

Potential for horticultural expansion in the tropics

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The tropical belt

The Australian tropics are defined as all areas north of the Tropic of Capricorn (from latitude 23°27'S). The word 'tropics' is however not always adequately understood since it can encompass areas of subtropical and even temperate crop range by virtue of continental influences and altitude.

In Queensland two regions are considered in this paper - the 'Dry Tropics' from Carmila (approximately 22°S) to the Cardwell Range (approximately 18°30'S) and the 'Wet Tropics' from the latter point to the Papua New Guinea coast line at 9°S. The effective inland range of horticultural production in the Dry Tropics is within 120 km of the coast and for the Wet Tropics is the coastal lowland belt from Cardwell to Cooktown and the Atherton Tableland/Mareeba/Julatten Districts - all within 100 km of the coast.

The Northern Territory production areas are mainly within the band from Darwin to Mataranka (12 to 15°S). The Alice Springs production area is excluded from this analysis. Western Australia production is at present predominantly included in the Ord River Irrigation Area and only production figures from that area are discussed. However, there is potential for production in other areas of the Kimberleys as postulated by Ellis (7). Some centres such as Kalumburu, Halls Creek, Derby and Broome have significant horticultural production for local markets and also supply Perth with commodities such as mango, watermelon, pumpkin, rockmelon and cucumber.

Carnarvon horticultural production lies south of the Tropic of Capricorn and thus is not included.

Crop potential and development

The key to future major expansion in horticultural crops in the Australian tropics lies in production of crops which:

- crop in winter and spring and which cannot be economically grown in the south at that time (tomatoes, rockmelon, etc.);
- are strongly or moderately dependent on a tropical climate (mango, cashew, rambutan, etc.);
- have productivity and economic advantage above and beyond extra transport costs to southern markets (banana, ornamentals, etc.);
- have a non perishable nature (coffee, macadamia, cashew etc.);
- have export potential.

In terms of new crops - and particularly fruits, those which harvest in the period April to November will have easier market access and usually better returns. It is not easy to postulate future trends and export in particular because the market scene is always fluid - quarantine requirements, promotion, the value of the Australian dollar, the extent of domestic markets and their influence on price acceptability, effective transport and its availability are all important factors. Crop industries sometimes have modest beginnings and then events begin to fall in place which lead to substantial developments. One such example is the macadamia industry which **six** years ago was deeply concerned about future marketing and over-production. Promotion of the produce overseas has created unprecedented demand.

Considerable pressure and inducements are now apparent in terms of the national desire for export. Export and import substitution crops are attracting substantial Federal grants. This trend is very welcome since developing the product and, the post harvest handling are all critical. Development of a domestic market base for most fruits and nuts is necessary. Premature exploration of overseas markets without

fully understanding the product and its shelf life and, continuity of substantial supply not interfered with by domestic prices is critical. As an example, existing lychee exports to date have really done nothing for the lychee industry.

The extent of the research base in developing crops and, particularly new crops is critical. Unfortunately many crops have been introduced on an ad hoc basis without sufficient exploration, analysis and action in regards to total world gene pool. In Queensland there has been particularly substantial cultivar importation of some fruits such as non astringent persimmon, rambutan and coffee but others such as lychee, mango and macadamia have been piecemeal with the result that these industries have developed on a productivity base which is perhaps far from ultimate. Citrus has also been restricted - but this has really been from quarantine reasons rather than lack of research planning.

Transport is also a major factor in terms of development in tropical Australia. Exports from the north east coast of Queensland have been limited by absence of satisfactory shipping to Asia. This may change in the near future. The possible advent of substantially increased charter flights from Darwin to Singapore and Hong Kong this year may well change the perspective of development of crops such as rockmelon, mango, etc. In the domestic area, some industries have suffered from insufficient economy of scale to attract efficient interstate trade. Some examples are the avocado, banana, mango, tomato and other vegetable industries in north Queensland which were severely restricted from market opportunities and by adequate transport temperature control. Most of these problems have now been overcome because of the influence of quantity of produce on the service organisations.

Substantial increases in production for the domestic market may however in future depend on population growth except in crops such as macadamia, coffee, cashew, newer tropical fruits etc. which are currently not at all supplied, or undersupplied to the market.

The establishment of a processing base for fruit and vegetables in one or more areas in tropical Australia could also change the situation in a short period. The only significant processing in north Queensland is limited drying and freezing of mango and, drying of banana. Significant quantities of mangos are sent to Brisbane for juicing and nectar preparation, and some contracts for crops such as capsicums have been let by southern processors in the past. Mangoes (frozen, canned, pulp), bananas (canned and frozen puree), avocados (frozen pulp and frozen savoury spread), West Indian limes (juice and oil) sweet corn (frozen), frozen tropical fruit salad -(pineapple, papaw, rockmelon, banana, passionfruit, mango) were products proposed by Anon (1) as having processing potential in north Queensland. To this list there may now be added dried banana and banana chips, mango juice and nectar. However the interest in avocado and lime products has declined.

Physical factors limiting potential for various crops in tropical Australia are mainly irrigation availability, pest and diseases, economical transport and, very significantly, the availability of labour.

