

**RAMBUTAN PRODUCTION IN THE NT TOP END
AN AGRONOMIC AND ECONOMIC EVALUATION**

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SUSTAINABLE AGRICULTURE

THE DEPARTMENT OF PRIMARY INDUSTRY AND FISHERIES IS COMMITTED TO THE PRINCIPLES AND PRACTICES OF SUSTAINABLE AGRICULTURE

Sustainable agriculture is the use of agricultural practices and systems which maintain or enhance:

- . the economic viability of agricultural production;
- . the natural resource base; and
- . other ecosystems which are influenced by agricultural activities.

Principles:

1. Agricultural productivity is sustained or enhanced over the long term.
2. Adverse impacts on the natural resource base of agriculture and associated ecosystems are ameliorated, minimised or avoided.
3. Harmful residues resulting from the use of chemicals in agriculture are minimised.
4. The net social benefit (in both \$ and non \$ terms) derived from agriculture is maximised.
5. Agricultural systems are sufficiently flexible to manage risks associated with the vagaries of climate and markets.

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SUMMARY

This paper aims to provide basic agronomic and economic data on rambutan for those who wish to consider this new crop in the Northern Territory. The orchard size selected in the study is 5 ha which is considered suitable for a one-person operation with casual labour for picking and packing.

The general financial prospect of rambutan production in the NT has been found to be very promising if a yield of more than 15t/ha (75kg/tree) can be achieved; and a wholesale southern market price of from \$4 to \$6/kg can be maintained in the future. At the above mentioned yields and prices which are considered to be achievable and realistic, the financial internal rate of return (IRR) ranges from 13.40% (using air transport - \$1.00/kg) to 20.54% (road transport \$0.30/kg). Gross profit (before tax and financing costs) for such a project is estimated to be from \$73,000 (using air transport) to \$117,000 (road transport) per year. Factors which need further investigations include the technical feasibility of using road freight to southern markets and the efficiency of post harvest handling and packing rate which appear to have significant impacts on the overall profitability of the crop.

The total capital investment required for a 5 hectare rambutan orchard (to maturity) is estimated to be about \$278,000 including :

- capital costs such as land, housing costs, packing shed and a small cool room.
- planting and maintaining of the orchard to maturity.

Peak debt at \$278,640 (assuming no borrowing) occurs in year 4. The pay back period for the total capital investment (assuming no external borrowing) is about 7 years.

At a medium yield of 15t/ha, the break-even price is \$3.69 (using air transport) and \$2.99 (road transport).

I. INTRODUCTION

Rambutan (*Nephelium lappaceum*) is a tropical fruit tree which originates from Malaysia. It is now widely grown in South East Asia as well as other tropical parts of the world, including Australia. The tree is a member of the Sapindaceae family and is related to the lychee and longan. The rambutan derived its name from the Malay word "rambut", meaning hair, referring to the hairy fruit.

In Australia, rambutan production is restricted to tropical areas of Far North Queensland and areas around Darwin in the Northern Territory. [ABS statistics indicate a total of over 6400 trees planted by the end of 1987. At 200 trees/ha, this represents about 32 ha in area. Over 90% of the trees planted are under 6 years old]. Plantings have increased rapidly over the last few years and estimates of plantings are well above the 1987 date.

The fruit has attractive appearance with colour ranging from yellow to red and pink. The edible portion of the fruit, called the aril, is pearl white and surrounds a single seed. The fruit's market attractiveness and its popularity in South East Asia have created market opportunities in Australia among the local Asian population. Increased interest in new fruits in Australian has also created market demand for quality exotic fruits such as rambutan.

The production period in the NT is from November to December, outside North Queensland's supply period of February to May and the major South East Asian production period of June/July. Some areas of Indonesia produce at a similar time to the NT and North Queensland. On the other hand, NT rambutan production occurs at a time of heavy supply of other fruits such as new season deciduous crops (peaches, plums, apricots) and other fruits such as mango (Queensland) and lychees. These may be significant competitors for rambutan.

In terms of labour requirements and the utilization of other facilities, the NT rambutan season is in November/December, therefore, the NT rambutan season in the Top End complements the mango production harvest season, which is mainly October/November.

II. AGRONOMIC ASPECTS

2.1 Varieties

A large introduction program has seen most of the good varieties from Indonesia, Malaysia, Singapore and Thailand planted in Australia. These are being evaluated by scientists, farmers and the market. It will be some years before definite varietal recommendations will be reached. Currently, the varieties Jitlee, R134, Binjai, R156 (red) and R167 appear the most adaptable though other varieties are also acceptable (eg. Gulah Batu, Rongrien, Chompoo, Lebak Bulus, Bogor, R9, R7, R162).

Characteristics of a good variety will include :

- . Consistent high yields of at least 15t/ha,
- . Good size (40g) attractive fruit preferably red with the flesh peeling free of the seed with little seed coat adhering,
- . Early maturity to avoid competition from other fruits.

2.2 Propagation

Rambutan should be vegetatively propagated for commercial plantings to minimize quality variation and to produce fruit at a younger age. Seedling trees are highly variable in yield and quality, have a high percentage of non-producing male trees and many not start producing until year 5 or 6.

Clonal varieties are propagated by budding or approach grafting. Budding is more technically difficult but is a more rapid system of multiplication. Approach grafting is easy and very reliable but difficult to manage on a large scale. A separate DPIF Agnote (No. 377) describes propagation methods for rambutan. There are no recognized rambutan rootstocks. Rambutan seeds have short viability (2 weeks) and seeds (including fruit for seeds) should not be cold stored.

