the grafting techniques used both in quarantine and nurseries.

PRINCIPAL GRAFTING TECHNIQUES

Side Veneer. Of all techniques this has been the most useful in quarantine. This is probably due to the capacity to handle material which has been in transit for a long period, or has been collected in an indifferent condition at source.

Scions should preferably be pre-cinctured — although unnecessary for carambola and casimiroa. Mamey sapote, on the other hand, requires a 2 to 3 month cincture period for best

Table 1. Clonal introduction through Kamerunga Research Station and grafting techniques found successful.

	IN	% G	S.V.	We/M.We	F.B.	A.L.	B.G.
Artocarpus heterophyllus (jackfruit)	3	−	+	(+)	+	−	+
A. polyphema (chempedak)	1	−	+	(+)	+	−	+
A. heteropyllus × *A. polythema* (hybrid jackfruit)	1	−	+	+	+	−	+
Averrhoa carambola (carambola)	25	100	(+)	(+)	+	−	
Bouea macrophylla (maprang)	4	−				+	+
Casimiroa edulis (casimiroa)	29	100	(+)	(+)			
Chrysophyllum cainito (caimito)	4	50	(+)	+		+	
Clausena lansium (wampee)	2	−	(+)	+	(+)		
Diospyros digyna (black persimmon)	2	−	+	(+)			
D. discolor (mabolo)	1	−	+	+			
Durio zibethinus (durian)	16	80	(+)	(+)	+		+
Euphoria longan (longan)	15	70	+	(+)	(+)	(+)	
Lansium domesticum (langsat.duku)	16	70	(+)	(+)	+	−+	
Litchi chinensis (lychee)	30	40	+	+	+	(+)	
Mammea americana (mammea)	1	100	+	+			
Mangifera indica (mango)	75	90	+	(+)	+	+	
Manilkara zapota (sapodilla)	22	85	(+)	(+)	+	+	
Matisia cordata (matisia)	5	100	+	+			
Myrciaria cauliflora (jaboticaba)	1	100	+				
Nephelium lappaceum (rambutan)	52	85			(+)		
N. mutabile (pulasan)	6	65			(+)		
Pouteria campechiana (canistel)	4	50	(+)	+			
P. sapota (mamey sapote)	5	80	(+)	+			
Sandoricum koetjape (santol)	3	80	(+)	+			
Syzygium cumini (jambolan)	1	−	+				
S. malaccense (Malay apple)	3	−	+	(+)			
S. samarangense (wax jambu)	3	−	+	(+)			
Tamarindus indica (tamarind)	7	−		(+)			+
Ziziphus jujuba (Chinese jujube)	2	−	+				
Z. mauritiana (Indian jujube)	2	−	+				+

Key

IN = Number of cultivars imported through Kamerunga.
% G = Percentage grafted in quarantine (balance introduced as rooted trees).

Grafting Techniques Used Successfully

S.V. = Side veneer graft
We/M.We = Wedge or modified wedge graft.
F.B. = Modified Forkert bud graft.
A.L. = Air layer
B.G. = Bottle graft

\+ = graft successful
(+) = grafts most commonly used commercially
− = not feasible

No annotation = either uncommonly used, or low percentage success.

results. All grafts are either PVC taped, bagged following graft tying, or placed in high humidity chambers.

Wedge or Modified Wedge. Stocks must be extremely vigorous and scions preferably terminal in a "hard", near-to-bud-

burst condition. The Fitzroy technique has been particularly successful, even for *Artocarpus* species (which have troubled most northern nurserymen). The criteria are "hard" scions, with all leaves or at least 50% of leaves (cut) retained. Stocks must be young, vigorous, and the graft made high so as to retain at least 50% of original leaf area on the stock. The scion match should be nodal — and with near equal diameter for stock and scion. The leaf on the stock nodal joint should preferably be left intact. The critical factor in the Fitzroy technique is to enclose completed grafts in an environment with zero air movement. In practical application this requires PVC, glass, or mylar cabinets. Stock vigour is essential and may necessitate bottom heat for some species — even in north Queensland. Extremely hot, dry periods (October — December) should be avoided.