The Burdekin irrigation scheme in the Dry Tropics presents a significant opportunity for development if markets are available (1). Scholfield and Blackburn (10) consider that in N.W. Australia the main horticultural production will be restricted to the Ord and Katherine areas because of water availability and good soils. Anon (1) in summarising the potential of the Burdekin/Bowen region of north Queensland and north Queensland in general listed market prospects:

Good Market Prospects	Fair Market Prospects
Avocado*	Banana
Capsicum	Cucumber
Eggplant	Sweet corn
Mango*	Watermelon
Papaw	Zucchini
Pumpkin	
Rockmelon	
Sweet Potato	
Tomato*	

* Market prospects are only fair in the long term due to anticipated production increases.

The present (1989) perspective for all of tropical Australia may be as:

Good Market Prospects	Fair Market Prospects
Capsicum	Avocado
Cashew	Banana
Coffee (arabica)	Carambola
French Bean	Cucumber
Grape	Custard apple
Grapefruit	Lychee
Honey Dew Melon	Minor tropical vegetables
Macadamia	Minor tropical fruits
Mandarin	Passionfruit
Mango*	Pummelo
Mangosteen	Pineapple
Papaw	Potato
Ornamentals	Pumpkin
Rambutan	Sweet corn
Rockmelon	Tea
Sweet Potato	Watermelon
Tomato*	Zucchini
Tropical cut flowers	

In respect to coffee, cashew and macadamia, all of which present exciting development prospects, productivity must be proven and viable economics established (including processing of cashew and machine harvest of coffee) before the industries can successfully develop. All require very significant risk capital and infrastructure unless using cooperative processing facilities (cashew and coffee).

In terms of *new* crop industries it is very appropriate to accelerate research in those with reasonable prospects and particularly if they have export or import substitution potential. Further, the organisation of cooperative research between State departments and independent organisations and growers through a task force approach is very appropriate. However in translating the research results to a commercial development plan, it is appropriate to hasten slowly and not be committed to the wrong cultivars, unsuitable environment and soils etc.

Climatic advantages and disadvantages

Tropical Australia is by no means comparable to many other areas of the world lying within the same latitude either north or south of the equator. The climate in any one area is distinctly modified by proximity to the sea, sea currents, altitude, direction of the prevailing winds, rainfall and air humidity (4). The

continental influence is very strong in Australian horticultural production areas within the tropics - principally in effects on temperature and precipitation.

Winter temperatures have a very substantial influence on not only the crops which can be grown, but also the seasonal variation in production volume and quality - particularly for bananas, papaw, pineapple and ornamentals. To realize that frost or near frost conditions can exist as far north as Cardwell/Tully on north Queensland's tropical coast is probably a surprise to many.

The cultivation of strictly tropical species is limited to those areas where frost never occurs but both the species identified as withstanding near frost conditions and, the areas in tropical Australia where frost occurs are poorly identified. The average frost free period as shown by Alexander and Possingham (4) from Australian Bureau of Meteorology data is incorrect in detail. For example, the Atherton Tableland is shown as frost free, whereas many areas have regular damage to perennial 'tropical' crops such as mango, avocado, coffee etc. although in many situations the frequency of damage may be regarded as 'acceptable'. Details of mean minimum temperatures in relation to crop species commercial potential are described by Watson (12).

A major factor in the suitability of a site for horticultural production within the Australian Tropics is water supply. Only some areas in the coastal zone between Cairns and Cardwell have precipitation exceeding 2,500 mm per annum and almost the whole of the tropics experience at least 7 months with precipitation averaging below 50 mm. Supplementary irrigation for nearly all horticultural crops is a necessity and even in the wettest areas (Tully, Innisfail and Babinda) in north Queensland irrigation provides an economic advantage for all crops grown. Evaporation varies from around 1,500 mm minimum to 3,600 mm in the driest areas of the tropics. Dry periods and cooler temperatures are however beneficial in providing stress for adequate and compressed flower induction periods for a number of crops including mango, cashew, avocado, custard apple, citrus, coffee, grape, macadamia, etc. In addition, a dry environment during flowering and fruit development periods is very beneficial in regards to absence of fungal pathogen development in mango, cashew, grape cucurbits and many other fruits. Relatively cool temperatures in winter in tropical areas also provide suitable conditions for growth of many vegetable crops including the Chinese cabbages which have export potential during the period of hot, wet summer conditions in Asia.

The effects of wind are substantial in all horticultural production areas. Most of the tropical coast is subject to cyclones and apart from Kununurra and Katherine all major production areas have suffered catastrophic damage during the past century.

Additionally, the strong south-east trade winds cause rapid evapotranspiration losses and foliage and fruit damage if not adequately protected by windbreaks. Windbreaks are a relatively new feature on the Australian scene, but fortunately grower awareness has improved in the last decade and action taken at least for a number of tree crops.

Soils and fertility

Australian soils are generally infertile and this has placed emphasis on research on both macro and micronutrient requirements. However, given the relatively high value per hectare from production of most tropical and subtropical fruit and vegetables, fertilizer costs as a percentage of total variable costs seldom exceed 10%.

In the case of a few crops such as mango it is in fact preferable to plant on light textured low cation exchange capacity soils with free draining characteristics in order to be able to control vegetative growth and easily manipulate moisture stress. For most crops a free draining soil profile and friable texture is preferable since for perennial crops in particular a heavy wet season can be disastrous if drainage is impeded.

Development and potential of individual horticultural crops

Avocado

The avocado has been grown as a backyard tree in tropical Australia since the turn of the century but never developed into an industry until plantings commenced on the Atherton Tableland in the mid 1970s. Early plantings rode on a wave of high prices but since 1982 prices have declined to near marginal economic levels.

