Value-adding options for tropical fruit using jackfruit as a case study

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by Adrian Best

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Foreword

This report was commissioned by RIRDC following discussions with representatives of the Tropical and Exotic Fruit Association (TEFA). These discussions identified that there was a need to provide a value-adding model for a range of tropical fruit and that jackfruit, reaching commercial production levels (in growing whole fruit), would provide a good basis for such a study.

There is potential to improve the competitiveness and sustainability of the Australian tropical and exotic fruit industry by value adding to fruits in a way that provides additional returns to growers and increases the available market for the fruit.

Using jackfruit as a case study, the project breaks down and analyses value adding and market opportunities for tropical fruits. While jackfruit is the focus of the case study, this report provides lessons and points to opportunities that may be applied to other tropical fruits.

Jackfruit (*Artocarpus heterophyllus*) is one of the most popular tropical fruits grown in Asia and is the largest of all the tree-borne fruits, deemed to have excellent taste, nutrition, and versatility. Jackfruit has been grown in northern Queensland and the Northern Territory for several years.

This project was primarily a desktop analysis. The report contains information on the status and location of the industry in Queensland and the Northern Territory, production estimates, potential for growth, uses of jackfruit, and an exploration of potential value-adding possibilities including the infrastructure required for a profitable and more sustainable Australian jackfruit industry.

This project was funded from RIRDC Core Funds that are provided by the Australian Government.

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our New and Emerging Plant Industries RD&E program, which aims to conduct research, development and extension for new, emerging and other core funded plant industries that contribute to the profitability, sustainability and productivity of regional Australia.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at [www.rirdc.gov.au](http://www.rirdc.gov.au). Purchases can also be made by phoning 1300 634 313.

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Mr Brett Wedding    Principal Scientist, Crop and Food Science, Agri-Science Queensland
Mr Han Shiong       Tropical Primary Products, Northern Territory
Mr Peter Salleras   Fruit Forest Farm, northern Queensland
Abbreviations

AUD  Australian dollars
COS  Cootamundra Oilseeds
FNQ  Far north Queensland
g    Gram
kg   Kilogram
MAP  Modified atmosphere packaging
ml   Millilitre
pa   Per annum
PE   Polyethylene
QA   Quality assurance
QDAFF Queensland Department of Agriculture, Fisheries and Forestry
QLD  Queensland
R&D  Research and Development
RDA  Recommended daily allowance
RIRDC Rural Industries Research and Development Corporation
SA   South Australia
SWOT Strengths, weaknesses, opportunities and threats
T    Tonne
TEFA Tropical and Exotic Fruit Association
TGNC The Gourmet Nut Company
tsp  Teaspoon
Tbsp Tablespoon
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Executive Summary

What the report is about

Using jackfruit as a case study, this project aims to provide a model for the value adding of tropical fruits and to support engagement in developing new products, especially using second-quality fruit.

The bulk of the study was a desktop analysis of the potential uses of jackfruit produced in Australia. Some sampling, analysis and trials were undertaken to establish ‘routes-to-value-adding’ as a part of the study. This report is a vehicle to engage growers and potential processors in a process of change and innovation, to build value-added products that could be commercially successful.

Embracing value-adding is a necessary element in building a better industry that is more efficient and responsive to market needs. This report reviews the jackfruit industry, located in north Queensland and the Northern Territory, and provides information on the status and location of the industry, production estimates, an overview/analysis of the market including the potential for growth through value-adding, pricing estimates and a consideration of the industry infrastructure required for a more profitable and sustainable Australian jackfruit industry.

Who is the report targeted at?

This report targets growers and further food manufacturing or food service industries that may wish to become involved in the production, marketing and value-adding of tropical fruits, including jackfruit, into value-added products.

Where are the relevant industries located in Australia?

Jackfruit is an increasingly important component of the tropical fruit industry. Major plantings exist in the Northern Territory, as well as in far north Queensland (FNQ). The Northern Territory accounts for close to 78 per cent of commercial production, with the remainder in FNQ. In north Queensland the primary production region for jackfruit ranges from Cooktown (15° 46’S) to Murray Upper (18° 04’S) with the bulk of production being along the coastal strip within a 150 km radius of Cairns. In the Northern Territory, the industry is roughly located within a 100 km radius of Darwin.

Current annual production is estimated to be between 700–800 tonnes, mainly produced from orchards with an average planting area of 0.5 hectares to 2 hectares. The Northern Territory has 7240 trees, and Queensland has 2031 trees.

Who will benefit from this research and where are they located in Australia?

The primary beneficiaries of this research are the jackfruit industry growers, value-adding food processors and food-service participants (chefs/restaurateurs). Consumers will also benefit from this study. During this research, especially during the survey, discussions with food service and food manufacturing companies located in south-east Queensland, New South Wales and Victoria, it was evident that food industry knowledge around the jackfruit industry and the potential uses for jackfruit was very poor.

A common reply when asking middle to senior Australian managers across a variety of firms was ‘we were not sure what it was, and had to go online to find out’. Predominantly, knowledge and enthusiasm for eating jackfruit comes from consumers and chefs with Asian and Indian backgrounds.

Background

The proposal for this research was developed through talks between the principal researcher, RIRDC, and the president and secretary of the Tropical and Exotic Fruit Association (TEFA) that took place at
the New Rural Industries Australia Conference in November 2010. These discussions identified that there was potentially a large quantity of jackfruit that was not being sold to the market due to lack of industry and consumer education.

Following these discussions, RIRDC commissioned this review of the status of the industry, and its requirement for investment in research and development.

**Aims/objectives**

The objective of this research is to use jackfruit as a case study, to promote value-adding in Australia’s tropical fruit industries. This research report filters, collates, and consolidates information on the Australian jackfruit industry.

The following key issues are addressed in the study:

- the status and location of the industry in Australia
- production estimates
- potential for growth
- pricing estimates for value-added products
- the need for further knowledge of the nutritional and reputed health benefits of the jackfruit and of industry infrastructure required for a profitable and sustainable Australian industry.

**Methods used**

Overall, the methodology was based on desktop research, consultation and discussion with industry growers and potential end-users including chefs, food manufacturing and food service companies that may incorporate potential value-added products from jackfruit.

A desktop study was undertaken of the overseas industry and markets, primarily on the uses of the value-added fruit overseas and its possible adoption/applicability to the Australian situation. This report attempts to identify future industry priorities, key issues and research investment opportunities, and an analysis of possible routes to market for the produce. A strategic strengths, weaknesses, opportunities and threats (SWOT) analysis was undertaken to identify current and future potential issues that may affect the jackfruit industry.

Identified value-added product opportunities for further investigation by the industry were documented, including the potential for testing of skins for electrolyte properties, production of an alcoholic/non-alcoholic juice, testing of seeds, and testing of pulp.

A food service trial was undertaken in Adelaide at the South Australian Jockey Club on the cost breakdown structure for using jackfruit and the perceptions of food service staff about using the product. Jackfruit pulp was further trialled in the creation of a distilled beverage by Patritti Wines, Adelaide. The project also involved research on the potential of jackfruit oil as a value-added product, including discussions with Cootamundra Oilsseeds.

**Results/key findings**

As a new tropical fruit industry to Australia, jackfruit is predominantly sold as whole fruit to the Darwin, Adelaide, Melbourne, Sydney and Brisbane markets. There is little information on the fruit available to inform food manufacturers and food service businesses, including retailers and consumers (not of Asian, Indian or Chinese origin) of how to process the fruit.

Currently the industry has done little to assist growers. Viability of this and other industries will require this and other industries to work together to successfully value add to a range of tropical fruits, including jackfruit, in a regionally operated production facility. TEFA is an ideal association to assist
growers to identify, plan and access resources needed to build a more commercially sustainable industry looking toward the future. The industry needs to compete with increased production of other Australian and imported tropical fruits. It is critical for the industry to work on key areas such as consumer education, sustainable business models, and new innovation in value-added product development.

The successful establishment and growth of value adding of jackfruit and other tropical fruits in Australia would bring significant benefits to rural Australia, providing alternative sources of income, specifically for supporting growers and regional communities in the Northern Territory and far north Queensland.

Jackfruit has the ability to provide several different value-added products for the food service industry that are both exotic and 'natural’, i.e. that have traditional appeal to Southeast Asian, Indian and Chinese consumers and will provide new opportunities to attract non-Asian consumers.

The project has identified that there are opportunities in commercialisation of jackfruit from a food service or further processed perspective. Possibilities have been identified in this report for expansion of growing capacity/industry through new value-added products. Further opportunities exist for food service and food manufacturers nationally, to take advantage of this type of product that has a traditional wide appeal for Asian, Chinese and Indian consumers.

The models suggested could be readily applied to other tropical fruits grown in Australia.

Value adding will allow better utilisation of the commercial jackfruit crop. Currently jackfruit that is not sold is destroyed rather than further processed. Value adding will produce income from the produce that is not sold as fresh whole fruit, increasing the economic returns from the production practices used.

Value-added products will provide highly sought-after food products to Australian and Asian consumers with potential health and nutraceutical benefits.

Implications for relevant stakeholders

Value adding of Australian jackfruit in commercial quantities is an emerging opportunity. The supply of available jackfruit for product development is now available at a level that will provide commercial opportunities for value-added products in a quantity suitable for the Australian domestic market.

The industry has developed over the last five years. It is entering a new phase of commercial growth and has the opportunity to become a sustainable commercial supplier of value-added jackfruit products. To achieve this growth, support and suitable funding are required at an industry level.

Recommendations

The recommendations are targeted at key stakeholders including RIRDC, federal and state government departments, Australian tropical fruit growers and other growers keen to undertake growing or value adding to jackfruit or similar tropical fruit.