2.3 Site Selection and Development

Rambutans require deep (1m), well drained soils not subject to flooding. Sandy soils are the most common though heavier soils closer to lagoons may prove better, provided trafficability is maintained throughout the year. They have high water requirements and a good water supply is essential. They are sensitive to cold and are unlikely to be adapted to areas south of Adelaide River. Some tree damage (heavy leaf fall) and loss of young trees have occurred in the NT in some years due to cool temperatures. Dry season winds can be damaging to young trees especially at flowering. Wind protected sites are preferred or windbreaks should be established. Artificial windbreaks are quick

and easy to establish but expensive. Natural windbreaks commonly make use of bana grass every 40m, effective for the first four years and taller trees (mango, jackfruit, natives - *Acacia manjium*) every 70-80m for mature orchards. These are planted at the same time as the rambutans and, provided with irrigation and fertilizers, will protect the orchard for the whole of its life. The taller trees need to be at least 10m from the first rambutan row to avoid competition.

A number of tree spacings are being tried by different producers. For commercial orchards, where access by tractors for slashing and spraying is essential, row spacings in the range of 8-10m should be selected. In-row spacings are more difficult to select. Spacings in the range of 5-8m are adequate. At 5m spacings, early yields will be high, maximizing returns when prices are also high. At this spacing, trees will grow into each other by year 5 and a decision will have to be made to thin out or to maintain a hedgerow. It is not clear if rambutans can withstand pruning to a hedgerow though current indications are favorable.

Prior to planting it is preferable to rip the tree rows for good root development. Irrigation systems must be established with laterals at least 1m from the tree row. Trees can be planted any time of the year but planting just prior to the wet season (October-December) is preferred. Fertilizer can be applied in the planting hole (mixed with soil in the bottom of the hole) at the rates of 100-200g dolomite and 100-200g of single superphosphate. Slow release tree pellets applied halfway up the planting hole can aid early growth. Trees can be planted in variety blocks (with a field label and a plan) as there does not appear to be a need for pollinators (except for female varieties such as Chompoo, Rongrien, Semtjaan). If trees need to be staked, wire threaded through poly-pipe and tied in a figure "8" around the tree and stake (one at the top and one half way down) is the strongest and safest method.

Mulching with any organic material (eg. hay, prunings, slashings from inter-rows, shredded newspaper) assists early establishment particularly during the dry season. Mulching assists weed control, reduces the chance of damage to young trees from herbicides, improves water use, improves nutrition and provides organic matter creating a good environment for roots.

Trees need to be irrigated immediately after planting to settle the disturbed soil. The initial watering can be up to 24 hours or longer if the soil was dry at planting (eg at the end of the dry season). In the first year, the spinner is usually removed from under tree sprinklers and trees should be watered daily for about 0.5 hours per day. The first fertilizer application should be one month after planting at 50-100g/tree of a complete fertilizer.

Rambutans establish slowly in the first year. Care should be taken not to over-fertilize. Young trees are easily damaged by heavy application of manures (use at 2kg/sq.m.). Some training is necessary in the early years, particularly on straggly varieties such as Gulah Batu and Rongrien. Trees should be pruned to force branching at 1m height and subsequent branches cut back at 1m length to establish a well rounded tree. Weak shoots or acute angles or branches growing back inside the tree or crossing over should be removed.

2.4 Irrigation and Nutrition

Rambutans are not as easy to grow as other tree crops such as mango. Errors in management result in major setbacks to the tree. Good early establishment and subsequent management of irrigation and nutrition lead to good health.

Rambutans appear to require frequent irrigations, every one or two days. Peak water requirement for a mature orchard is around 250,000 litres/ha/week when the canopy reaches full capacity. A rule of thumb is 320L/tree/week per year of age i.e. a 3 year old tree receives 960L/week. In some weeks of high evaporation eg. high winds in October, irrigation rates may be 20% higher. Mulching assists water use. Irrigation may have to be maintained throughout the wet season. Periodically, trees should be given a larger irrigation to ensure the rooting zone is fully wet (eg. during the dry season). Irrigation systems are usually based on approximately 80L/hr under tree sprinklers. Sprinklers require constant maintenance particularly if filtration is poor. Where bore supplies have high bicarbonate levels, it may be necessary to inject acid.

Rambutans are heavy feeders. Frequent light applications year round are preferable eg. fertilizer injection of nutrients. For young trees, fertilizer use is greatest in the wet season and least in the dry season when trees are not growing. Bearing trees have a high nutrient requirement over fruit growing (August-November) and post harvest flushing (November-February). Fertilizer application can be reduced in the months prior to flowering (March-July).

Table 1 : Approximate Monthly Rates of Fertilizer Application for Complete Mix and Injected Fertilizers on Bearing and Non-bearing Trees.

Fertilizer Types	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
Complete Mix (1)													
Non-bearing Trees	125	125	75	75	75	50	50	75	75	75	100	100	1,000
Bearing Trees	125	75	75	50	50	50	50	100	100	100	100	125	1,000
Injected Fertilizer (2)													
Non-bearing													
Urea	6	6	4	4	4	2	2	4	4	4	6	6	208
Potassium nitrate	9	9	6	6	6	3	3	6	6	6	9	9	312
Bearing													
Urea	6	4	4	2	2	2	2	6	6	6	6	6	208
Potassium nitrate	9	6	6	3	3	3	3	9	9	9	9	9	312

(1) g/tree/month/yr of age

(2) g/tree/wk/yr of age

Rambutans appear to have a low phosphorous requirement. A mixed fertilizer in the approximate ratio of 10:2:10 N:P:K is suitable, preferably with added trace elements. A general rule of thumb for rate of application is 1kg/tree/year of age i.e. a 3 year old tree receives 3kg annually of 10:2:10 split into monthly applications. Superphosphate and dolomite are optional additional fertilizers applied in one application per year (early wet season November-December) at rates of 50-70g/sq.m and 100-200g/sq.m of under tree area respectively.