The modified wedge is a simple technique for "easier" species, such as mango, carambola, casimiroa, etc. Only one face of the wedge is cut on the scion and it is particularly useful for small diameter scion/large stock combinations since cambium match location is simplified.

Modified Forkert Budgraft. This technique was borrowed from Asia and is an essential method for propagating rambutan and pulasan. However, in Malaysia it is also used for a wide range of species — including carambola, durian, jackfruit, chempedak, sapodilla, etc. In practice it is a simple procedure but requires considerable experience.

The rootstock patch flap can be subtended from either top or bottom, but the flap must be cut so that it does not overlay the scion bud initial(s). Critical factors are: vigorous rootstock, and obtaining, scion sticks from vigorous, upright branches on the donor tree. On completion buds must be tightly, but not heavily, taped. Good light exposure is essential. Taking of budwood and budding is best attempted only on bright, sunny days.

In addition, the modified forkert bud technique has been valuable in quarantine for difficult species, such as lychee and longan, and for other species when graftwood is extremely limited.

Chip Budding. This is seldom used on tropical species since in all except a few, e.g. casimiroa, wampi, it is not as reliable as the aforementioned techniques. The same comment applies to T-budding.

Punch Budding. There has been very little research with this technique for tropical exotic fruit trees. Whilst it does work for rambutan it is generally not as reliable as the modified forkert. It appears that success is most likely with species

which have a relatively thick cortex and show a good carbohydrate build-up after cincturing.

Cuttings. Garner, *et al.* devote considerable discussion and tabling of trial data to point out the merits of cutting propagation. In practical application, however, there is very little use of it in nursery production of tropical fruit species. The problems are essentially reliability and the length of time required. For most sapotaceous species it is even necessary to remove initial callus formation in order to stimulate rooting. However, for some of the tropicals, e.g. durian, rambutan, there has been little definitive research — particularly that concerned with comparison in variation of juvenility, nutrient status, carbohydrate induced accumulation, controlled bed temperature, hormonal stimulation, misting, incident light exposure, etiolation, and orientation of the cutting in the medium.

With low cost reliable propagation as the ideal (assuming eventual tree growth and longevity satisfactory) cutting research is warranted.

Approach Grafting. Whilst relatively common in Asia this technique is not used significantly in Queensland principally because of the shortage of stock trees. It is, however, very reliable for any species if the prescribed procedures are followed. These are: vigorous stock and scion branches, grafting with semi-mature (green/brown) stem combinations, and proper attention to the scion weaning process are adhered to.

The technique has been particularly useful in quarantine for ensuring the survival of cultivars which have established poorly from rooted tree introductions — and, for multiplication of single survivals to a level of security. For field grafting on stock trees the grafting period is best restricted to the wet season.

Bottle Graft. The Thais have developed this technique with remarkable success, particularly for mango, durian, tamarind, and artocarpus species. Seed are bed-sown and seedlings pulled when 3 to 4 months old, then transferred into small, clear poly bags with the roots balled in coconut fibre. The seedlings are then decapitated, tied up to an appropriate branch of the scion tree and approach grafted (side veneer graft) into a suitable shoot. After 4 to 6 weeks the scion branch is cut at a level near the roots of the seedling. Following potting, the scion base usually develops roots and a double root system is provided. The technique works best during the summer monsoon season and whilst not practised widely in north Queensland it is a practical technique for more difficult species, such as durian and jackfruit. Table 2 lists a summary of propagation techniques for selected fruit tree species in

Table 2. Summary of propagation techniques for selected species in north Queensland.