The major recommendations are that the industry engages in three areas to build a sustainable industry for the future:

- development of a sustainable grower business model and strategic marketing plan
- education of food manufacturers, food services and consumers
- research into value adding and product development for jackfruit and other tropical fruits.
1. Australian jackfruit industry overview

Jackfruit (*Artocarpus heterophyllus*, see Figure 1-1) is a relative of breadfruit and mulberry and in many Asian countries is chiefly grown for its ripe fruit that is eaten fresh or used in curries, desserts and sweet drinks. Jackfruit is the largest tree-borne fruit in the world, ranging in size from 5 to 30 kilograms and up to 36 inches long and 20 inches in diameter. There is strong domestic demand for Australian-produced jackfruit and all production is consumed domestically. There are no countries that have approval to export jackfruit to Australia (Foster & Bird 2009).

Jackfruit is widely cultivated in tropical regions especially India, Bangladesh, Sri Lanka, Vietnam, Thailand, Malaysia, Indonesia and the Philippines.

The exterior of the compound fruit is green or yellow when ripe. Jackfruit has an inedible core extending from the stem, and a thick inedible rind, pointy on the outside. Between the core and the rind are the fruit arils with their seeds. These arils are embedded in ‘rags’, which are actually unfertilised flowers that haven’t developed. The seed is 0.75 to 1.5 inches long and 0.5 to 0.75 inches thick and is white and crisp within. There may be 100 or up to 500 seeds in a single fruit, which can quickly lose their viability as they can go mouldy after a few days. If used as a food, the seeds need to be boiled, dried and stored for further preparation.

The flavour of the jackfruit flesh is similar to a tart banana. When fully ripe, the unopened jackfruit emits a strong disagreeable odour, resembling that of decayed onions, while the pulp of the opened fruit smells of pineapple and banana.

Varieties of jackfruit are distinguished according to the characteristics of the fruit’s flesh. There are two main varieties of jackfruit in Australia. The variety produced in the Northern Territory is a softer variety with small fibrous, soft, mushy but very sweet carpels with a texture somewhat akin to a raw oyster. The other variety, grown in northern Queensland, is known as ‘Orange Crunchy’ (Figure 1-2).
Appealing more to Vietnamese and Thai consumers, these are crisp and almost crunchy though not quite as sweet. This form is considered by some growers to be more palatable to western tastes.

Figure 1-2. The variety known as ‘Orange Crunchy’ grown in northern Queensland.

Both varieties freeze well. It is harder to separate the fruit from the skin of the ‘Orange Crunchy’ variety which needs to be cut away, whereas in the softer variety, it is easy to pull the skin and internal fibre away from the fruit.

**Australian production and location**

The jackfruit industry is located in northern Australia (9300 trees). Jackfruit is an increasingly important fruit with major plantings in the Northern Territory and in far north Queensland (Table 1-1). In Queensland the primary production region for jackfruit ranges from Cooktown (15° 46’S) to Murray Upper (18° 04’S) with the bulk of production being along the coastal strip within a 150 km radius of Cairns. In the Northern Territory the industry is located within a 100 km radius of Darwin.

Annual production is 700–800 tonnes, mostly from the Northern Territory, with an average planting area of 0.5 to 2 hectares. The Northern Territory has 7240 trees (78 per cent of total production) and the remaining 2031 trees (22 per cent) are grown in north Queensland.

The fruit also has an important profile in farmers’ markets in the Northern Territory. Jackfruit can be found at outdoor produce markets during the dry season particularly in Darwin, where the majority of the fruit are supplied as whole fruit. Very little value adding is done with the fruit in an Australian context, the remaining production from both Northern Territory and northern Queensland is supplied to southern markets in Adelaide, Melbourne, Sydney and Brisbane.

The estimated current annual production of jackfruit, at a yield of 80 kg/tree is 741 tonnes valued at $2.6M (Table 1-2). Note that in the following tables the average price per kg has not changed significantly since 2006–07 (Table 1-3) and that the production has almost doubled from 2006–11.
Table 1-1. Numbers of jackfruit trees growing by locality and by age.

<table>
<thead>
<tr>
<th>State</th>
<th>Tree age (years)</th>
<th>0–1</th>
<th>2–4</th>
<th>5–10</th>
<th>11–19</th>
<th>20+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td></td>
<td>40</td>
<td>260</td>
<td>861</td>
<td>570</td>
<td>300</td>
<td>2031</td>
</tr>
<tr>
<td>NT</td>
<td></td>
<td>0</td>
<td>650</td>
<td>6110</td>
<td>480</td>
<td>0</td>
<td>7240</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>40</td>
<td>910</td>
<td>6971</td>
<td>1050</td>
<td>300</td>
<td>9271</td>
</tr>
</tbody>
</table>

Source: Diczbalis (2012)

Table 1-2. Estimated value of jackfruit produced in the Northern Territory and Queensland.

<table>
<thead>
<tr>
<th></th>
<th>Qld</th>
<th>NT</th>
<th>Gross value ($M)</th>
<th>Total tree number</th>
<th>Total production (T)</th>
<th>Average yield (kg/tree)</th>
<th>Average price ($/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: Diczbalis (2012)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1-3. Jackfruit grower numbers, production and value 2002–07.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Growers No.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area Hectare</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume Tonne</td>
<td></td>
<td>405</td>
<td>405</td>
<td>405</td>
<td>300</td>
<td>400</td>
</tr>
<tr>
<td>Gross value $'000</td>
<td></td>
<td>1,419</td>
<td>1,561</td>
<td>1,215</td>
<td>800</td>
<td>1,102</td>
</tr>
<tr>
<td>Price, Sydney market $/kg</td>
<td></td>
<td>3.22</td>
<td>3.35</td>
<td>2.81</td>
<td>3.08</td>
<td>3.18</td>
</tr>
</tbody>
</table>

Source: Foster & Bird (2009)

Supply period

- Australia: In northern Queensland there is a small harvest in September–October (approximately 5 per cent of the harvest). The main harvest is mid-January to early March. The Northern Territory variety is in production from late July till late September–early October.

- International: In Asia, jackfruit is a seasonal crop with a ripening season of late spring to late summer from March to June, April to September or June to August depending on the climatic region, with some off-season crops from September to December. In the West Indies, many ripen in June; and in the USA (Florida), the season is August to November.
Quality indicators

A fully ripe jackfruit will have a bit of flexibility in the outer rind, a light but distinct aroma, and may sound a bit hollow if patted. The fruit should still be fairly green in colour and have no evidence of cracking in the outer rind due to drying out. Its outer surface is covered with blunt thorn-like projections, which become soft as the fruit ripens. Uncut jackfruit keeps a few days at room temperature but starts to dry out, evidenced by cracking of the green outer rind between the points and softening of the stem. Once cut, the whole fruit should be completely disassembled.

Tips for finding a good one

- Smell: take a deep smell; a ripe jackfruit has a strong pungent odour and if you can't smell anything it's not ripe yet
- Colour: a ripe jackfruit is greenish yellow in colour
- Feel: a ripe jackfruit is a little bit soft, but not squishy.

Figure 1-3 shows the arils, seeds and ‘rag’ in a jackfruit.

Figure 1-3. The jackfruit shown has arils or fruit segments anchored to the skin and attached to the ‘rag’ or fibrous inner parts of the fruit.

Each of the arils or segments shown has a seed that has to be removed in the processing of the fruit.
Preparation

Australian-produced fresh whole jackfruit is available in the major capital city markets.

Young or small jackfruit

At the early stages of growth, (approximately 1–2 kg size) the fruit can be cut up like a zucchini or similar to pineapple. The fruit at this stage is not perfectly shaped. When chopped, the seed is still soft.

Large jackfruit

The interior of a large jackfruit consists of orange-yellow coloured edible bulbs. Each bulb consists of sweet-flavored sheaths called arils that enclose a smooth, oval, light-brown coloured seed. There may be as many as 100 to 500 edible bulbs embedded in a single fruit interspersed between thin bands of fibres.

The yellow fruit arils can be refrigerated for a few days or frozen for a year or so. Jackfruit seed is 2–4 cm long and 1–3 cm thick and is white and crisp within. The seeds should be processed as soon as the fruit is cut open (they go mouldy rather quickly). If you intend to use the ‘rag’ it should be refrigerated and used within a few days.

The industry generally has found that for non-Asian purchasers of the fruit, jackfruit is most acceptable in the full-grown but unripe stage, when it has no objectionable odour and can be used like cooked green breadfruit and plantain. The fruit at this time is simply cut into large chunks for cooking.

If the jackfruit is allowed to ripen, the bulbs and seeds should be extracted in a well-ventilated area and the odorous residue should be removed from the kitchen at once. The biggest problem when preparing a fresh jackfruit is the white latex sap it exudes when cut. The latex bleeds vigorously and almost all parts of the tree exude white sticky latex when injured. It has been found that the latex found in the fruit dissipates over a period of more than two days in cold storage, leaving only a small residue that is generally innocuous.

When cutting fresh jackfruit, latex can accumulate on the knife and hands. It is recommended that knives, cutting surface and hands be coated with salad oil before proceeding with preparation of the fruit. Be prepared to wash and re-oil occasionally.

Cut the jackfruit in half crosswise, then again lengthwise so you have quarters. Then cut out the core and start working on removing the seeds and fruit arils from the ‘rag’ (level of difficulty varies depending on jackfruit cultivar and the ripeness of the fruit). This reveals the different components of the fruit:

- **arils**: the yellow arils surrounding the seeds need no cooking or other preparation except removing the seeds
- **seeds**: the seeds are perishable and should be immediately removed from the arils, rinsed and dried quickly. They should be kept only a few days before cooking. N.B. COOKING IS ESSENTIAL TO ELIMINATE A TRIPSIN-INHIBITING ENZYME WHICH WILL CAUSE THE SEEDS TO BE INDIGESTIBLE, AND SLIGHTLY TOXIC. Generally they are par boiled for 5 minutes, then roasted in a pan with a little oil, or in the oven
- **‘rag’**: the ‘rag’ in a ripe jackfruit is actually composed of unfertilised flowers, those that didn't develop into seeds. Many references describe it as ‘inedible’, but that isn't correct. It's somewhat sweet, but a bit fibrous, so it should be separated into individual strands (cut off any attached base) and steamed for 15 minutes to soften it before using in recipes.