The continual requirement for nutrition can be met more accurately by fertilizer injection into the irrigation system. Urea and potassium nitrate are used at weekly rates of 4-6g/tree per year of age respectively for a total annual application of 200g urea and 300g potassium nitrate. These rates can be adjusted accordingly for less frequent applications (eg. fortnightly at 8g and 12g).

Fertilizer applications should be distributed throughout the year as described in Table 1.

In the NT, a number of micro-nutrient deficiencies occur. Regular applications of foliar zinc (zinc sulphate heptahydrate) at 2-4g/litre, 3-4 times a year are necessary. This is generally compatible with

most agricultural chemicals. Zinc can be soil applied using zinc sulphate mono-hydrate at 5g/sq.m but is readily leached. Iron deficiencies are common and iron chelate should be soil applied at 2g/sq.m, 3 or 4 times a year. Young trees require more frequent applications to correct deficiencies. Symptoms occur in the new young leaves. Leaf yellowing, necrotic (dying/black) spots, short internodes are symptoms of zinc and iron deficiencies. Other minor elements that can be deficient are magnesium and boron. Boron levels are generally low and can be corrected with 2-3 foliar sprays per year at 2g/litre of Solubor. Magnesium deficiency causes old leaves to fall and trees are light green in color. Good responses are obtained to foliar sprays of magnesium sulphate at 10-15g/litre. The addition of 5g/litre low biuret urea (0.4% biuret) and 10g/litre potassium nitrate to foliar sprays can assist uptake. Annual applications of dolomite improve magnesium nutrition.

2.5 Insect/Pest Control

Most of the pest problems in rambutan are caused by insects. Diseases currently cause relatively minor problems. Flying foxes and birds can cause large losses at harvest.

The two most serious insect pests are mealy bugs and loopers. Loopers are caterpillars that eat fresh new shoot growth and flowers and bore into young fruit. Leaf damage coincides with the time of new flush growth. A number of species attack new flush growth, which can be completely destroyed. Most are easily controlled with timely pesticide applications coinciding with the time of the new growth. If the damage occurs just before the resting phase prior to flowering, a new flush can be stimulated reducing the chance of good flowering. Flower damage is caused by one species which is small and difficult to detect. It is usually characterized by webbing of the flowers. This same species can attack young fruit and bore into larger fruit. It can be difficult to control as it may inhabit the closed area between 2 fruit or enclose itself in a web in the flowers. Control at flowering is complicated by the need to protect pollinators (mainly flies, wasps and bees). Most pesticides are harmful to pollinators. Excessive pesticide use during flowering when insects are active should be avoided. Spraying should be done in the late afternoon or evening.

Mealybug is primarily a pest in fruit where it causes cosmetic damage making fruit less marketable. It can also cause distortion or curling of new growth, particularly in nurseries. Mealybugs become more prominent at flowering as ants become more active, collecting and also spreading mealybugs. Good ant control from the period just prior to flowering can help stop the spread of mealybug. Once fruits are infected control can be difficult. There is a biological control agent available but its effectiveness in the NT is unknown. Any insecticide control program should be based on ant control and control of mealybug. Spraying for mealybug during flowering requires similar precautions as for loopers.

Ants cause problems, mainly because they spread mealybug. Some ants eat the margins of leaves and probably cause some flower damage eg. meat ants. They are a severe problem where a regular insect control program is not used. This is the most effective control program. Tree banding, ground spraying, baiting or treating nests all help to reduce ant populations particularly just prior to and during flowering and during fruit development.

Mites can cause growth checks particularly in nursery stock. Symptoms are roughening of the leaf (like sand paper) or mottling. Control can be difficult depending on the mite species. Mite resistance builds up rapidly and pesticides need to be used carefully. Predacious mites are available and can be effective as a control for some species, particularly in nurseries.

Thrips do attack rambutan but attacks are not as severe as in mango and rambutan damage is usually confined to leaves. Scale insects are not yet regarded as causing significant damage. Fruit piercing moth

will attack late maturing fruit. The puncture mark allows other pests to enter (including diseases) making fruit unmarketable. Fruit spotting bug has caused cosmetic damage to fruit skins in Queensland, particularly noticeable on yellow varieties. Some shoots can also be deformed by fruit spotting bug. Swarming beetles can rapidly cause severe damage to young shoots and leaves. They are more prominent in the wet season but can also appear at flowering time, attacking new flower growth.

There are no registered chemicals for use on rambutans so no chemicals can be recommended. The only guides to chemical use are experience, and control of similar pests in other fruit crops.

Control of birds and flying foxes is difficult. Experience with electric fences in other crops has been useful, particularly where the first few scouts are removed. Netting is an effective control but is very expensive and creates some management problems.

2.6. Post-Harvest Handling

The post-harvest handling of rambutan is demanding. Rambutans have a short life of 10-11 days using current technology. The labour requirements for handling are high.

The main cause of the short life is a rapid decline in appearance due to the blackening of the soft spines and eventually the whole skin. Flesh eating quality remains high for a longer period. The loss of colour is due to loss of moisture (particularly at high temperature) and fungal rot. Breakage of spines during handling accentuates both losses.

The major methods to reduce losses are :

- . Speedy handling and marketing
- . Cooling to 7-10 C degrees at high humidity
- . Packaging to reduce moisture loss

Fruit are harvested when Brix levels (measured with a refractometer) reach 18-20 degrees. This is usually a few weeks after fruit turn red. Holding the fruit on the tree for too long can lead to blackening of the spines on the tree. To keep fruit cool and moist, harvesting is preferably done in the morning. Picked crates should be left in the shade, cooled down with water sprays and moved to the shed as quickly as possible. Usually whole panicles or bunches of fruit are harvested. However for early, high prices individual fruit can be harvested but this is very labour intensive. Bunches can be cut at 15-20 cm from the flower stalk to prune the tree.