Atherton Tableland and Mareeba district plantings have occurred mainly on the deep well drained krasnozems. The industry has readjusted in relation to cultivars with Hass being favoured between 500 and 1000 metres altitude and Sharwil, Fuerte and Shepard between 300 and 600 m. Shepard is the main cultivar now figuring in new or replacement plantings due to its early season harvest capacity (January to April). It attracts higher prices in the short supply period January to March.

Production in the Northern Territory and Northern West Australia has never reached significant levels and due to high temperatures in coastal areas it is unlikely that Mexican and Guatemalan cultivars would produce produce quality fruit. West Indian cultivars are possible and some trial work has been initiated in Broome. However the market is mainly interested in high oil content cultivars. Oil is usually low in the West Indian cultivars. Exports have increased in recent years but at 290 tonnes in 1986/87 (2) it is still of minor value. The difficulty is finding a market window in Europe/Scandinavia not filled by Israel and South Africa. Exports to Asia are limited but increasing.

Banana

Production of bananas in Australia has increased substantially in the past two decades and there have also been significant changes in industry location.

The production (tonnes) by State is compared for 1968, 1978 and 1988:

	1968	1978	1988
Wet Tropics Region Queensland	11,700	42,000	113,000
Rest of Queensland	18,000	16,000	18,000
New South Wales	111,000	68,000	78,000
West Australia	6,000	6,000	14,000
Northern Territory	100	300	814
	146,800	132,300	223,814

(N.B. Sources: QDPI, NT DPI&F, WA DA)

The figures show a fall in production in New South Wales (which has come from reduction in area rather than in productivity), a very substantial rise in north Queensland (area under crop has increased from 800 ha in 1968 to 3,800 ha in 1988), a static situation in southern Queensland and a steady increase in West Australia. Cavendish (Williams and Mons Mari) dominate production in the order of 95%, followed by Lady Finger, Pacific Plantain, Ducasse and Red Dacca. The increase in north Queensland production has undoubtedly arisen from production benefits and the 'ease' in management compared with S. Qld./NSW. Additionally the economy of scale and palletisation in transport to market have contributed to the trend. Kununurra and Darwin production has increased but the 'harder' environment and distance from southern markets remains a constraint.

From a total Australian industry point of view however it is preferable plantings be well distributed. Cyclone Winifred in 1986 destroyed 90% of the north Queensland crop. It immediately forced a severe market shortage followed by a massive glut late in 1986 and early 1987 due to a compression of the cycle. It took all of two years for orderly marketing to return. Total consumption of bananas in Australia

has increased substantially in the past decade but the past two years has seen production in excess of achieving an attractive return. This has been mirrored by a halt in increased plantings in north Queensland and some other areas. Export potential appears limited due to the price differential between export and domestic markets and, the requirement that sea freighted fruit must have a substantial green life. Due to winter effects and bunch green life variability (bunch age determination is not critical for the Australian market) it is difficult to supply consistent quality off shore. Export has largely been restricted to the New Zealand market in windows provided by occasional shipping problems from Ecuador and Tonga/Cook Islands. North Queensland supplied 130 and 109 tonnes to New Zealand respectively for 1987 and 1988. Total exports from Australia never exceeded 55 tonnes per year between 1973 and 1986 but did increase to 299 tonnes in 1988 (2) & (3).

Some processing to dried banana in Queensland and New South Wales exists mainly for muesli mixtures and health food shops. 1988 processing totalled about 120 tonnes of product. Approximately 1000 tonnes of banana chips are imported annually and some will be produced in north Queensland in the near future (13).

Carambola

Carambola has taken on a new market image following Queensland import programmes which brought in superior cultivars from Malaysia, USA, Taiwan and Thailand in the mid to late 1970s. The crop is now widespread from Coffs Harbour north up the east coast and through to the NT and WA.

Total volume marketed in 1988 probably did not exceed 60 t but the demand is increasing quite apart from ethnic Asian interests. More of the product is going to decorative uses, and vegetable and fruit salads, etc. The cultivar selection and promotion is by no means complete since although there are some excellent cultivars - e.g. Fwang Tung, Kembangan and Maha, we still lack those with superior packing (less bruising) and post harvest life characteristics. Fruit piercing moth (Queensland) and fruit fly - *Dacus aquilonis* (NT) are substantial problems. There is no export as yet, but New Zealand is probably the best opportunity. Production is virtually year round because of complimentary seasons in production areas from 12° to 30°S.

Citrus

Citrus is a very minor crop in tropical Australia although there is substantial backyard production and, some commercial development for local markets as in Koah, N.Qld. (lemon, orange, mandarin) and some other centres. The main new developments are mandarin and tangelo plantings on the Atherton Tableland - mainly for the early season market. There is also possibly considerable potential for the Texas grapefruit cultivars now being imported and after further local selection and importation, pummelo. Australia has for quarantine reasons not previously had access to superior sweet grapefruit and some mandarins and tangelos. West Indian limes have often been promoted for northern Australia but a lime oil industry has never eventuated and as well, the fresh market appears to prefer Tahitian which is currently oversupplied from NSW and S.Qld. except for a few months of the year.

Custard Apple

Within the tropics development of atemoyas (principally African Pride cultivar) has been mainly restricted to the Atherton Tableland in Queensland.

The crop appears to fit a niche between 400 and 600 m altitude on the Tableland and whilst it has only progressed to about 23 ha following earliest plantings in the early 1970's it is supplying an early season market gap. Harvest starts in March and is completed by mid July whereas South Queensland and northern New South Wales production starts later and runs on to about September. Some production also exists in the coastal Dry Tropics region of Queensland.