If you intend to use the ‘rag’, it should be cut away from the outer rind immediately, separated into individual strands and immersed in cold water acidulated with citric acid or lemon juice to prevent


browning. After soaking for 15 minutes or so they can be squeezed out, bagged in plastic and refrigerated.

**Yield**

In a commercial-scaled trial undertaken as a part of this study, a 12.895 kg jackfruit yielded 6.3 kg of yellow fruit arils (49 per cent), 1.2 kg of seeds (10 per cent) and 1.4 kg of ‘rag’ (11 per cent) and the remaining jackfruit skin 3.995 kg (30 per cent). Yield varies slightly with the variety of jackfruit, however; the trial indicates that there is potentially 70 per cent edible yield if you use the ‘rag’, or 59 per cent if you don't use the ‘rag’ for culinary purposes.

**Nutrition**

The pulp constitutes 25-40 per cent of the fruit's weight. In general, fresh seeds are considered to be high in starch, low in calcium and iron but are a good source of vitamins B1 and B2. Table 1-4 presents the nutritive value of jackfruit in regards to mineral and vitamin composition as well as energy, protein and other nutrients.

**Toxicity**

Jackfruit is rich in dietary fibre that may cause digestive ailments if the fruit is eaten in excess, as it may cause diarrhoea. Raw jackfruit seeds are indigestible due to the presence of a powerful trypsin inhibitor, which is destroyed by boiling or baking for a period of 5 minutes or longer.
Table 1-4. Jackfruit nutritive value per 100 grams (source: USDA National Nutrient Data Base).

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Unit</th>
<th>Value (per 100g where weight)</th>
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<tbody>
<tr>
<td><strong>Approximate value</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>kcal</td>
<td>95</td>
</tr>
<tr>
<td>Protein</td>
<td>g</td>
<td>1.72</td>
</tr>
<tr>
<td>Total lipid (fat)</td>
<td>g</td>
<td>0.64</td>
</tr>
<tr>
<td>Carbohydrate, by difference</td>
<td>g</td>
<td>23.25</td>
</tr>
<tr>
<td>Fibre, total dietary</td>
<td>g</td>
<td>1.5</td>
</tr>
<tr>
<td>Sugars, total</td>
<td>g</td>
<td>19.08</td>
</tr>
<tr>
<td><strong>Minerals</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium, Ca</td>
<td>mg</td>
<td>24</td>
</tr>
<tr>
<td>Iron, Fe</td>
<td>mg</td>
<td>0.23</td>
</tr>
<tr>
<td>Magnesium, Mg</td>
<td>mg</td>
<td>29</td>
</tr>
<tr>
<td>Phosphorus, P</td>
<td>mg</td>
<td>21</td>
</tr>
<tr>
<td>Potassium, K</td>
<td>mg</td>
<td>448</td>
</tr>
<tr>
<td>Sodium, Na</td>
<td>mg</td>
<td>2</td>
</tr>
<tr>
<td>Zinc, Zn</td>
<td>mg</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Vitamins</strong></td>
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<td></td>
</tr>
<tr>
<td>Vitamin C, total ascorbic acid</td>
<td>mg</td>
<td>13.7</td>
</tr>
<tr>
<td>Thiamine</td>
<td>mg</td>
<td>0.105</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>mg</td>
<td>0.055</td>
</tr>
<tr>
<td>Niacin</td>
<td>mg</td>
<td>0.920</td>
</tr>
<tr>
<td>Vitamin B-6</td>
<td>mg</td>
<td>0.329</td>
</tr>
<tr>
<td>Folate, DFE</td>
<td>mcg_DFE</td>
<td>24</td>
</tr>
<tr>
<td>Vitamin B-12</td>
<td>µg</td>
<td>0.00</td>
</tr>
<tr>
<td>Vitamin A, RAE</td>
<td>mcg_RAE</td>
<td>5</td>
</tr>
<tr>
<td>Vitamin A, IU</td>
<td>IU</td>
<td>110</td>
</tr>
<tr>
<td>Vitamin E (alpha-tocopherol)</td>
<td>mg</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Lipids</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatty acids, total saturated</td>
<td>g</td>
<td>0.195</td>
</tr>
<tr>
<td>Fatty acids, total monounsaturated</td>
<td>g</td>
<td>0.155</td>
</tr>
<tr>
<td>Fatty acids, total polyunsaturated</td>
<td>g</td>
<td>0.094</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>mg</td>
<td>0</td>
</tr>
</tbody>
</table>

National Nutrient Database for Standard Reference

a Folate value based on the analysis of 5-methyltetrahydrofolate

* Values based on analysis of cultivars grown in Florida.
Health benefits

The fruit is made of soft, easily digestible flesh (bulbs) with simple sugars like fructose and sucrose. Jackfruit is rich in dietary fibre, which makes it a good bulk laxative. The fibre content helps to protect the colon mucous membrane by decreasing exposure time and as well as binding to reactive chemicals in the colon.

Fresh fruit is a good source of potassium, magnesium, manganese, and iron. Potassium is an important component of cell and body fluids that helps control heart rate and blood pressure. Jackfruit has small amounts of vitamin A and flavonoid pigments such as carotene-β, xanthin, lutein and cryproxanthin-β.

Jackfruit is also a good source of vitamin C (13.7 mg/100g or 23 per cent of recommended daily allowance, RDA). It is one of the rare fruits that are rich in the B-complex group of vitamins. It contains very good amounts of vitamin B-6 (pyridoxine), niacin, riboflavin, and folic acid.

There may be nutraceutical or pharmaceutical opportunities in jackfruit given its widespread usage in traditional Chinese and Indian medicine.

Jackfruit seeds contain a large number of nutrients. These nutrients will interact with each other during processing, and it is essential that nutritional information is determined for each product following processing.

Studies have been undertaken on the composition of seed (for example, see Kumar et al. 1988; Airani 2007). The seed is a good source of carbohydrates, protein and energy. Jackfruit seeds have been trialled for nutrient enhancement and functional properties such as water and oil absorption capacity (Odoemelam 2005) to determine their value as an addition for convenience food products.

Latex from the skin of the fruit (and leaves) is used as a topical treatment in a number of cultures. The wood of the tree also yields ‘morin’, a yellow food dye.
2. Business model development

Considerable research is required to develop business and industry models that may engage prospective jackfruit growers, encourage development of valued-added jackfruit products (see Figure 2-1), and generate market demand.

![Figure 2-1. Uneven fruit are not considered first quality for many buyers and offer potential for value adding and product development.](image)

TEFA was established in 2007 to improve the profile and foster the development of the tropical exotic fruit industry, estimated to be worth over $9 million annually. With appropriate support, TEFA can improve the industry by commissioning national research and development projects in partnership with RIRDC and others. TEFA aims to present a united voice to provide a visible profile for tropical exotic fruit crops and to represent growers on critical industry issues.

The involvement of TEFA is critical to the maintenance and development of the industry, and indeed, the regions concerned. TEFA should be supported to maintain the coordination of the industry, assist in the education of the Australian consumers of jackfruit and other tropical fruits, and build knowledge in developing new value-added products.

While many Asian chefs may understand and appreciate the potential of jackfruit, it is evident that many Australian consumers, chefs and processors are unfamiliar with it and unappreciative of its value and potential as a new food. Education of consumers and markets with ready access to information on how to open, prepare, eat and process the fruit is important for the growth of the industry, especially for the further development of processed and value-added jackfruit products.
SWOT analysis

The following analysis highlights the strengths, weaknesses, opportunities and threats (SWOT) for the jackfruit industry in identifying opportunities for value adding (Table 2-1). This SWOT analysis may be used by the industry to develop and review strategies and implementation plans. Internal factors contribute to the strengths and weaknesses within the industry, while external factors contribute to the opportunities and threats affecting the industry.

Table 2-1. Marketing and commercial focus SWOT analysis

<table>
<thead>
<tr>
<th>Strategic issue: Marketing and commercial focus</th>
<th>Strengths</th>
<th>Weakness</th>
<th>Opportunity</th>
<th>Threat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Quality of Australian jackfruit&lt;br&gt; • Australia’s Clean and Green reputation&lt;br&gt; • Diversification/spreading risk for rural farms&lt;br&gt; • Growing capacity to supply value-added jackfruit products&lt;br&gt; • Reputation of jackfruit for flavour &amp; nutrition</td>
<td>• Limited financial industry resources&lt;br&gt; • Lack of strategic market research for value-adding opportunities&lt;br&gt; • Understanding of market requirements between wholesale, and restaurants&lt;br&gt; • Lack of foodservice market education about jackfruit&lt;br&gt; • Understanding of packaging needs for distribution&lt;br&gt; • Scientific proof of claims for excellent health properties&lt;br&gt; • Marketing skills &amp; experience of TEFA members</td>
<td>• Demand for domestic supply of exotic tropical fruits&lt;br&gt; • Availability of supply of fresh jackfruit&lt;br&gt; • Market reputation of jackfruit as a prized food&lt;br&gt; • Jackfruit can enhance a wide range of foods/sauces&lt;br&gt; • Exploitation of nutrition and health opportunities</td>
<td>• Market non-acceptance of whole jackfruit due to odour when ripe and size of whole fruit&lt;br&gt; • Pricing fluctuations due to supply/demand&lt;br&gt; • Product substitution from similar products&lt;br&gt; • Existing knowledge of supply &amp; distribution chains for value-added jackfruit products</td>
</tr>
</tbody>
</table>

Drivers for industry growth

The following drivers for industry growth provide a checklist that may assist in planning the development of the industry:

1. growth in Australian market demand for jackfruit
2. consumer and retail education to promote jackfruit
3. industry partnerships to promote and supply value-added production of jackfruit in the short term
4. knowledge of production and demand factors affecting market-pricing trends
5. increased yields of jackfruit as trees mature, and through improving the industry in Australia
6. development of quality standards to ensure consistency of Australian jackfruit and building capacity for value-added products
7. development of recipes and information on preserved and value-added jackfruit products
8. development of technical and research resources for industry
9. efficient communications and management of whole-of-industry issues.