Fruit are destalked off the bunches to be sorted. A destalking machine has been developed for lychees which may be modified for rambutans.

Sorting is an important step for top quality presentation, but is time consuming. Preliminary sorting should be done during harvesting and destalking. Sorting is done to remove damaged and marked fruit and for variation in size and colour. Varieties are not as important as in other crops and can be mixed but they do differ in size, colour and shape and should be kept separate as far as possible. Varieties also differ in the drying out of spines. Fruit spotting bugs and mealy bugs cause most marks. Light coloured or yellow varieties show marks more clearly.

Packing systems will change as markets develop and prices change. The current standard is a 2.5 kg single layer tray. Fruit are packed in rows stem-end down, with a liner to maintain humidity, similar to the 2.5kg lychee bag. This is an expensive pack appropriate to current high prices. Other forms of packaging include:

- . a 3-4kg double layer carton packed in rows with a liner
- . bulk filled lychee bags
- . punnet pre packs.

The bulk-filled lychee bag is filled then turned over to present an even pack. Fruit should preferably be retailed out of the bags. Punnet pre-packs give the best presentation to prevent blackening of spines through the whole marketing chain from wholesalers to retailers and consumers. Much of the deterioration in appearance occurs in retail shops at the end of the market chain. Humidity in an air-conditioned shop is usually low. Markets have not accepted punnet pre-packs as cost per unit is high.

Presentation efforts by the grower will be rewarded while rambutans remain a high priced exotic fruit. Presentation can include the following:

- . design and printing of carton
- . in-store displays eg. lift ups and cut outs in cartons
- . in-carton pamphlets
- . large stickers for liners or bags
- . printed liners and bags

There are no major quarantine restrictions on inter-state marketing of rambutans except to Western Australia for which fruit should be dipped in dimethoate under quarantine supervision. It is advisable to check with Quarantine for changes in inter-state requirements.

Fast cooling is crucial to maintaining appearance. Fruit should be cooled to 7-10 C degrees quickly in a high humidity cool room. The main way to achieve this is by forced air cooling of packed cartons. Liners and bags will increase cooling times to 12-24 hours. Other means to assist cooling include:

- . early morning harvest
- . speed from harvest to packaging and cooling
- . water sprays prior to cooling and during harvesting and packaging
- . hydro-cooling prior to storage in the handling chain.

While prices are high, fruit can be air freighted. Provided fruit are moved quickly, air freighted fruit may not require cooling. In the longer term, as prices drop and consignments increase in volume, road freighting in refrigerated trucks will be used, necessitating cooling.

Post-harvest equipment needs for rambutan are undeveloped. While individual farm volumes are small, all that is required is a sorting table, harvesting equipment, and an area for carton assembling, set up in an efficient manner. Dip tanks, destalking machines and size graders will develop as post-harvest treatments develop and market requirements change.

New methods to increase life are being developed, particularly by Queensland Department of Primary Industries. These include fungicide dips, refining storage temperatures, new liners, pre-cooling times and other systems to improve out-turn.

III. MARKET PROSPECTS

Rambutan is expected to have high market acceptability in Australia due to its attractive appearance and its similarity to the well-known lychees. It is already familiar among the ethnic population of Asian origin. It is felt that with some systematic market promotion and a declining price in the long term, its

demand and popularity will be enhanced. As mentioned earlier, the NT rambutan season is mainly from November to December whereas the Queensland rambutan production starts from February to May. Therefore, NT and Queensland rambutan production tend to complement, rather than compete with each other. On the other hand, NT production occurs at a time of surplus of other fruits especially new season deciduous crops (peaches, plums, apricots) and other fruits such as mango (Queensland) and lychees. These may be significant competitors for rambutan.

With regard to export prospects, Australian rambutan, being an off-season fruit, has export potential to some South East Asian markets, particularly Hong Kong.

Rambutan prices at the Brisbane fruit and vegetable market ranged from \$8 to \$12/kg during 1988 and 1989 season. Retail price of rambutan in the NT during the 1989 season was from over \$20/kg to about \$14/kg during the end of the season. Long term prices of rambutan are expected to decline with increasing supply as planted trees come into full production. For budgeting purposes, three long term price scenarios ranging from \$6 to \$4/kg were used in this assessment.

IV. ECONOMIC ANALYSIS

4.1 METHOD OF ANALYSIS

The assessment of the profitability of rambutan production is based on the whole farm budgets for a 5 hectare orchard unit. A 5 ha unit is considered to be easily worked by an owner/operator without too much reliance on outside hired labour, except during harvesting and packing. The 5 ha model can also be used as a rough 'cost base' for larger planting units of multiples of 5 ha. such as 10, 15 and 20 ha if required. Larger units enjoy the benefit of economy of scale, therefore better rates of return can be expected. Financial indicators such as internal rates of return (IRR), net farm income (NFI), pay back period and break-even prices are used to determine the level of profitability.

Definition of financial terms used in the report is as follows :

Internal rate of return (IRR) is defined as the maximum interest rate that a project can pay for the resources used if the project is to recover its investment and just break even. It can be used as a comparison with real interest rates (i.e. after inflation) offered by other investment opportunities such as long term Government bonds, long term/fixed deposits.

Net Farm Income (NFI) is defined as the net income before tax and financial or borrowing expenses are taken into account.