Some north Queensland custard apples have been successfully exported to Singapore but returns have been comparative to or less than from the domestic market. At ambient temperatures the fruit has a relatively short post harvest life and QDPI is actively involved in a breeding programme aimed at producing a fruit with lower seed content, increased acidity and most importantly, - improved shelf life. Given the success of the latter eventuality we could see a marked increase in production in subtropical and tropical Australia for both domestic and export markets.

Grape

There has been a long standing industry in the Herberton district of north Queensland - both for table grapes and wine but production is virtually static due to increasing competition from warmer districts. The most recent innovation has been out of season production of Cardinal, Muscat Hamburg, Early Muscat and one or two other cultivars achieved near Townsville in the Dry Tropics. Production in the traditional market gap between July/August (end of cold stored grapes) and December has been proven and quality is satisfactory. The development has now attracted Australian and Japanese corporate investment. Areas of similar climate exist elsewhere in tropical areas of Queensland, Northern Territory and Western Australia and development for domestic and possibly export markets could increase substantially. Some confusion exists as to whether potassium nitrate or cyanamid is the best bud break stimulant following pruning.

Lychee

Lychee has become somewhat of a cinderella crop in Queensland and New South Wales but in many cases the handsome prince has failed to show up and deliver the glass slipper. Very substantial plantings have occurred in Queensland and northern New South Wales since the early 1970s.

Tree number estimates for Queensland in 1985 were:

Wet Tropics	25,000
Dry Tropics	25,000
Central	6,400
Burnett	18,000
North Moreton	93,000
Total	167,000

(Source: Other Fruits Sec. Group - COD)

QDPI projections for Queensland yield are 12,900 tonnes by 1995 however this may be unduly optimistic. Some cultivars heavily planted have proven to be unsuitable for a number of climatic regions (e.g. Tai So and Bengal in S. Queensland and northern NSW). The cultivar by climate interaction is extremely sensitive and despite a much improved understanding of the crop and better cultural advice grower disappointment is obvious in many districts. We are however coming to the situation where cultivar by site recommendations are now more appropriate.

Growers contemplating lychee growing in non traditional areas should research the cultivar/environment lessons from Queensland and NSW. Production in the Wet Tropics region is still increasing by virtue of overall young tree age, but new plantings have slowed. Only specific climatic areas have a successful cropping history. Cultivar introduction and screening is still progressing. Lychee exports have been very minor (only 21 and 38 tonnes in 1986/87 and 1987/88) (2),(3) mainly due to insufficient quantities of superior quality fruit.

Mango

Of the perennial tree crops, mango has probably shown the fastest growth in area planted in recent years. This trend is across all three States in the tropics although it has been most substantial in the Wet

and Dry Tropics of Queensland. (1,000 ha and 2,650 ha total area under crop respectively in 1988). Over 90% of plantings are still Kensington Pride cultivar (parthenocarpic seedlings) in Qld. although Keitt, Palmer, R₂E₂ and Kent cultivars are now significant.

With plantings increasing over a wider latitude, Kensington Pride is now available from September (NT and WA) to February (S. Qld. Northern NSW and Carnarvon) although the harvest peak is still December (N. Qld.). Other cultivars can extend the total mango marketing period from August to April. Kensington Pride is however not without its problems - it assumes excessive vegetative growth in some areas (e.g. coastal NT). It also has a relative short post harvest life and often exhibits the spongy stem end disorder if left on the tree past the mature green stage. It has however a flavour almost universally preferred by Australians and inhabitants of many overseas countries and presents an excellent flavour in juice and nectar preparations.

QDPI projects a Queensland harvest of 33,000 tonnes by 1995 based on current planting trends. If this quantity eventuates (in Queensland alone) then large scale fresh export and/or processing will be a necessity. Mango juice and nectar have been proven to have market opportunities, but the major Queensland processor has not been able to obtain sufficient fruit for adequate market promotion and penetration over the past two years due to lower than expected production and good domestic fresh fruit prices.

Mango exports have risen from virtually nil in 1977 to 1,027 tonnes in 1987/88, mainly to the Middle East and New Zealand (2). However, quarantine barriers prevent entry to some countries and Kensington Pride has as yet not proven its capacity to cool store by ship to Europe even in controlled atmosphere trials. However increased air freight capacity out of Australia is imminent and it may be the price restraint which will govern future export.

Papaw

Papaw is a crop with extraordinary potential for increased marketing in Australia if not overseas as well. However the potential will only be realized when the product offered is consistent in quality. Current production is almost wholly from open pollinated dioecious lines which are extremely variable in quality. Unfortunately the hermaphrodite lines from Hawaii are extremely environment sensitive and have cropping and quality problems due to cold (S.Qld.) and heat (N.Qld., NT and northern WA). However two approaches to producing cultivars in Queensland may provide a future for dioecious types. One is tissue culture which is at the field test stage. T.C. plant field performance is as good or better than seedlings in terms of growth and stability. The other technique is the male selection programme and production of F₁ hybrids.

Production in Queensland appears to be shifting from south to north - the Wet Tropics area has expanded to 95 hectares and is eclipsing Yarwun (Central Queensland) areas. NT production appears static or may even have decreased over the past two years. Both the NT and N.Qld. are capable of producing in the summer months of December to March when production from subtropical areas is at a low level and prices relatively good. There appears to be few limitations in finding adequate areas for increased production in tropical Australia. However pest and disease incidence appears to be increasing, - particularly the aerial form of Phytophthora palmivora. Export from Australia has increased over the years and achieved 50 tonnes in 1985/86, but is still very minor.