**Constraints for industry growth and sustainability**

The following constraints represent issues that are likely to require TEFA to find a solution:

1. variable understanding of strategic value-added markets for individual jackfruit components
2. lack of consumer and market education about Australian jackfruit
3. different types and attributes of Australian jackfruit
4. lack of quality assurance and training for industry
5. lack of access to technical and research resources
6. competition from and/or substitution by exotic fruits from other countries
7. limited further processing facilities for Australian jackfruit especially commons/seconds
8. lack of a sustainable business model to engage growers to invest in value adding for the industry.
## Jackfruit processing costs

Estimated capital and operating costs for a facility to process whole jackfruit are presented in Table 2-2 below.

### Table 2-2. Estimated capital and operating costs for facility processing whole jackfruit.

<table>
<thead>
<tr>
<th>Item description</th>
<th>Cost estimate</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major capital cost items</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land – including site preparation, connection of utilities, water treatment space and suitable roads</td>
<td>$135,000</td>
<td>Consultant estimate and dependent on factory location</td>
</tr>
<tr>
<td>Suitable building – suitable for processing jackfruit</td>
<td>$75,000</td>
<td>Consultant estimate</td>
</tr>
<tr>
<td>Equipment including benches, cool rooms, freezer, staff amenities and processing area</td>
<td>$90,000</td>
<td>Consultant estimate</td>
</tr>
<tr>
<td><strong>Total capital</strong></td>
<td>$300,000</td>
<td></td>
</tr>
<tr>
<td><strong>Whole jackfruit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jackfruit provided for processing by growers based on a per kg price of $3.50</td>
<td>$202,720</td>
<td>Consultant estimate</td>
</tr>
<tr>
<td><strong>Total inputs</strong></td>
<td>$202,720</td>
<td></td>
</tr>
<tr>
<td><strong>Labour costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manager, admin and 8 processing staff, (based on a season of 12 weeks)</td>
<td>$138,500</td>
<td>Staff of ten with an average annual salary of $60,000 each including on costs would be $600,000 per annum</td>
</tr>
<tr>
<td><strong>Major operating cost items per annum</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repairs and maintenance</td>
<td>$15,000</td>
<td>Based on 5% of capital cost</td>
</tr>
<tr>
<td>Interest on capital</td>
<td>$30,000</td>
<td>Consultant estimate and assuming commercial interest rate of 10%</td>
</tr>
<tr>
<td>Utilities</td>
<td>$20,000</td>
<td>Consultant estimate</td>
</tr>
<tr>
<td>Other operating costs</td>
<td>$15,000</td>
<td>Consultant estimate</td>
</tr>
<tr>
<td><strong>Approximate annual operating</strong></td>
<td>$80,000</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

Based on available whole jackfruit for processing of 10% of annual production in Northern Territory, approximately 58 tonnes.

Average labour production costs of 80–100 kg per day per person, noting that the season is July–September (12 weeks or 60 production days) would require an average of 563 days for processing, packaging and some administrative duties; this equates to a staff of ten including administration and management team to operate the facility successfully during the season. Costs of whole jackfruit from growers valued at an estimated $3.50 per kg.
Market analysis

To attract consumers who have never seen the fruit before, prices for value-added jackfruit need to be competitive to pre-cut or pre-prepared wholesale prices of similar products. It is difficult to give reliable price data for value-added products including fresh cut fruit. Small quantities of the fruit sold as pre-prepared cut jackfruit fetched from $3.00 to $15.00 per kg in the low season of 2012. It is difficult to establish whether this can be achieved with high volumes of the prepared fruit on the market, as the product is new to most Australian consumers. However, this is likely to be attractive to industry participants if it can be sustained, as the market pricing in 2012 for whole jackfruit was highly variable across the season (largely, but not entirely, determined by availability). In FNQ, production selling prices can be from $2 to $3.50 per kg, while other prices achieved by growers undertaking further processing varies from $6 to $15 per kg for premium prepared/fresh-cut fruit.

Further market research is required to establish what consumers are seeking in processed fruit and the potential value-added products for local Australian markets. Consideration, in the market context, needs to be given to determining the target prices for the value-added fruit products to establish the viability of a production facility, as well as obtaining an understanding of the market potential for value-added products.

This research will clearly identify opportunities across different market segments, especially differences between consumer, food service and retail markets. Requirements of size and quality of produce will vary between these market segments. The industry as a whole needs to invest in strategies to underpin future prices for Australian jackfruit which may include branding, labelling, packaging and quality standards.

Grower and market interest in a range of tropical exotic fruits continues to increase. The industry needs to actively support promotional activities for a range of tropical fruit at food industry events. These promotional events are a way to generate strong interest in the range of tropical exotic fruits produced in northern Australia and provide education to consumers in how to obtain, prepare and use the fruit on a seasonal basis.

Outside of countries where it is grown, jackfruit can be obtained year-round either canned or dried. To generate significant additional demand for value-added Australian jackfruit, we require extensive education of consumers across the value chain from the food service and food manufacturing industries, through retailers, to consumers. In a recent limited survey of food service operators and food manufacturing firms, it was evident that, at all levels, information about and knowledge of Australian jackfruit was limited.

To date, all of the Australian jackfruit supply has been directed to the fresh food wholesale markets in Darwin, Adelaide, Melbourne, Sydney and Brisbane. It is also estimated that the sales of the product are primarily to Asian food service providers and consumers.

TEFA and the industry need to provide consumer education and identify value chain partners that will engage with the industry to provide the demand for value-added products armed with good information on pricing, availability and seasonality. In developing value-added products, the industry needs to ensure that the product is of a high quality and backed with appropriate quality assurance systems to ensure the product achieves a premium status among Australian consumers.

Many chefs and fine food wholesalers are strong supporters of new products that enable them to add interest to their menu and sales range. The industry needs to undertake some strategic consumer education to develop networks of top restaurateurs, food writers and food service operations to build knowledge and an understanding of how to use jackfruit, and to educate consumers to build wider and stronger demand for the fruit and its value-added products.
**Estimated jackfruit value-adding costs**

The following trial data was established in a high-throughput commercial trial in a SA restaurant:

- jackfruit total weight 12.895 kg – 100%
- arils or segments 6.3 kg – 49%
- jackfruit seeds 1.2 kg – 9%
- jackfruit skin 3.995 kg – 31%
- jackfruit fibre and other 1.4 kg – 11%
- labor based on $20 per hour (including on costs) 40 min – $13.40
- cost input per kg of the whole jackfruit at $3.50 per kg – $45.13.

Using these results and the sale price of various seeds and nuts (online health food shops, Table 2-3), we are able to estimate the costs for pricing the components of the whole jackfruit suitable for sale to other enterprises for value adding or further production based on 10 per cent of the Northern Territory production or 58 tonnes of production per season.

**Table 2-3. Wholesale pricing for products available online from health food suppliers.**

<table>
<thead>
<tr>
<th>Item description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macadamia, unsalted 1 kg</td>
<td>$37.50</td>
</tr>
<tr>
<td>Pepitas (pumpkin seeds)</td>
<td>$24.60</td>
</tr>
<tr>
<td>Brazil nuts 1 kg</td>
<td>$19.50</td>
</tr>
<tr>
<td>Walnuts 1 kg</td>
<td>$17.99</td>
</tr>
<tr>
<td>Cashews, raw 1 kg</td>
<td>$16.00</td>
</tr>
<tr>
<td>Almonds, raw 1 kg</td>
<td>$13.95</td>
</tr>
<tr>
<td><strong>Jackfruit seeds 1 kg (estimated pricing)</strong></td>
<td><strong>$12.95</strong></td>
</tr>
<tr>
<td>Sunflower seed kernels 1 kg</td>
<td>$11.80</td>
</tr>
<tr>
<td>Peanuts, Australian, roasted 1 kg</td>
<td>$7.50</td>
</tr>
</tbody>
</table>


Online pricing for pre-prepared nut and seed products was reviewed to identify a base for pricing jackfruit seeds for sale. When reviewing the available nuts and seeds priced online, an estimated price was established for the jackfruit seeds at a 1 kg pack.

It was noted that jackfruit seeds were similar in size to Brazil nuts and due to the further processing required for the jackfruit seeds, a higher pricing should possibly be sought for the retail seeds. With marketing and consumer education, the sale price for seeds may extend closer to the Brazil nut pricing over time.
Table 2-4. Production cost analysis based on further value-added costs for processing.

<table>
<thead>
<tr>
<th>Item description</th>
<th>Estimated production (kg)</th>
<th>Food cost ($)</th>
<th>Labour cost ($)</th>
<th>Production costs ($)</th>
<th>Total production costs ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole fruit</td>
<td>57,920</td>
<td>202,720</td>
<td>138,500</td>
<td>80,000</td>
<td>421,220</td>
</tr>
<tr>
<td>Total production costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>421,220</td>
</tr>
</tbody>
</table>

Identified in Table 2-4 are the estimated production costs to extract the value-added products from the whole jackfruit. This table is based on 10 per cent of Northern Territory production being available for processing. As a stand-alone product, it would be difficult for the production facility to operate seasonally for jackfruit. Development of a business model that incorporates other tropical fruits is critical to enable the production facility to operate at capacity for a full 12 months per year. As part of this business model, quality standards, share offerings based on product supply to the facility, and agreed equity in distribution of profits are important components that require careful consideration.

Table 2-5 presents estimated sales revenue generated from sales of different value-added jackfruit products.

Table 2-5. Estimated sales revenue generated from sales of jackfruit value-added products.