Pay-back period is the minimum time needed to recover the total investment in the project. No financing costs are taken into account in the analysis.

Break-even-price is the minimum long-term-price which will enable the project to just cover all operating and fixed costs.

Major assumptions used in the analysis are given in Section 4.2.

Input prices used are in 1989 terms, as quoted by suppliers in the NT. These prices have been kept constant throughout the projected cashflow period. Results of the analysis therefore are in constant or real terms with no inflation effects taken into account. Rambutan sale prices, on the other hand, have been projected to decline in real terms to allow for possible price reductions in the future due to the expected increased supply as planted trees mature.

4.2 MAJOR ASSUMPTIONS

4.2.1 Capital Costs

Major capital items are the cost of land, house, irrigation system, tractors and implements required for weed, insect/pest/disease control, establishment costs, post harvest treatment and cold storage facilities. The cost of the irrigation was estimated by Irri-Tec, Darwin. Machinery prices were provided by Agserv Industries, Darwin. Details are given in Appendix 6. For existing producers, some capital costs such as land or housing may not be applicable. However, for investment analysis purposes, the costs of these should be taken into account.

4.2.2 Establishment Cost

The establishment cost includes items such as land clearing, pre-planting preparation, planting materials and the actual cost of planting. At 10m x 5m spacing, the total establishment cost is estimated at approximately \$3,500 per ha. Planting materials at \$15/plant account for most of the field establishment costs.

Mango trees, planted at 10m apart and at 80m row spacings are assumed to be used as windbreaks. The cost of establishment of roughly 80 trees (or 0.8ha) has been allowed for in the budget.

4.2.3 Field Maintenance

This includes cost items such as annual irrigation, weed and insect/disease control, fertilizer application and pruning/shape control. Maintenance costs in the early years increase steadily until year 4, then stabilize from year 5 onwards as trees mature. Physical inputs per hectare, per tree and costs are summarized in Appendix 3. Annual costs at year 6 and after are as follows:

	\$/5ha	\$/ha
Weed control	724	144.80
Insect/Disease control	1,728	345.60
Fertilizer application	4,154	830.80
Irrigation	4,123	825.00
Pruning	500	100.00
Fire-break discing	50	10.00
Slashing	166	33.20
Sundries	519	103.80
Total annual maintenance costs	11,964	2,393.2

Mango trees used for windbreaks are assumed to be irrigated, fertilized and maintained in a similar fashion with rambutan.

4.2.4 Fixed Costs

These include fixed costs such as accounting/book keeping, insurance, registration, telephone, rates and other sundries. Details are shown in Appendix 8.

4.2.5 Yields

Field trials in the Northern Territory and north Queensland show that well grown clonal trees would normally start fruiting about 3 years after planting. In Queensland, yields of up to 24t/ha (120kg/tree at 200trees/ha) at the age of 5/6 years old have been recorded. For budgeting purposes, three yield levels are assumed as shown in Table 2.

Table 2: Rambutan Yields (t/ha)

Year	High	Medium	Low
1	-	-	-
2	-	-	-
3	2.40	2.00	1.50
4	7.20	6.00	4.50
5	12.00	10.00	7.50
6 & after	18.00	15.00	11.25

These yields are illustrated in Figure 1.

4.2.6 Harvesting costs

All harvesting is assumed to be done by casual labor and is based on a rate of 80kg of fruit per hour at \$10/hour.

4.2.7 Post-harvest Handling and Packing Costs

This includes costs of separation of the individual fruit from the whole bunches, cleaning, post-harvest treatments, grading, packing and cold storage. A post harvest handling and packing rate ranging from 9kg/hr (3.6 trays/hr) to 15kg/hr (6trays/hr) has been assumed in the sensitivity analysis.

4.2.8 Marketing Costs

It is assumed that most of the rambutan would be sold in wholesale southern markets. Marketing costs include:

- . transport costs by refrigerated trucks at \$300/tonne or \$1,000/tonne by air.
- . agent's commission of 15% of gross sale.

4.3 SUMMARY OF RESULTS

Cash flow budgets for three yield levels, ranging from 11t/ha, 15t/ha to 18t/ha have been estimated (Figure 2). The following are the main findings of the analysis.

4.3.1 Break-even prices at various yield and price levels range from \$2.88/kg to \$3.91/kg, depending on mode of transport. These are summarized in Table 3.

FIGURE 1: PROJECTED RAMBUTAN YIELDS (t/ha)