Pineapple

Pineapple production in tropical Australia is all for the fresh fruit market. Both Smooth Cayenne and Queen types are grown. In the case of north Queensland the industry now has virtually year round production which satisfies local markets and as well provides fruit in spring and early summer for southern markets. The largest production area is the Rollingstone/Mutarnee district in the Dry Tropics (5,650 t from 190 ha in 1988). Winter and spring fruit out of tropical Australia is decidedly sweeter than that from southern Queensland. However the southern market situation lacks promotion based on regional industry fruit quality superiority.

High temperatures presents problems for smooth Cayenne for summer flower induction (January to March) in coastal areas of north Queensland and the NT/WA areas. However recent research with paclobutrazol indicates treatment prior to induction with ethephon may provide satisfactory flowering and thus reduce the spring production gap. NT and WA production is obviously insufficient to meet local demand - particularly from Darwin. Potential for this and other markets down the west coast to Perth is substantial and it is somewhat of a mystery why a significant industry has not developed.

A small export trade out of Townsville to New Zealand exists. Total exports of fresh fruit from Australia have increased substantially in recent years from virtually nothing in 1975 to 1,100 t in 1986/87 (2).

Rambutan

Rambutan has emerged as a significant crop in north Queensland and the NT over the past five years although it is still very minor in terms of market value.

QDPI ran an importation and screening programme from 1975 to 1985 and subsequently recommended 9 out of some 50 odd cultivar introductions for the industry. Current planted area in N.Qld. is 110 ha and although not reported in NT, DPI & F figures, NT area may be in the order of 70 ha.

The crop has proved to be interesting in that whereas in the NT the main harvest season runs from October to December, the NQ season runs from December to August with a peak in February/March. Future research will look at ways and means of extending the volume of crop into the winter in NQ and no doubt the NT growers would be interested in producing earlier -preferably in the July to November period.

The product is ephemeral in terms of attractive post harvest life but research development has as in a similar case with lychees arrived at cling wrap type film covering in the pack which in conjunction with pre-cooling is providing adequate (but not the ultimately desirable) attractive post harvest life.

In Queensland, climatic limitations confine commercial production to areas north of Townsville.

Rockmelon (Including other melon types)

As in the case of watermelon, production of rockmelon and associated types has decreased slightly in north Queensland but increased markedly in the NT and northern WA in recent years. Rockmelon is the predominant type but Honey Dew production has increased substantially, particularly in the NT. Some 3,146 tonnes of rockmelon went interstate from the NT in 1988 and perhaps half that quantity from Kununurra also. The NT exported nearly 400 tonnes to Asia - mainly Singapore and Hong Kong in 1988. They expect a dramatic increase in export in 1988 following introduction of increased charter flights. Production capacity from the NT and the Ord Irrigation area is unlimited (Baker pers. comm.).

Watermelon

Production of watermelon in tropical Australia has been substantial - but historically mainly in winter and spring for southern markets. North Queensland production has decreased in recent years due both to virus diseases and increased competition from the NT and northern WA (1,340 and 2,000 t respectively in 1988). The market is reasonably finite in the winter months and future expansion may depend on export potential.

Other Minor Fruits

Low chill peaches and nectarines are produced on the Atherton Tablelands and some areas of the Dry Tropics and the main benefits are from early season marketing interstate, and, local markets. However the rapid increase in production throughout Queensland had dampened further expansion. Passionfruit, granadilla, and strawberry are also produced but the market appears finite except for some southern production gaps for passionfruit.

Of the tropics, durian, sapodilla, abiu, jackfruit, chempadek and black sapote are increasing in planted area, particularly in the Wet Tropics of Qld. and in the NT. There is an assured ethnic Asian market for these products but abiu in particular has potential for a very wide market. However the main problem remaining in development is the necessity to select and promote superior cultivars. Much of the present plantings are of seedling origin and product quality is unpredictable - as in the case of papaw. The market can be quite unforgiving when turned off by variable quality. A suitable analogy was the poor market appreciation of carambola before the 1970s cultivar introduction programme.

Cashew

Commercial cashew production in the Australian tropics has been postulated for many years (8), (11), but until recently no positive action has been taken mainly due to unknown yields, and the necessity to ship nuts overseas for processing. An economic assessment in the Northern Territory suggests that it would be necessary to achieve a peak yield of 5 tonnes per hectare and achieve a price of \$1.10 per kg nut in shell (NIS) in order to provide a satisfactory internal rate of return from a 100 ha cashew orchard (6).

Yields of that order and even greater in 5 year old trees have been achieved on a single tree basis from a number of selections in NT, DPI & F trials (Baker pers. comm.).

Commercial planting has started on three major developments -two at Kununurra and the other near Dimbulah in north Queensland. Suitable areas for extensive planting in all three northern states are available, but irrigation is probably essential. The main key to the success of the cashew industry will undoubtedly lie in adequate selection from a very diverse gene pool and, possibly breeding. The gene pool reserve in Australia is already substantial in terms of diversity of seed introduction and includes also Indian and Brazilian clones. Selections arising from a very diverse world wide seed collection planted at Kamerunga (QDPI) Cairns in the early 1970's are proving very promising in the NT. A major but perhaps temporary restraint to future low cost processing in Australia is the need as yet to design a mechanical process for removing the seed testa after dehusking.