<table>
<thead>
<tr>
<th>Item description</th>
<th>Estimated production (kg)</th>
<th>Estimated selling price ($ per kg)</th>
<th>Total revenue ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds, 9%</td>
<td>5,212.8</td>
<td>12.95</td>
<td>67,505.76</td>
</tr>
<tr>
<td>Fresh fruit, 49%</td>
<td>28,380</td>
<td>13.50</td>
<td>383,130.00</td>
</tr>
<tr>
<td>Fibre, 11%</td>
<td>6,371.2</td>
<td>1.00</td>
<td>6,371.20</td>
</tr>
<tr>
<td>Skin, 31%</td>
<td>17,955.2</td>
<td>0.50</td>
<td>8,977.60</td>
</tr>
<tr>
<td>Total revenue</td>
<td></td>
<td></td>
<td>465,984.56</td>
</tr>
</tbody>
</table>

Please note that the sales pricing indicated above is an estimate only. Actual income will vary depending on market conditions. Given that, the above ‘model’ represents a return of 10 per cent on investment, and an outlay of $421,000 to achieve a (speculative) gross income of $465,000. This would rate the value-adding of jackfruit as a fairly high investment risk when considered in isolation. Such a processing operation would only be viable if the use of the facility was maximised by including other fruits (maybe including vegetables) to spread the risk and achieve economies of scale – in terms of diversity, volume, and time, i.e. aiming for a twelve-month/all-year-round operation.

The production costs above are an estimated annual cost for a dedicated facility. Another, less risky option may be to subcontract the processing of jackfruit to an existing fruit and vegetable processing operation (to take account of the seasonal availability of the fruit).

A business model that compensates growers for providing produce and for building the industry to develop value-added products is necessary in this form of grower enterprise (Figure 2-2). Establishing a business model to support the industry would be the first critical step in research for the industry.
Figure 2-2. Asian consumers of jackfruit prefer evenly rounded fruit. Fruit that is disfigured and damaged is cut from the tree and left on the ground to rot or for animals to forage.
3. Product development

To identify food-manufacturing industry and food-service industry perceptions of jackfruit and potential uses for various components from jackfruit, a telephone survey was undertaken with a sample group of manufacturing companies and food-service operators.

These organisations were surveyed for their knowledge and information known about jackfruit and opportunities for using the value-added products. As a result of the survey, some of the firms showed an interest to review jackfruit as a potential source for the development of a variety of products. These potential products include ready-to-eat fruit portions and purees, nutraceutical products, ice cream and gelato bases, fruit juices, alcoholic beverages, roasted seeds for savoury mixes and prepared meals.

Easy Way Tea (jackfruit juice)

First launched in Taiwan in 1992, Easy Way Tea is an international franchise specialising in tea, with an extensive range of unique tea-related beverages. Currently with stores in operation around the world, Easy Way continues to build and develop franchise stores in many more locations worldwide. It arrived in Sydney at the end of 2001 and now has over 70 stores nationwide in Australia.

Boost Juice (jackfruit juice)

Boost Juice is an Australian franchise with 250 stores in 14 countries. Their product range includes fruit-based smoothies, crushes, juices, and a retail range. Boost Juice is an amazing retail phenomenon with a growth platform of on average of four countries and 30 stores a year for the last four years and with a group turnover exceeding AUD135 000 000 per annum and climbing every year. Boost Juice have appointed Master Franchisees in the UK, Republic of Ireland, Thailand, Indonesia, South Africa, Macau, Mexico, Hong Kong, Chile, Lithuania, Estonia, Singapore, Malaysia, and Germany.

Majans Pty Ltd (jackfruit seeds)

Majans manufacture an Indian range of mixed and spiced nut products including the Bhuja range. An Indian family favourite, the origin of Bhuja mixes and spices is its own recipe. In Australia, Majans was the first company to manufacture Bhuja commercially and make it available nationwide.

The Gourmet Nut Company (jackfruit seeds)

The Gourmet Nut Company (TGNC) is an Australian manufacturer located in Victoria. They process various types of nuts including almonds, cashews, macadamias and peanuts by applying unique coatings. The company is HACCP and SOF accredited. The company's products are Australian and natural. TGNC’s current range of coatings includes: honey, cinnamon, lemon myrtle, Indian chai, Moroccan tajine, Thai sweet chilli (and with lime), Japanese wasabi (with honey) and Canadian maple. Not all flavours are available on all types of nuts as standard product. TGNC can make special customer orders using any flavour on any nut product or in this case proposed jackfruit seed. TGNC offer a contract roasting and coating service. The product supplied by the client is roasted and coated and either returned in a 10 kg packaging option or can be contract packaged in the client’s own packaging. To undertake a sample production requires 35–40 kg of product that will be roasted with a pre-agreed coating and provided back to the client in a 10 kg pack (food-grade lined carton) at an estimated price of $3.60 kg (for 10 kg carton) or additional costs if packaging is required in smaller units. TGNC currently pack their product in 50 g and 175 g packaging.

Sanitarium (young jackfruit or large jackfruit segments dried or juice)

Dr John Aston, Sanitarium Development and Innovation Centre at Cooranbang, New South Wales, was contacted for comment and discussion on jackfruit. Dr Aston explained that all product used in the development of products was semi or fully processed, without seeing any samples of the product it
was thought that the jackfruit could be used as an ingredient such as a dried powder, or dried diced fruit used in a breakfast cereal or as a juice ingredient for incorporation into a further developed product.

**Simplot (jackfruit young or portions for meal development)**

Melbourne-based Simplot Australia is a wholly owned subsidiary of the JR Simplot Company, a privately held food and agribusiness corporation based in Boise, Idaho. Simplot has sales per annum in excess of AUD7.5 billion. Simplot Australia was established in 1995 and has grown to become one of the biggest consumer food businesses in Australia with leading brands such as John West, Birds Eye, Edgell, Leggo’s, Chiko, I& J and Top Cut. Simplot Australia provides products in the Australasian ready meals market through a combined license and acquisition arrangement with Nestlé Australia.

Simplot Australia has under licence the leading frozen meals brand Lean Cuisine and Maggi frozen brand, and the Papa Giuseppi frozen pizza brand manufactured at the Pakenham facility, near Melbourne operating as Gippsland Food Company. In discussion with the purchasing area, little or no knowledge of jackfruit was shown. Its use as a meat substitute would require it to be semi-processed by being prepared and steamed ready for further cooking. The product would have to be individually quick frozen in either 2.5 or 5 kg packs. If there was need for a small trial run, Simplot would require 30–50 kg and for a small run of a product (for example, a meal such as a curry) approximately 250–500 kg.

**Patties Foods Operations (Chefs Pride range of frozen fruit, jackfruit frozen)**

Chefs Pride specialises in supplying high quality frozen fruits, purees and vegetables to the Australian food industry. It has an interest in the supply of frozen fruit and manufactured fruit puree. It requires further discussion with industry and identification of manufacturing volumes. Patties Foods also use a processing company in Brisbane to process fruit into purees to meet their requirements.

The results of the telephone survey were mixed; most companies showed an interest in jackfruit when they understood what the product was and that it was grown in Australia. General knowledge about the fruit from most of the companies surveyed was very low and most commented that their Asian staff knew a lot more about the fruit and what to use it for. To be effective in developing value-added products for use in further manufacturing requires the industry to engage these and other manufacturers, working with them to develop new and exciting products. Almost one-third of the firms contacted in the survey by email and by telephone declined to comment on the use of jackfruit for further manufacturing purposes due to the lack of availability of processed value-added products ready for trials and testing.

**Food industry/consumer education**

A domestic strategy is required to build consumer knowledge about Australian jackfruit. That will be important for growing the market among small retailers, consumers and the food industry, including the uses for further processed and value-added jackfruit products. Understanding and recognition of quality standards applying to the industry’s produce and the potential to label and brand Australian jackfruit is critical for the market. The potential also exists to develop a certified trust mark to identify Australian jackfruit under the ‘Grown in Australia’ brand thereby enhancing the reputation and integrity of the Australian industry.

**Packaging and distribution systems**

Currently jackfruit is sold loose and ‘hand to hand’ at the fresh fruit markets. Building commercial volumes and new product development for value adding of jackfruit will require the use of packaging and distribution systems which maintain the integrity and value of the product in transportation and in cold storage.
Technical trials need to be developed to support the integrity and premium value of the product and to maximise two-week shelf life in a retail environment. The following packaging systems outline potential opportunities for value-added jackfruit products.

**Fresh cut fruit and vegetables**

Minimally processed fruit and vegetables are composed of living tissue undergoing catabolic metabolism including respiration (basal metabolic rate varies for each commodity – respiration quotient), enzyme systems remain functional, water loss occurs under normal atmospheric conditions (evaporation), and abundant micro flora are present at the time it is packaged prior to storage and distribution. Minimal processing exacerbates this quality loss by increasing respiration rate, increasing the availability of released nutrients for micro flora utilisation and growth; cellular constituents (enzyme/substrates) intermix and induce discoloration reactions (polyphenol oxidase) as well as tissue softening. The rate of metabolism is temperature dependent, and metabolic reactions are affected by the levels of oxygen, carbon dioxide, ethylene and other volatiles in the atmosphere.

The aims when packaging minimally processed fruit and vegetables to extend their shelf life are to: decrease aerobic respiration rate, decrease microbial populations and/or microbial growth rate, retard moisture loss, inhibit or retard enzyme-catalysed softening and discoloration reactions, and delay ripening/maturity/senescence. However, avoiding anaerobic respiration is crucial to maintaining a quality product.

**Modified atmosphere packaging (MAP)**

MAP involves the enclosure of a food product in a package in which the atmosphere inside the package is modified so that its composition is other than that of air. Atmospheric modification for preserving fruit and vegetables can be achieved by removing air and replacing it with a controlled mixture of gases (gas flushing). The gas mixture is dependent on the type of product. The gaseous atmosphere changes continuously throughout the storage period owing to factors such as respiration of the packed product, biochemical changes and the slow permeation of gases through the packaging material. In general with fresh produce, the packaging restricts the transmission of respiratory gases, resulting in an accumulation of carbon dioxide and a depletion of oxygen around the product, slowing down the degradation processes and thus increasing the shelf life. Once the package is sealed, you have no further control over the internal gas concentrations.