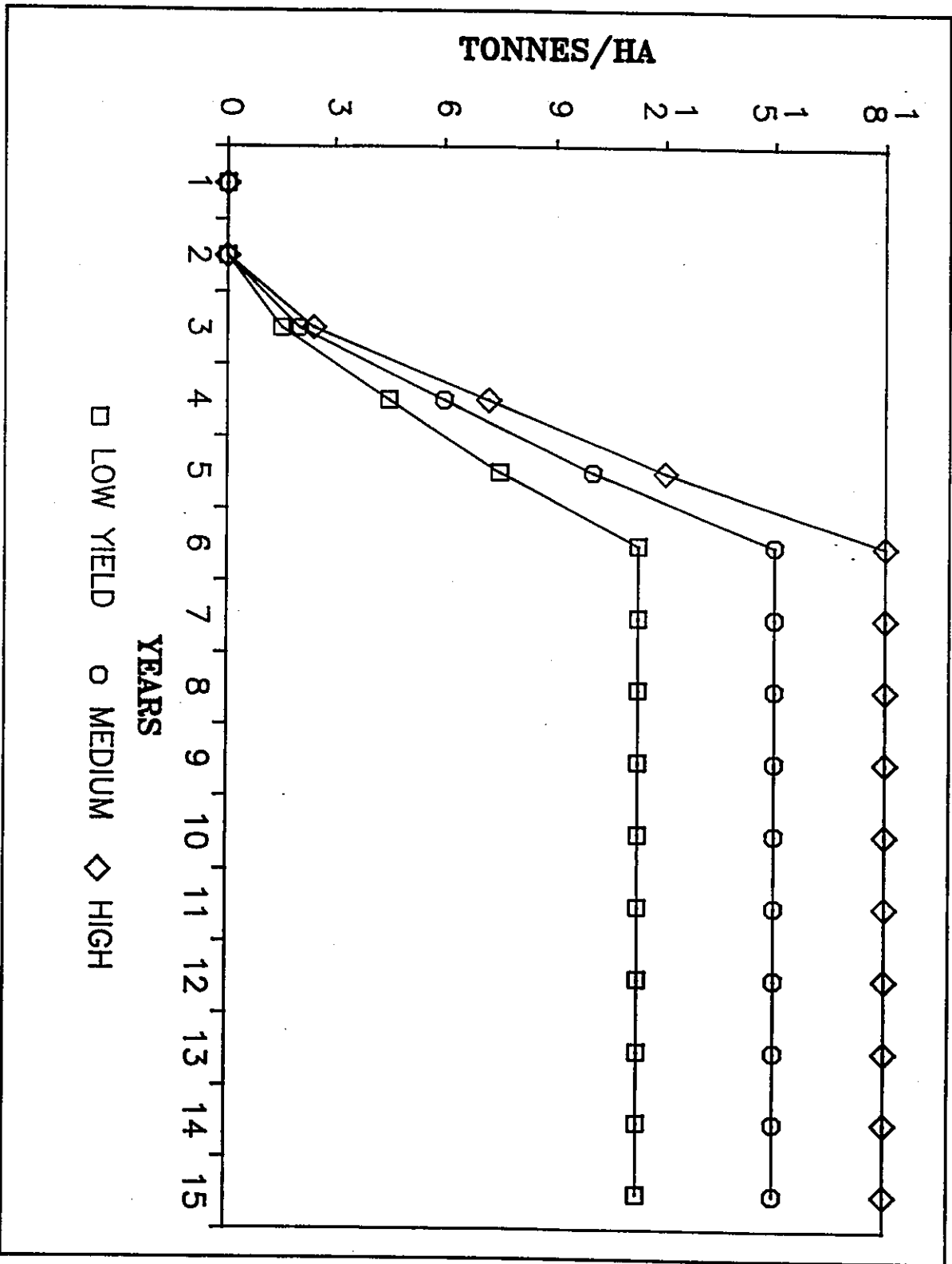


FIGURE 2: NET CASH FLOWS AT VARIOUS YIELD LEVELS
(in constant 1990 terms and before financing costs and tax)