Cashew is one crop with considerable potential for import substitution (2,164 t of kernel valued at \$20.7M imported in 1986-87 and yearly range is 2,100 to 3,250 tonnes) and hopefully, an excellent export opportunity. Annual world production now runs at round 350,000 tonnes.

Coffee

Current imports are about 30,000 tonnes per year (mainly as green bean) and the 1985-86 value was \$150M (3). About 40% of imports of coffee are arabica which is the main crop under consideration in Australia. This crop has an historical background - with substantial production in north Queensland and some other areas of Australia in the period 1890-1920. Higher labour costs for hand picking than in undeveloped countries was the principal reason for the industry demise. The development of a machine harvester in Brazil stimulated new arabica plantings in the Mareeba district of north Queensland in the late 1970s.

The two pioneers in the north Queensland industry have unfortunately suffered cash flow problems but there is continuing planting from other growers and, a substantial research programme involving QDPI, CSIRO and the NSW Dept. of Agriculture. The key to profitability in coffee is obviously achieving adequate yields and at least 2 tonnes per hectare per year of green bean is required (Hosegood pers. comm.). Until recently all Mareeba coffee has been planted on tobacco soils (light sandy loams derived from sandstones and granite) but these are difficult to manage in terms of irrigation and, maintenance of nutrient levels in the plant. Some new trials and commercial plantings are on kraznozems. Research is mainly in the areas of cultivar assessment, factors influencing concentrated flowering and subsequent maturity, and, selective maturity machine harvest. Total north Queensland area under crop is approximately 235 ha (mostly immature) and the 1988 yield was 110 tonnes.

Quality of Mareeba/Tableland coffee (350 to 500 m altitude) is adequate -although low in acidity, and there does not appear to be much difference to that produced on the wet coast.

At present arabica coffee planting is not being promoted by QDPI and investment risk is obvious until productivity is adequately demonstrated and, machine harvest is perfected. There may well be other areas in both tropical and subtropical Australia which have potential for arabica coffee. Small trial and commercial plantings exist along the east coast as far south as northern NSW.

Macadamia

Macadamia appears viable commercially only in elevated areas in tropical Australia. Under lowland conditions the tree flowers poorly and irregularly, although no comprehensive trialing has been attempted with a wide range of cultivars. The only areas planted are some 800 hectares on the Atherton Tableland in the Wet Tropics region. All plantings are between 350 and 800 metres altitude and yield figures to date indicate that areas above 450 metres may be most suitable. Plantings only commenced in the early 1980's but yields are encouraging - particularly with the cultivars 344, 258 and 660 (although nut size for the latter is less than desirable). A major trial encompassing 37 cultivars has been underway for five years and indications are that a number of new cultivars will surpass the existing ones recommended in terms of yield and acceptable kernel recovery. However, the crop is exacting in terms of its management requirements, including windbreaks, nutrition, irrigation and pest control and the break even point on investment is at least year 9. The Tableland crop is entirely mechanically harvested, but, cultivars 660 and 344 fall and require harvesting in March/April which can present problems in extended wet seasons.

Current prices are excellent at circa \$A4.00 per kilo nut-in-shell. Australian mean peak yields are less than Hawaii (2.5 t/ha compared with 5 t) but production is more seasonal in Australia and the terrain much more suitable for mechanical harvesting. It should be possible to select suitable areas outside the Atherton Tableland for production in the tropics although this may be limited to medium elevation (200 to 600 m) in the Dry Tropics of Queensland and odd frost free areas. The NT and northern WA are unlikely to have many areas climatically suitable for macadamia because of excessive temperatures. Australia produced some 982 tonnes of kernel in 1987 worth approximately \$10M (9) and will be producing circa 3,570 tonnes by 1993-1995 due to a large percentage of existing juvenile trees. Export demand is very substantial.

Tea

The tea industry has been established in the Wet Tropics Region of north Queensland since the 1950s. However it developed slowly until the late 1970s when prices rose substantially for a period. Whilst originally based only in the Nerada area near Innisfail the industry has expanded on to the southern end of the Atherton Tableland as well as north of Cairns. In 1978 the area under tea was only 150 ha but it has now expanded to 600 ha (Table 1) producing some 800 tonnes. The industry is highly mechanised in all operations.

Production is expected to increase dramatically over the next three years due to the extensive area of young plantings. All current plantings are in areas with mean rainfall exceeding 2,500 mm annually (some up to 3,800 mm) but irrigation in the drier spring and early summer months does provide an economic advantage. It is expected that plantings will continue to increase, but with a payback period of 9 to 17 years, the crop is not for the faint hearted. Additionally, prices are variable and since 1975 have ranged from \$1.10 to \$4.00 per kg. A new processing factory is due to open on the Atherton Tableland this year. Imports average about 30,000 tonnes per year and in 1985/86 imports of 21,000 t were valued at \$54M. Other areas in tropical Queensland are regarded as suitable for tea, including the coast down to Ingham and perhaps elevated areas behind Mackay (3). It is uncertain if there are suitable climatic areas in the NT and northern West Australia. Any plantings in those states would require substantial irrigation inputs.

Capsicum

This crop is of major importance in Queensland's Dry Tropics and the NT. Bowen and the Burdekin delta areas are the major producers (560 ha and 9,840 tonnes in 1987) and supply the winter and spring markets in the eastern states in particular. Production has also increased significantly in the NT and with increasing exports from Australia (1,050 tonnes in 1987/88 compared with 50 tonnes in 1976) production opportunity could further increase for northern areas.