Different products may require different films. The ideal package must balance atmospheric and storage conditions with package design, barrier properties and microbial load. For example, fresh herbs are packaged in plastic films (passive MAP) to prevent excessive water loss. Anaerobic respiration may occur in non-perforated, sealed polyethylene (PE) liners, while micro perforated PE liners prevent anaerobic respiration. The use of MAP and a suitable film with mango slices increases product shelf life substantially (up to 12 weeks) under MAP with high barrier laminated foil film. This may provide a useful model for packaging of processed jackfruit.

**Value-adding opportunities**

Fresh jackfruit has a shelf life of between 1–2 weeks in refrigerated storage. With the growth of commercial volumes of the fruit, there will be increasing competition for top retail prices for whole fruit.

There are several opportunities for value adding of fruit (see Figure 3-1, Figure 3-2, Table 3-1). The industry should seek support for research that achieves the following:

- shelf life extension including processing and packaging technologies supporting the extension of supply periods of value-added products for Australian domestic markets
- further processing technologies to enhance jackfruit as a value-added product.
Existing and new technologies need to be reviewed and evaluated for their potential to support the packaging and distribution of jackfruit as fresh pulp or flesh. As an example, such technologies may include blast freezing, vacuum packaging and high-pressure processing for the preservation and/or extension of shelf life of fresh jackfruit.

There is a high demand for new products for the food service and retail markets. For growers, the ability to provide specialised products provides a valuable outlet for jackfruit. Given the increase in future production facing the current growing group, the industry needs to find a market for its excess fruit as well as seconds.

Figure 3-1. The jackfruit arils (fruit segments) can be frozen well; and with the use of modified atmospheric packaging may achieve a refrigerated shelf life of up to 9–12 days to meet retail requirements for the food service industry.

Figure 3-2. Jackfruit while highly sought after have a strong odour.

Young smaller fruit are easily prepared however, older ripe fruit have a smell that has to be removed from the kitchen as soon as possible after processing. For this reason the fruit may not be as appealing to non-Asian consumers and may require processing of fruit at the regional level prior to sending to food service and food manufacturing businesses.
<table>
<thead>
<tr>
<th>Jackfruit product</th>
<th>Characteristics</th>
<th>Opportunity or use*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food uses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole fruit</td>
<td>Ripe jackfruit is greenish yellow in colour. The ripe jackfruit is a little bit soft, but not ‘squishy’.</td>
<td>Whole, well-formed fruit are supplied to Australian markets.</td>
</tr>
<tr>
<td>Skin or rind</td>
<td>Its outer surface is covered with blunt thorn like projections, which become soft as the fruit ripe.</td>
<td>The rind or skin is considered inedible, however it can be utilised in yielding a clear jelly with citric acid. A pectin extract can be made from the peel, undeveloped perianths and core, or just from the inner rind.</td>
</tr>
<tr>
<td>Pith/fibre</td>
<td>The fibre or ‘rag’ as it is commonly known can be eaten, it is semi sweet and once separated from the hard core can be steamed for use in stir-fry mixes or curries.</td>
<td></td>
</tr>
<tr>
<td>Young leaves</td>
<td>Used in curries and casseroles, tender jackfruit leaves and young male flower clusters may be cooked and served as vegetables.</td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>The seeds are floury, and high in carbohydrates.</td>
<td>The seeds, appeal to Asian and Indian tastes, may be boiled and eaten, or boiled and preserved in syrup like chestnuts. They have also been successfully canned in brine, in curry, and, like baked beans, in tomato sauce. They are often included in curried dishes. Seeds normally are steamed and eaten as a snack or used in curry or stir-fry dishes. The seeds are dried and powdered to get jackfruit seed powder or flour that has been blended with wheat flour for baking. Sugars obtained from the flour after starch hydrolysis can be effectively used in the fermentative production of organic compounds. Jackfruit seed starch had a narrower gelatinisation temperature range and requires less gelatinisation energy compared with modified starches, this in turn reduces the cost of starch hydrolysis.</td>
</tr>
<tr>
<td>Flesh</td>
<td>100 to 500 orange-yellow coloured edible bulbs in a single fruit. Smells of pineapple and banana. Flavours similar to a mix of passionfruit and banana</td>
<td>Frozen fruit – fruit can be frozen whole, in the skin or separated from the skin. Trials of the fruit show that they can be stored fresh in cold storage for as long as two months at 12–14°C. In Malaya, where the odour of the ripe fruit is not avoided, small jackfruits are cut in half, seeded, chilled, and brought to the table filled with ice cream. Ripe bulbs, sliced and packed in syrup with added citric acid, and frozen, retain good colour, flavour and texture for one year. Canned fruit – the flesh of the unripe fruit has been experimentally canned in brine or with curry. It may also be dried and kept in tins for a year. The crisp types of jackfruit produced in northern Queensland are preferred for canning. The canned product is more attractive than the fresh pulp and is sometimes called ‘vegetable meat’. Canned jackfruit retains quality for 63 weeks at room temperature (75° to 80°F/23.89° to 26.67°C), with only 3% loss of B-carotene. It may be canned in syrup made with sugar or honey with citric acid added. The addition of synthetic flavouring – ethyl and n-butyl esters of 4-hydroxybutyric acids at 100/120 ppm, respectively – greatly improves the flavour of the canned fruit and the nectar. Fruit juice – may be supplied as a juice either by itself or in a mixed juice product. The ripe bulbs are mechanically pulped to make jackfruit nectar or reduced to concentrate or powder. Fresh cut fruit packaged for the fresh cut market – whole fruit are cut into chunks, boiled in lightly salted water until tender, flesh is cut from the rind.</td>
</tr>
</tbody>
</table>
**Jackfruit product | Characteristics | Opportunity or use**
--- | --- | ---
and served as a vegetable, including the seeds which, if thoroughly cooked, are mealy and agreeable. The bulbs may then be enjoyed raw or cooked (with coconut milk or otherwise); or made into ice cream, chutney, jam, jelly, paste, ‘leather’ or Papad, (a form of pancake or baked bread product). Green fruit is also commonly used in vegetable curries.

Dried fruit (pieces) – used in fruit & nut mixes. Cross sections of dried, unripe jackfruit are sold in native markets in Thailand. By a method patented in India, the ripe bulbs may be dried, fried in oil and salted for eating like potato chips. It may also be dried and kept in tins for a year.

Dried fruit (powder) – used as a spice or flavour enhancer.

Preserved or pickled fruit – tender young fruit may be pickled with or without spices. Candied jackfruit pulp has been sold in countries like Brazil. The ripe bulbs, fermented and then distilled, produce potent liquor. Improved methods of preserving and candying jackfruit pulp have been devised at the Central Food Technological Research Institute, Mysore, India.

**Non-food uses of jackfruit**

**Latex**
Almost all the parts of the tree gives white sticky latex like juice when injured. After a period of time in cold storage little or no latex is present in the fruit.

The latex serves as birdlime, alone or mixed with Ficus sap and oil from Schleicheria trijuga Willd. The heated latex is employed as household cement for mending chinaware and earthenware, and to caulk boats and holes in buckets. Tanchico and Magapanlay have reported on the chemical constituents of the latex. It is not a substitute for rubber but contains 82.6 to 86.4% resins that may have value in varnishes. Its bacteriolytic activity is equal to that of papaya latex.

**Leaves**
Young leaves are readily eaten by cattle and other livestock and are said to be fattening. In India, the leaves are used as food wrappers in cooking, and they are also fastened together for use as plates. Leaves are often used for wrapping foods for steaming.

**Skin or rind**
Its outer surface is covered with blunt thorn-like projections, which become soft as the fruit ripe.

This waste product has previously been used for tobacco curing, although tobacco is no longer grown in Australia, this product may have uses for other natural fibre applications. Surplus jackfruit rind is considered a good stock food and in India and Asia it is fed to cattle.

**Wood**
Known as ‘jackwood’, it is an important timber in Ceylon and, to a lesser extent, in India; some is exported to Europe. It changes with age from orange or yellow to brown or dark-red; is termite proof, fairly resistant to fungal and bacterial decay, seasons without difficulty, resembles mahogany and is superior to teak for furniture, construction, turnery, masts, oars, implements, brush backs and musical instruments. Its strength is 75 to 80% that of teak. Though sharp tools are needed to achieve a smooth surface, it polishes beautifully. Roots of old trees are greatly prized for carving and picture framing. From the sawdust or chips of ‘jackwood’ boiled with alum, there is derived a rich yellow dye commonly used for dyeing silk and the cotton.

Creative woodcrafters use the wood to make the body of Indian drums such as Mridangam and Kanjira. In Indonesia and Philippines it used to make musical instruments like the Gamelan and Kutiyapi.

In Indonesia, splinters of the wood are put into the bamboo tubes collecting coconut toddy in order to impart a yellow tone to the sugar. Besides the yellow colourant, morin, the wood contains the colorless cyanomaclurin and a new yellow coloring matter, artocarpin. Six other flavonoids have been isolated at the National Chemical Laboratory, Poona. There is only 3.3% tannin in the bark that is occasionally made into cordage or cloth.

*see Morton (1987) for more detail on various uses of different jackfruit products
Trials and research

As a whole fruit

The jackfruit is a delicious fruit. It is highly sought after across Southeast Asia and the Indian subcontinent. The flesh of the jackfruit is starchy and fibrous and is a source of dietary fibre. The flavour can have characteristics similar to a tart banana, or a mixture of banana and pineapple. Varieties of jackfruit are distinguished according to the characteristics of the fruit’s flesh.

Jackfruit is commonly used in South and Southeast Asian cuisines, it can be eaten unripe (young) when cooked, or ripe uncooked. Jackfruit seeds may be boiled or baked like beans (cooking is necessary to make the seeds digestible). The leaves are used as a wrapping for steaming food.