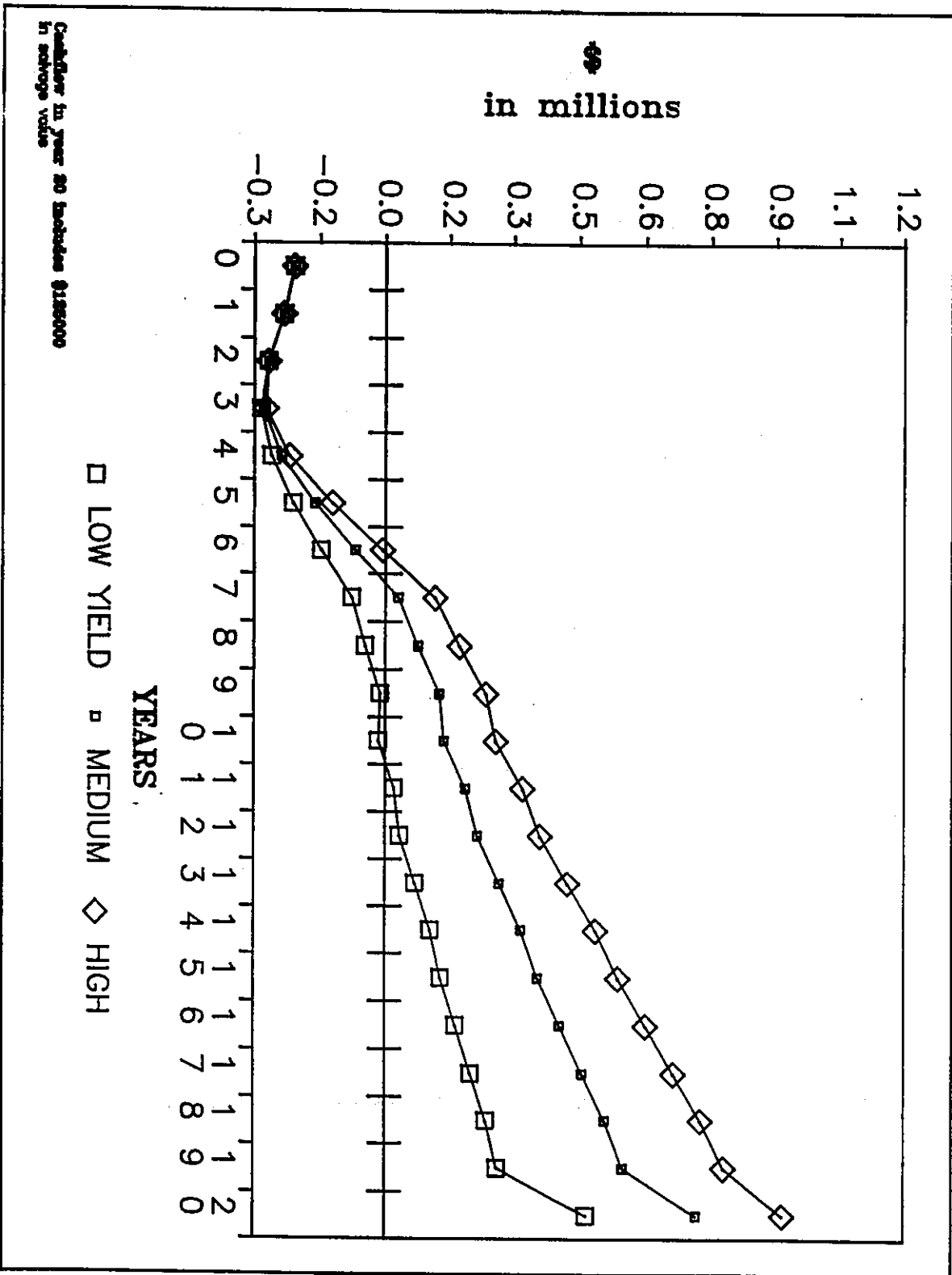


Table 3 : Break-even Prices of a 5 ha Rambutan Orchard at various Yield Levels ⁽¹⁾

Yield	Break-even Prices (\$/kg)	
	By Road (\$300/t)	By Air (\$1,000/t)
11t/ha	3.21	3.91
15t/ha	2.99	3.69
18t/ha	2.88	3.58

⁽¹⁾ assuming 12kg/hr packing rate.

4.3.2 Internal rates of return (IRR) and net farm income (NFI) before tax at various prices and yields are summarized in Table 4.

Table 4: Internal Rates of Return and Net Farm Income at various Yields and Prices ⁽²⁾

Yield	Wholesale Prices					
	\$5 down to \$4/kg		\$6 down to \$4/kg		\$8 down to \$5/kg	
	Road	Air	Road	Air	Road	Air
LOW - 11t/ha :						
IRR(%)	12.65	6.87	15.38	8.91	23.04	16.55
NFI(\$'000)	37	21	77	45	164	102
MEDIUM - 15t/ha :						
IRR(%)	17.06	10.57	20.54	13.40	29.11	22.72
NFI(\$'000)	63	37	117	73	234	144
HIGH - 18t/ha :						
IRR(%)	20.19	13.34	24.25	16.72	33.32	26.97
NFI(\$'000)	84	49	149	96	288	177

⁽²⁾ assuming 12kg/hr packing rate.

Sensitivity analysis of the effects of various packing rates, modes of transport and yield and investment costs (assuming a most likely price of from \$6 to \$4/kg) are illustrated in Table 5.

Table 5 : INTERNAL RATES OF RETURN - Sensitivity Analysis

I.R.R in	HIGH YIELD			MEDIUM YIELD			LOW YIELD		
	Packing rate			Packing rate			Packing rate		
	9kg/hr	12kg/hr	15kg/hr	9kg/hr	12kg/hr	15kg/hr	9kg/hr	12kg/hr	15kg/hr
Real Terms:									
Air freight	12.56%	16.72%	18.81%	9.47%	13.40%	15.39%	5.53%	8.91%	12.05%
Road freight	21.51%	24.14%	25.58%	18.01%	20.54%	21.92%	10.74%	15.42%	16.68%
W/O housing costs ^(c)		20.89%			17.12%			11.82%	
Nominal Terms:									
Air freight	19.56%	23.72%	25.81%	16.47%	20.40%	22.39%	12.53%	15.91%	19.05%
Road freight	28.51%	31.14%	32.58%	25.01%	27.54%	28.92%	17.74%	22.42%	23.68%
W/O housing costs		27.89%			24.12%			18.82%	

^(c) Assuming air freight

At the "most likely" yield of 15t/ha and the "best estimate" price of \$6/kg initially then down to \$4/kg, IRR of the project ranges from 13.40% (air transport) to 20.54% (road transport). This is equivalent to about 20.40% - 27.54% in nominal terms, assuming a long term inflation rate of 7% per annum. This rate of return compares very favorably with the current long term (10-year) Government bond of approximately 13% (as of January 1990). If housing costs are excluded from the total investment, the IRR figure will increase to 17.12% in real terms (24.12% in nominal terms), assuming air transport.

4.3.3 Pay-Back Period

At \$6-\$4/kg price and using air transport, the pay back period ranges from 6 to 8 years at yields of 18t/ha and 11t/ha respectively.

4.3.4 Peak Debt

At the likely yield of 15t/ha and estimated prices of \$6-\$4/kg, peak debt is expected in year 4 at a level of approximately \$278,640, assuming is external borrowings.

4.3.5 Other things being equal, if the post-harvest handling and packing rate can be improved from 9kg of fruit per hour to 15kg/hr, the IRR can be expected to increase by more 5%.

V. CONCLUSION

The general financial prospects of rambutan production in the Northern Territory look very promising if a yield of more than 15t/ha can be achieved; and a wholesale southern market price of over \$3/kg (\$7.5/tray) can be maintained in the future. Other influencing factors which need further research include the technical feasibility of using refrigerated road freight and the efficiency of post-harvest handling and packing rates which appear to have significant impact on the overall profitability of the crop.