Cucumber

Apart from local markets, cucumber production is mainly for the southern states winter and spring markets. Bowen and the Burdekin districts of Queensland are the main areas, totalling 9,300 tonnes from 520 hectares in 1987. NT and northern WA production is for both local and southern markets. Exports from Australia increased from 25 tonnes in 1983/84 to 480 tonnes in 1987/88 mainly as a result of New Zealand trade through CER.

Eggplant

Eggplant (aubergine) is a substantial crop in the Burdekin district of Queensland during winter. Production has risen from 700 to 800 tonnes per year in 1970-1972 to 2,100 tonnes in 1987. Australian exports, whilst small, rose from 5 tonnes in 1973 to 80 tonnes in 1986/87.

French Bean

French bean production is a significant crop in the Dry Tropics region of Queensland and with the advent of mechanised harvesting, winter production has increased dramatically. Production was from only 60 ha in 1984 but rose to 3,150 tonnes from 600 ha in 1987 (Table 3). The significant breakthrough has been in local invention of four-row tracked harvesters -each capable of 150 times the rate of hand picking. Traditional S.Qld. producing areas are suffering as a result of the northern development. There is export potential for *New Zealand* in particular. Australian exports rose from 25 tonnes in 1984/85 to 130 tonnes in 1986/87.

Onion

Onion production is only significant in the Mareeba and Atherton Tableland districts of Queensland (700 to 1,100 tonnes per year) but the area has potential because it fills a market gap due to the southern winter. Unfortunately the area does not suit the red types which have export potential. Some inland areas of the NT and WA could well have onion potential.

Potato

The main production areas in the tropics are the Atherton Tableland and Mareeba districts in Queensland's Wet Tropics. As is common with other vegetables, while supplying local markets the main volume of produce is for winter and spring southern markets. The main area of the crop is between 450 and 1,000 metres altitude. Production has risen steadily over the years and reached 24,900 tonnes from 1,075 hectares in 1988 (Table 2). Recently the yellow fleshed cultivar Deseree has been grown specifically for the Singapore/Malaysian market which has a market window between August and October due to a production gap in the Netherlands. Fortunately the cultivar is also acceptable in Australia and export differentials are easily absorbed. If quality is consistent the export market could widen (Kilpatrick pers. comm.) The Katherine district of the NT is also a traditional potato area - but is relatively small (circa 300 to 400 tonnes per year) and for local markets.

Pumpkin

Pumpkin covers all of Butternut, Queensland Blue, Jarrandale, Jap, Gamma, etc. but the principal varieties in tropical Australia are Butternut and Jarrandale. Production is mainly for southern winter and spring markets although local markets are significant. During 1988 there was a substantial downturn in

demand for Jarrandale and Queensland Blue although prices were held for Butternut. There may be a consumer swing away from large pumpkins which often have to be retailed as sections. However the major producer (the Dry Tropics of Queensland) marketed a total of 17,500 tonnes in 1987.

Sweet Corn

Again, sweet corn is grown in northern Australia mainly for the southern winter and spring market. The Bowen and Burdekin districts of the Dry Tropics produce approximately 3,400 tonnes. Unfortunately all processing (mainly freezing) is carried out in the south and it is unlikely that the tropics will achieve part of this action in the short term.

Tomato

Tomato is grown (principally in winter) in all states within the tropics and is important for the local markets. However, only the Bowen district in the Dry Tropics is responsible for major interstate trade. The crop in the latter area is invariably grown on the ground (not trellised as in southern Queensland production) but is sophisticated in terms of polythene mulch, drip irrigation, fertigation, etc. The Bowen industry has been under the restraint of *Fusarium wilt* (race 3) for the last 10 years but a successful breeding programme has now produced market acceptable varieties complete with resistance. The 1987 crop was 42,000 tonnes from 2,100 hectares. Due to proximity of Bundaberg to the export terminals and the fact that the latter has a trellised crop, it has captured the winter export market to New Zealand rather than Bowen. Queensland exported 1,090 tonnes of tomatoes in 1987/88. Sixty per cent of this went to Singapore and Malaysia.

Zucchini and Squash

Zucchini has developed into a major winter and spring crop in tropical Australia but principally in the Dry Tropics of Queensland and Darwin districts. Problems with zucchini yellow mosaic virus and watermelon mosaic virus are increasing in Queensland growing areas.

New Zealand has recently placed an embargo on some cucurbits from north Queensland due to fruit fly interceptions.

Cut Flowers, Foliage and Ornamentals

The Australian tropics have not traditionally been a source of cut flowers except for local markets. However, the Wet Tropics region of Queensland has shown substantial growth in the past five years - with roses, chrysanthemums, carnations etc. on the Atherton Tableland and heliconias, anthuriums and cut foliage on the coast. Heliconias look set to be a major cut flower resource and new cultivars (many with good vase life) are continually being imported. They are already traded interstate in substantial volume.

Even more dramatic than heliconias though is the increase in potted foliage plant sales to southern Queensland and interstate. Principal interest is in palms, dieffenbachia, and aeglonema. There is also a very substantial increase in in-ground advanced nursery stock, but mainly for local sales.

The situation in other centres in the northern Australian tropics is not as dynamic as the Wet Tropics, but Darwin also has a significant potted plant interstate trade. Little cut flower and ornamental nursery material has been exported as yet and the distance to European and USA markets is a major limitation.