Researchers in India have developed several value-added products from jackfruit bulbs, seeds and rind. Value-added products like halva, finger chips, ready-to-serve beverages, candy bars, Papad, dehydrated flakes, wine, vinegar, dairy-based products (like srikhand, kulfi and ice-cream), pickle from the rind (also a good source of pectin), and bulb flour have all been successfully prepared from jackfruit. Several bakery products such as biscuits, muffins masala vada and chapathi have also been developed from the seed’s flour.

Unripe jackfruit is much used by vegetarians in Southeast Asia and India as a substitute for meat, providing a fibrous texture similar to chicken. Jackfruit is available in the frozen food section of supermarkets in Southeast Asia. Out of season, it is available as frozen or dried slices of immature jackfruit (most useful for curry recipes) and frozen fruit arils. Canned unripe jackfruit packed in brine is called for in many recipes of Asian origin.

The arils (around, but not including, the seed) can be eaten as is, used for cooking or mixed into fruit salads or used as a juice in fruit beverages. The seeds need to be cooked through to render them digestible, but are extremely flavoursome once roasted or boiled. Recipes for cooking jackfruit always call for unripe jackfruit (whether stated or not).

Unripe jackfruit is the basis for many tropical curry recipes and most other recipes that call for cooked jackfruit. It is imported into Australia as frozen or tinned and is highly prized among communities with a strong Southeast Asian cultural influence. Frozen jackfruit (usually the smaller unripe fruit – approximately 360 g) is used right out of the package with no further preparation save thawing and cutting to the desired size. The outer rind is already peeled off, so there is no waste. The inner rind, rag, tender seeds and core are all edible. Recipes of Asian origin often call for ‘1 jackfruit’. The size intended is the small-unripened fruit, between 500 g to 1 kg, (around 400–700 g after cutting off the outer rind). Other recipes call for ‘1 can’, this indicates a 440 g can, (common in Asia) which will yield about the 360 g when drained.

Jackfruit recipes

A sample of recipes is attached as an appendix to this document to show the versatility of the fruit and demonstrate opportunities for its use.

Fresh cut fruit supply

There is strong potential for the value adding of jackfruit into the fresh-cut market. To enable this requires further processing in grower regions to enable the product to be competitively priced before shipment to market. Fresh fruit provided to the markets in modified atmospheric packaging (MAP) will provide the necessary long shelf life required for the product.

There’s a large saving in transportation costs if the fruit is treated in this manner. Fresh jackfruit arils account for less than half of the whole fruit once processed. Processing can either be undertaken by the growers (either individually or as a collective) or subcontracted to a fruit processing business in the
region. Processed fruit sells for up to $15.00 per kg in Australia and provides several benefits towards promoting the fruit to non-Asian market (one whole jackfruit can be as much as 40 kg and the waste, mess and odour generated from processing a whole fruit can readily turn consumers away from the fruit).

**Alcoholic fermentation**

Jackfruit wine is a traditional alcoholic beverage made by ethnic groups in eastern India. It is produced from the pulp of jackfruit. Ripe fruit is peeled and the skin discarded. The seeds are removed and the pulp soaked in water. Using bamboo baskets, the pulp is ground to extract the juice, which is collected in earthenware pots. A little water is added to the pots along with fermented wine inoculum from a previous fermentation. The pots are covered with banana leaves and allowed to ferment at 18 to 30ºC for about one week. The liquid is then decanted and drunk. During fermentation, the pH of the wine reaches a value of 3.5 to 3.8, suggesting that an acidic fermentation takes place at the same time as the alcoholic fermentation. Final alcohol content is about 7 to 8 per cent within a fortnight (Steinkraus 1996).

A commercial appetiser wine is currently made under the Chinnoose Brand, by Thekkumkattil Herbal Products located in Kinfra Park, Chungam, and Thalassery in Kannur District, Kerala. This appetiser wine is made using only natural ingredients like the choicest jackfruit, with no synthetic or artificial flavours. It can be consumed either as a social drink appetiser or as a wine. Processing deseeded aril bulbs through microbial fermentation has developed the wine. The developed wine is slightly yellowish in colour, acidic in taste and low in alcohol content. There is a huge demand from consumers for this wine due to its special taste and aroma. (Dr B Ranganna, Bangalore).

As part of this research, jackfruit has been trialled to manufacture a refreshing light alcoholic drink. Geoff Patritti from Patritti Wines, South Australia, trialled jackfruit sourced from the Northern Territory in the design of an alcoholic beverage. The trials were unsuccessful and this was thought to be a result of the thickness and consistency of the Northern Territory jackfruit pulp variety. Patritti Wines has indicated that there is a strong interest by consumers in fruit-based wines and drinks and believes that there would be an interest in undertaking product trials using the fruit of the ‘Orange Crunchy’ variety of jackfruit.

**Jackfruit oil extraction (jackfruit seed)**

Jackfruit is believed to contain a number of useful extracts including a yellow colouring (suitable for food use from the wood of the tree), seed flour and other health compounds.

Cootamundra Oilseeds (COS) provides services to the agricultural industry undertaking trials in oil extraction and seed-meal sampling. They have previously undertaken trials on jojoba, linola, mustard seed and a variety of other seeds. They discussed the opportunity of extracting oil from jackfruit seed. Initial investigation shows that it would require a solvent to extract the oil from the seed due to its low oil content, the seed is low in fibre, and is mostly carbohydrate and around 4 per cent moisture.

**Jackfruit seed flour**

Research in assessing the use of jackfruit seed in product formulation has been extensive in India and Southeast Asia. Opportunities for using ground flour from jackfruit seeds have been identified in formulations for biscuits, breads and savoury convenience products.

There is a potential opportunity for utilising the seed in the form of flour for value adding in industrial baking. Being rich in protein and carbohydrates, incorporating it into baking flour increases the nutritional value and attractiveness of the final product. An analysis of the seed flour (Airani 2007) has revealed the following (by percentage) composition: 14.07 of moisture; 9.03 proteins, 1.10 of fat, 2.25 of crude fibre, 3.01 of total mineral matter and 70.26 of carbohydrate. Jackseed flour packed in
polyethylene pouches was able to be stored for up to six months. There was an increase in the moisture content during the storage period both at ambient and refrigerated conditions.

Airani (2007), reports that on incorporation of jackfruit seed flour into two fried products, it brought down fat absorption to a remarkable extent with no discernible effect on the texture or flavour of savoury products (although it did affect the flavour of sweet products). It can be concluded from these studies that the replacement of seed flour up to 5 to 30 per cent is possible in various products.

These studies also found that the addition of 25 per cent jackfruit seed flour to biscuits, scored highest for extremely good colour and appearance, moderately good texture profile, and highly for taste and aroma. There is a clear argument for substituting a proportion of wheat flour with jackfruit seed flour.
4. The need for regional capacity building in the tropical fruit industry in far north Queensland

Building regional capacity for the tropical fruit industry in north Queensland or the Northern Territory requires the engagement of the broader industry and key stakeholders including the Queensland Department of Agriculture Fisheries and Forestry (QDAFF), other government agencies and industry peak bodies.

The flow-on effects from a successful industry will include long-term employment, added tourism and increased economic and social benefits to the region. Planning and coordination is the key to successfully building the capacity of the tropical fruit industry for successful growth and resilience.

There are key elements used in the building blocks for a successful industry:

- a strong industry association such as the Tropical and Exotic Fruit Association (TEFA) to act as a source of coordination and education and as the voice for industry participants
- the engagement of a training and education provider (a registered training organisation) to establish the training skills needed for the sustainment and growth of the industry
- the engagement of government agencies such as QDAFF to facilitate and guide the growth of innovation and research to underpin better industry outcomes.

Establishing a good, regionally-focussed training platform that addresses the skills needs of participants at all levels of the industry is essential. Even among industries as diverse as those that make up our emerging tropical fruit industries, common skill sets and training needs can be identified to support the growth of the industries concerned and the improvement of their value adding, supply chains and market management. During the compilation of this report, the author spoke with AgriFood Skills Australia about the steps required to build up skills capacity in the region to a point where it could support an expansion of the tropical fruit and related processing industries.

A registered training organisation would be well placed to provide the establishment and coordination of such a program. Such a course could encompass a Graduate Diploma in Agricultural Innovation and Diversification, delivered in combination of with face-to-face or distance (online) learning and incorporating recognition of prior education and training. Equally important to the establishment of such a training program is the identification and engagement of a significant proportion of growers/operators willing to undertake this training.

One potential source of funding for this would be the New Workforce Development Fund that provides priority funding for small, medium and large businesses to encourage employees to gain vocational education qualifications from Certificate 3 to a vocational graduate Diploma. Such a course requires the participation of at least 50 growers to be viable and cost effective. The involvement of growers from other industries (mango, avocado, banana etc.) may be necessary to achieve the required numbers.

Such a training package would provide training specifically targeted to the needs of the tropical fruit industry in the region. The benefits or outcomes of this twelve-month program would be the development of industry-specific products including:

- corporate governance and business skills training for industry participants, especially those involved or seeking to participate in the overarching industry association, i.e. TEFA
• an industry regional strategic plan that would provide direction and identify the requirements to underpin commercially, socially and environmentally sustainable regional growth for the industry. This document would play a crucial role in attracting government and other funding into the future.

• a business model that will engage growers and producers across and down the value chain to ensure that growers are properly remunerated for the input into a cooperative industry venture. A business model that incorporated the development of a regional tropical fruit industry value-adding facility would ensure that, at all levels of the industry, growers were engaged in driving change within the industry aimed at obtaining greater financial returns to the region.

• the skills, governance, strategic and business planning that this package would provide builds a solid platform from which the industry can strive to attract funding and support to commercialise, innovate and diversify businesses in a region, and to assist in financial growth and community resilience.