	Rootstock			Scion		
Mango	Grafting Best mths. 1 - 12	Min. R'stock Ht. (mm)	Stock age (mths)	Pre-cincture weeks before	Defoliate+ weeks before	Special notes
We./M.We	10 - 3	500 - 1000	6 - 24	N/N	2 - 4 +	Selection of plump buds is
S.V.	11 - 3	500 - 1000	6 - 24	N/N	2 - 4	critical for good "takes".
F.B.	10 - 3	300 - 1000	9 - 24	N/A	N/A	
Sapodilla						
S.V.	8 - 11	500 - 800	15 - 24	3 - 5	3 - 5	After 4 to 6 weeks remove
&	4 - 5					callus from cuttings base.
We/M.We	8 - 11	500 - 800	15 - 24	3 - 5	3 - 5	Cuttings very slow to root.
A.L.	9 - 3	N/A	large branch	N/A	N/A	
F.B.	9 - 12	400 - 800	12 - 24	N/A	3 - 5	
C	4 - 9	N/A		3 - 5	N/A	
Carambola						
S.V.	8 - 12	1000	5 - 12	N/N*	1 - 3 +	Air layers and cuttings very
&	4 - 6					difficult.
We/M.We	8 - 12	1000	5 - 12	N/N*	1 - 3 +	
F.B.	9 - 12	1000	5 - 12	N/A	1 - 3 +	
Rambutan						
F.B.	10 - 12	1000	12 - 24	N/A	only lower	Air layers not reliable.
&	4 - 5				leaves 1-2	Average only 50% survival.
Wedge and side veneer grafts are possible but much less reliable.						
A.L.	10 - 4	N/A	N/A			
Durian						
S.V.	9 - 1	700 plus	12 - 18	2 - 3	N/A	Use of scions with protruding
We/M/We	9 - 1	200 - 800	3 - 18	2 - 3	N/A	undamaged buds essential for
F.B.	9 - 12	700 plus	12 - 18	N/A	N/A	Forkert method.
A.L.	9 - 3	N/A	N/A	N/A	N/A	

Lychee and Longan						
S.V.	8 - 11	500 - 1000	12 - 20	3 - 4	N/A	Side veneer preferred for
We/M.We	8 - 11	500 - 1000	12 - 30	3 - 4	N/A	lychee.-growth slow for
F.B.	10 - 12	500 - 1000	12 - 20	N/A	only lower leaves 2 - 3	cuttings.
A.L.	9 - 3	N/A	N/A	N/A	N/A	A.L. the normal commercial
C	4 - 8	N/A	N/A	2 - 4	N/A	method.

N.B.

1. Preferred graft methods at top of each list.
2. For mango and sapodilla, terminal scions preferred for wedge, modified wedge and side veneer.
3. S.V. = side veneer; We = wedge graft; M.We. = modified wedge graft; F.B. = modified Forkert bud; A.L. = airlayer; C = cuttings; N/N = not necessary; N/N* = not necessary if use scion from drooping branches.
4. Bottom heat preferred for all cuttings with best results during winter.
5. Some nurserymen prefer leaving 6 to 8 terminal leaves (often cut in half) on the scion when grafting.
6. Approach grafting not listed — but can use for any species with good success.
7. + defoliate — but prefer to leave 6 to 8 terminal leaves intact.

north Queensland.

Rootstock Compatability and Tree Performance Uniformity in tree growth of the emerging tropical exotics has been compromised due to the "anything and all" approach by nurserymen in regard to access to numbers of rootstocks. Unfortunately, the same approach is often adopted in Asia and thus there are few guides to rootstock selection.

We have witnessed overgrowth of rambutan scions on some rootstock cultivars, incompatability with some lychee cultivars (particularly Amboina and Kwai May Red) on Tai So seedling rootstocks, and poor performance of Thai longan cultivars grown on Chinese cultivar rootstocks (and vice versa). Whilst some of these problems have been overcome (for example using Wai Chee or Bengal seedling rootstocks for lychee cultivars), obviously many more will arise particularly because there are varying incompatabilities at the cultivar level within species.

The Future Whilst there has been little organised and documented "emerging" tree fruit species propagation research in northern Australia, there has been a considerable body of knowledge built up (and is still being developed) by a number of innovative nurserymen.

What is essentially lacking is a coordinated approach to the gleaning of trial and error information right through to the field planting and cropping stage. Of major concern for the various crops is that rootstock (or own roots) choice be such as to achieve and maintain maximum productivity.

Tissue culture research should be pursued for the most promising of the exotics. Success in this area has been largely complicated by contamination and the difficulty in formulating the callus medium. Once achieved we still require field research on long term growth of own-rooted trees.

BUDDING OF EUROPEAN (SPANISH) CHESTNUT (*CASTANEA SATIVA* MILL.)

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The European (Spanish) chestnut is a relatively new tree fruit crop in Australia, especially for production in commercial orchards. The trees are grown for the shiny brown nuts which are produced in prickly seed cases or burrs. The starchy,