APPENDICES

APPENDIX 1: ESTABLISHMENT COSTS

OPERATION	TIMES REPLICATED	RATE	UNIT COST	AREA COST (5 ha)	TOTAL COST
1. LAND CLEARING AND PREPARATION:					
Clear/Rip/Rake (Contract)	1		320	1 600	
Discing (contract)	2		20	200	1,800
2. PLANTING COST:					
Material Cost - Rambutan	4.2	200	15	12 600	
Planting Cost (12 trees/hr-50% Casual)			10	417	
Material cost - Mango @ \$8/tree	1	80	8	640	
Provision for tree losses (2.5%)				325	13988
3. FERTILIZER:					
Single Super	1	30	0.33	50	
Crop King 55	1	16	0.6	48	
Kath. Dolomite (fertilizer put in hole before planting)	1	40	0.06	12	110
4. WEED CONTROL:					
Roundup	1	0.80	20	80	
Agral 60	1	0.02	3.50	0	
Application (2 metre band sprayed along rows @ rate of 4 L/ha)	1		5.43	27	107
Mulching - material: 1/2 bale of hay/tree			2.50	250	1 250
- labour		1 manday/ha		10	50
5. PEST CONTROL:					
Mirant	1	6	8	240	240
TOTAL ESTABLISHMENT COSTS					17545
ESTABLISHMENT COSTS/HA					3509

APPENDIX 6: CAPITAL INVESTMENT SCHEDULE

	PLANT & EQUIPMENT: LIFE & TRADE-IN VALUES					Y E A R												
	INITIAL COST	YR 1ST PURCH	EST LIFE (YRS)	TRADE-IN VALUE (%)	TRADE-IN VALUE (\$)	0	1	2	3	4	5	6	7	8	9	10	15	
	(\$)																	
LAND & BUILDINGS																		
Land	30000	0	100	100	30000	0	0	0	0	0	0	0	0	0	0	0	0	0
Manager's Residence	60000	0	50	50	30000	0	0	0	0	0	0	0	0	0	0	0	0	0
Workshop/Match Shed	4000	0	25	40	1600	0	0	0	0	0	0	0	0	0	0	0	0	0
Cold Storage (3-4 capacity)	10000	2	15	30	3000	0	0	10000	0	0	0	0	0	0	0	0	0	0
Pump Shed	1000	0	25	30	300	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL LAND & BUILDING	105000				64900	0	0	10000	0	0	0	0	0	0	0	0	0	0
PLANT & EQUIPMENT																		
Utility (2nd hand)	12000	0	5	30	3600	12000	0	0	0	0	8400	0	0	0	0	8400	0	8400
Motor Bike	1800	0	5	30	540	1800	0	0	0	0	1260	0	0	0	0	1260	0	1260
Tractor(46kw)	30000	0	10	30	9000	30000	0	0	0	0	0	0	0	0	0	21000	0	21000
Trailer	3000	0	10	20	600	3000	0	0	0	0	0	0	0	0	0	2400	0	2400
Disc Cultivator	2000	0	15	15	300	2000	0	0	0	0	0	0	0	0	0	0	0	1700
Shaver	2500	0	8	10	250	2500	0	0	0	0	0	0	0	2250	0	0	0	0
Fertilizer Spreader	1280	0	12	10	128	1280	0	0	0	0	0	0	0	0	0	0	0	0
PTO Spray Unit	2300	0	12	10	230	2300	0	0	0	0	0	0	0	0	0	0	0	0
Air Blast Mister	3100	0	12	10	310	3100	0	0	0	0	0	0	0	0	0	0	0	0
Cherry all	500	0	15	10	50	500	0	0	0	0	0	0	0	0	0	0	0	450
Cherry picker	9000	3	10	15	1350	0	0	0	9000	0	0	0	0	0	0	0	0	0
Small Tools	2000	0	10	20	400	2000	0	0	0	0	0	0	0	0	0	1600	0	1600
Fencing (Mat. Only)	900	0	25	0	0	900	0	0	0	0	0	0	0	0	0	0	0	0
Power connection (est.)	5000	0	0	0	0	5000	0	0	0	0	0	0	0	0	0	0	0	0
Irrigation System:																		
-Bore	12000	0	50	0	0	12000	0	0	0	0	0	0	0	0	0	0	0	0
-Pump (5.6 kW)	7000	0	10	20	1400	7000	0	0	0	0	0	0	0	0	0	5600	0	5600
-Mains/sprinklers/valves (incl. installation)	11000	0	12	20	2200	11000	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL PLANT & EQUIPMENT COSTS	105380				20358	96380	0	0	9000	0	9660	0	0	2250	0	40260	11810	11810

APPENDIX 7: MACHINERY ASSUMPTIONS

Name of Operation	Name of Implement	Tractor Details			Implement Details		Field Op Efficiency (%)	Work Rate (HA)	Fuel Price (C/L)	Repairs & Maint		Expected Life (HRS)	Implement Life (HRS)	Fuel Used (L/Hr)	Fuel & Oil (\$/HR)	Repair & Maint (Tractor) (\$/HR)	Repair & Maint (Implement) (\$/HR)	Cost (\$/HR)
		Avail. Power PTO (kw)	PTO (hp)	Price (\$)	Price (\$)	Speed (gpm)				% PC (Tractor)	% PC (Implement)							
Slashing	Slasher	45	60	30000	2500	5.0	80.0	2.00	35.0	72.0	30.0	10000	1200	70.0	3.85	2.16	0.63	6.64
Fertilizing	Spreader	45	60	30000	1380	7.0	60.0	4.20	35.0	72.0	30.0	10000	1200	7.0	2.70	2.16	0.52	5.18
Weed Control	Roundspray	45	60	30000	2300	4.0	60.0	2.40	35.0	72.0	30.0	10000	1200	7.0	2.70	2.16	0.58	5.43
Pest & Disease Control	Mister	45	60	30000	3100	2.5	60.0	1.50	35.0	72.0	30.0	10000	1200	9.0	3.47	2.16	0.78	6.40
Harvesting	Trailer	45	60	30000	3000	5.0	60.0	1.50	35.0	72.0	20.0	10000	2400	7.0	2.70	2.16	0.25	5.11