Finally, it is essential that industry and government (at all levels) do everything in their power to ensure the continuation of TEFA as a peak industry body for this industry. Without such a body, there will be insufficient coordination to sustain a training program, let alone the broader development of this industry towards economic sustainability.
5. Summary of results and findings

As a new tropical fruit industry to Australia, jackfruit has not been commercially developed for the Australian wholesale and food processing sectors and is predominantly sold as a whole fruit. There is little information on the fruit available to inform food service suppliers and food manufacturers including retailers, of the possibility of processing the fruit to value add and build a larger, more profitable industry. Ideally, TEFA would be an ideal association to assist growers to identify, plan and access resources needed to build a successful value-added jackfruit production facility in cooperation with other tropical fruit industry growers.

Apart from this current study, the industry requires extensive support in the development of research programs or assistance from Australian state or federal governments. Research needs to be focussed on developing a commercial business model that supports growers in a number of growing and supply issues ranging from marketing and value-added production of jackfruit, to the storage, transportation and management of the value-added fruit and other products to ensure a more profitable industry for growers in both the Northern Territory and north Queensland.

While the expansion of the industry is critical to its long-term success, TEFA does not have the resources available to promote and engage growers to build the industry.

Government agencies may be able to provide limited resources to assist in this. It is felt that improved industry communications by providing additional resources to organisations such as TEFA would support the growth of local or regional networks and increase the industry’s capacity to deal with issues such as production, quality assurance and market development.
6. Implications

Innovation is central to building different markets through identifying new ideas and putting them into practice. While TEFA and the growers support the growth of new tropical fruits, they require assistance to meet sustainable market demands through driving new directions in value-added products.

In the current global financial environment, product and market development presents both challenges and opportunities; although the jackfruit industry would appear to hold significant promise as a crop under the tropical fruit-growing industries, it requires an understanding of the opportunities for value-added products ready for development to grow the level of demand in existing markets for the available produce.

The industry is ready to take it forward to the next step of development, however it is distributed over two distinct locations in Northern Territory and in northern Queensland. Both locations grow distinctively different varieties of jackfruit. The challenge for the industry therefore, is the co-ordination and management of national issues associated with this anticipated growth, and TEFA has an important role to play here. Coordination of the industry’s development needs to be conducted in an efficient manner, which does not impose additional administrative costs upon the industry. Potential issues, which may require a whole-of-industry response in the future include:

- industry expansion marketing and consumer education
- industry quality and standards for the processing and development of value-added products
- industry sustainability through development of an efficient business model that can engage growers to work in a cooperative manner
- research and development to optimise product development and market intelligence.

While many of these issues will be commercial in nature, many may also benefit from investment in research. Research investment can support the Australian jackfruit industry in many areas such as:

- market research and consumer education (a critical issue for the industry)
- quality assurance in value-added product development
- packaging and distribution
- applications of new technology
- further research into the nutritional and health benefits of the fruit.
7. Recommendations

The recommendations are targeted at key stakeholders including RIRDC, other federal and state government departments, Australian tropical fruit growers and other growers keen to undertake growing or value adding to jackfruit or similar tropical fruit.

The major recommendations are that the industry engages in three areas to build a sustainable industry for the future:

1. Development of a sustainable grower business model and strategic marketing plan

   • Build regional capacity for the tropical fruit industry in north Queensland and the Northern Territory by engaging the broader industry and key stakeholders including QDAFF, other government agencies, industry peak bodies, and appropriate skills-training and coordination organisations such as AgriFood Skills Australia.

   • Establish a grower business model to engage growers to invest and support development of value adding to jackfruit.

   • Ensure that TEFA, as the representative body of the industry, has the resources and processes in place to manage and respond to potential whole-of-industry issues over the next five years.

   • Develop a regional or industry-based marketing plan that enables a cooperative effort from tropical fruit growers in north Queensland and the Northern Territory to value add a range of tropical fruits to sustain a manufacturing facility for 12 months continuous operation.

   • Establish an industry body to review strategies to underpin future policies for Australian jackfruit. These strategies may include branding, labelling, packaging and quality standards.

2. Education of food manufacturers, food services and consumers

   • Create a communication strategy that informs potential downstream chain partners and broader consumers about the whole fruit and new value-added product opportunities.

   • Support projects to educate local and national consumers and markets about the benefits and opportunities of using valued-added tropical fruit (including jackfruit) products. (For example, TEFA may like to offer top quality jackfruit as an ingredient in national chef’s competitions in addition to celebrity competitions. Each state has competitions to help them choose the state’s best 1st and 2nd year apprentice chefs. Jackfruit would be ideal for a mystery ingredient.)

   • Develop and support consumer and retail education of jackfruit to market associations nationally.

3. Research into value adding and product development for jackfruit and other tropical fruits

   • Most urgently, to engage in research into limited product development trials for value adding of jackfruit to establish new value-added products to utilise existing production levels. The research should be focussed upon new product developments that maximise the use of all parts of the fruit.

   • Establish and implement a quality standard for value-added Australian jackfruit and other tropical fruit products as the first stage of value adding and product development.
• Review and assess the benefits of processing and packaging technologies, which may enhance the
distribution and shelf life of processed jackfruit products.

• Carry out nutritional and health studies of jackfruit and other popular tropical fruit grown in
Australia.

• Encourage the availability of independent technical skills and resources in further processing and
value adding for tropical fruits (including jackfruit) through industry partnerships with food
service and food manufacturing organisations, encouraging them to engage in research into value-
added products suitable for further processing.
References


Research contacts

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**Simplot** for consumer information in Australia; Simplot Australia Locked Bag 3005 Braeside VIC 3195 Australia E: http://www.simplot.com.au/enquiry.asp

**Websites of interest for further literature on packaging, recipes and other information**


http://www.itfnet.org/gfruit/Templates%20English/Jackfruit.harv.pre.htm


Appendix. Some jackfruit recipes

Main Meal

Jackfruit curry

**Ingredients**

1. Young jackfruit, approximately 400 g (after skin removed)
2. 40g Bird chillies
3. 5cm Turmeric root
4. 225ml Coconut milk
5. 50g Anchovies
6. 2 pieces Dried tamarind slices
7. Salt to taste

**Preparation**

1. Peel the young jackfruit. Cut it into 2 x 2 cm cubes. Boil in water with salt and one piece of dried tamarind slice until soft.
3. Cook anchovies, ground ingredients, jackfruit, tamarind slices, coconut milk and a dash of water in a pot. Add salt to taste.
4. Simmer for 20 to 30 minutes over a moderate heat, add a little more water if necessary.
5. Remove from pot and serve.

Jackfruit fritters

**Ingredients**

1. 250 g young fresh jackfruit
2. 125 g chana dal (lentils)
3. ½ tsp jeera (cumin seeds)
4. ½ tsp kale mire (black peppercorns)
5. 1/4 tsp cloves
6. Pinch cinnamon
7. ½ stick ginger
8. 1 piece garlic cloves
9. 2 big onions
10. 1 medium-sized red dry chillies
11. 1–2 green chillies (as per taste)
12. 1–2 Tbsp cilantro
13. 1 cup water
14. Salt to taste

**Preparation**

1. Peel and chop fresh jackfruit.
2. In a saucepan, boil the jackfruit pieces in the water along with half an onion, green and red chillies, dal, ginger, garlic, jeera, cloves, peppercorns, cinnamon and salt. Simmer till tender and then let all the liquid evaporate completely.
3. Grind to a fine paste in a blender/food processor. Remove the spices that are difficult to grind. Mix remaining onion (chopped finely) and cilantro. Check for taste. Add a little cayenne pepper if its not spicy enough.

4. Mix well and then make small flat patties. These can then either be deep fried in oil or baked in the oven. I generally bake them in a preheated 375°F oven till they are golden brown (this can take a while, say 40 mins). Serve with mint chutney.

**Accompaniments**

**Jackfruit papad (Ponsa Appolu)**

The shelf life of this Papad is much longer than ordinary Papad and can be stored for a longer period. It can be utilised as an accompaniment to lunch as well as an evening snack.

**Ingredients**

- 1kg Raw jackfruit bulbs, deseeded
- Salt to taste

**Preparation**

1. Steam the bulbs for 20 minutes, when cool, add salt, mix and mash well with hands. Do not use a mixer. The dough should be very soft.
2. Make small balls out of it.
3. Take two small plastic sheet pieces. Smear them with oil on one side of each sheet. Place one ball on one oiled sheet, cover it with the other sheet, the oiled surface touching the ball.
4. Press plastic sheet covered ball with a manual wooden press or a metal press (a contrivance with two flat surfaces and a handle) to form round Papad. Or else pat the ball (keeping it between the plastic sheets) with the fingers to form a uniform thin round Papad. Repeat the process till all the dough is done.
5. Dry them in the oven on a low heat, if necessary in batches. When completely dried, store them in an airtight container.

**Desserts**

**Caramelised jackfruit and bamboo**

**Ingredients**

- 30 g brown sugar
- 1 vanilla bean, scraped for pulp
- 250 g jackfruit, segmented
- 125 g bamboo, pre-blanced in salted water
- 1 fresh lime, juiced
- 250 ml pineapple juice

**Preparation**

1. Heat a heavy-based pan and place the brown sugar in to caramelise, quickly.
2. Add the pineapple juice and vanilla bean pulp, add bamboo and reduce the syrup
3. Add the jackfruit segments and finish with freshly squeezed lime juice.
Jackfruit and coconut ice cream

Ingredients
- 250 ml coconut cream, canned
- 125 ml milk, full cream
- 400 g sugar, castor
- 1 g salt
- 450 ml cream, heavy
- 125 g cream, low fat
- 15 g vanilla extract
- 125 g jackfruit, fresh
- 100 g roasted coconut

Preparation
1. Place milk and coconut milk in a small saucepan, and warm over medium heat. Do not boil.
2. Remove from heat, and stir in sugar and a pinch of salt. Add heavy and light cream, and vanilla extract.
3. Pour milk mixture into an ice cream maker and churn as per manufacturers’ instructions.
4. Cut up jackfruit, and add to ice cream together with roasted coconut. Keep in freezer until serving.
Value-adding options for tropical fruit using jackfruit as a case study

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