Table 1. Crop statistics. Wet tropics - Queensland 1978-1988. Fruit, Nuts and Beverage Crops

Crop	1978		1983		1988		1988 Value M\$
	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	
Abiu			1		4	5	
Avocado	70	23	210	840	370	2,400	3.8
Banana	1,300	40,000	2,400	66,560	3,839	113,000	95.8
Custard apple	2		7	8	23	55	0.1
Caimito			2		10	35	
Carambola			2		6	40	
Citrus:							
Lemon	)	)		15	400)	
Mandarin	)	)			30	75)
Orange	)	810	45	912	30	720	) 0.8
Tangelo	)	)			17	18)
Pummelo	)	)			3	10)
Lime	)	)			2	2)
Cashew	2	-	5	2	145	2	
Coffee			200		235	110	0.6
Durian			2		9	1	
Grape	50	110	50	350	70	350	
Jack Fruit			2	16	10	80	
Longan			3		6	2	
Lychee	58	32	98	90	300	185	1.0
Mango	31	105	260	385	1,000	2,600	4.8
Macadamia	3		400	10	800	120	0.4
Mangosteen			20		45	1	
Misc. Trop Fruits			5		20	40	
Papaw	20	280	18	390	95	2,200	2.4
Passionfruit	2	26	5	60	10	130	
Pecan	3		5		10		
Peach and Nectarine	2		20	54	38	130	
Pineapple	40	970	45	1,265	97	2,200	1.3
Rambutan			20	2	110	22	
Strawberry	3	20	3	20	5	30	
Watermelon	480	7,900	400	6,000	100	2,300	0.6
Tea	150	250	300	500	600	800	

Source: QDPI.

N.B. Figures omitted are unknown.

N.B. Many of the tree crops are new plantings hence low production figures.

Table 2. Crop statistics. Wet tropics - Queensland 1978-1988. Vegetables and ornamentals

Crop	1978		1983		1988		1988 Value M\$
	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	
Capsicum	60	228	14	70	12	72	0.1
Crucifers	60	825	20	400	10	200	
Choko	4	80	4	80	6	120	
Cucumber	82	630	18	250	20	200	
French Bean	12	32			15	35	
Lettuce	12	224	8	216	0.5	15	
Onion			38	1,095	40	720	
Potato			750	16,000	1,075	24,900	
Pumpkin	360	6,480	700	15,000	380	6,000	0.7
Sweet Potato	15	450	36	600	70	1,300	1.3
Taro	2	10	2	10	8	30	
Tomato			64	900	30	200	1.2
Cut flowers and foliage	10		10		50		3.3
Ornamental and Fruit							
Tree Nurseries	30		60		90		18.5
Aloe Vera	-		5		20		

Source: QDPI
N.B. Figures omitted are unknown.

Table 3. Crop statistics. Dry tropics - Queensland 1987. Fruit, vegetables and ornamentals

Crop	1987 Area (ha)	1987 Production (t)	1987 Value M\$
Avocado	22	130	0.2
Banana	22	600	0.6
Citrus	35	620	0.6
Grape	74	200	0.9
Lychee	220	90	0.45
Mango	2,650	13,100	20.7
Pineapple	190	5,650	2.8
Rockmelon	800	11,200	11.0
Watermelon	550	9,700	1.45
Beans (French)	600	3,150	?
Capsicum and chilli	560	9,840	9.0
Cucumber	520	9,300	8.0
Eggplant	300	2,100	2.1
Pumpkin	900	17,500	1.4
Sweet Corn	475	3,390	4.9
Tomato	2,100	42,000	33.6
Zucchini and squash	220	3,500	3.85
Bean seed	500	300	
Ornamentals			
	1987	1987	1987
Tomato (t)	20,100	33,200	42,000

Source: QDPI

Table 4. Crop statistics. Northern Territory 1978-1988. Fruit vegetables and ornamentals

Crop	1978		1984		1988		1988 Value M\$
	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	
Banana	12		27	300	45	814	0.75
Carambola				0.2		3	0.01
Jackfruit				1.0		10	0.02
Mango	8		180	84	600	1,000	3.5
Melon green		)		83)		40	0.05
Melon Hami		)		)		62	0.07
Melon H.Dew		)	76	136)	280	485	0.48
Melon Snow))			
Chara						26	0.03
Melon Rock				890		3,778	4.18
Melon Water				459		1,342	0.41
Papaw				37		11	0.01
Pineapple				9		64	0.04
Bean (French)		50		48			
Bitter Gourd						24	0.05
Cabbage		130		100		110	0.08
Capsicum		13		56		210	0.4
Chinese vegetable						75	0.16
Cucumber		80		90		190	0.16
Lettuce		44		200		300	0.3
Potato		180		340			
Pumpkin		34		160		950	0.6
Sweet Potato		16					
Tomato		302		160		200	0.3
Zucchini		13		70		137	0.2

N.B. Figures omitted are those not available. A number of crops with small areas or small production are not included. Alice Springs area figures are deleted and in the process some errors may have occurred thus above figures for applicable crops should be regarded as approximate only.

Source: NT - DPI & F.

Table 5. Crop statistics. Ord River irrigation area - Western Australian 1978-1988. Fruit and vegetables

Crop	1978		1983		1988		1988 Value M\$
	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	Area (ha)	Prod. (t)	
Banana	2		6		140	4,000	3.38
Mango	-		15		80	71	0.28
Rockmelon	-		143		180	2,700	3.32
Watermelon	-		41		100	2,000	0.66
Cucumber	-		9		10	200	0.22
Pumpkin	-		103		70	700	0.3

* N.B. All area figures are for area harvested. Source: Western Australian Department of Agriculture.

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