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Commercialisation of Boab Tubers

A report for the Rural Industries Research and Development Corporation

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Foreword

The young root and shoots of the Boab *Adansonia gregorii* were previously identified as having potential as a horticultural crop. There is currently no commercial use of the Boab for this purpose or any evidence of historical or cultural use. Thus boab is an entirely new product in the market place.
This study addresses many of the issues identified in a previous RIRDC study (publication number 02/020) that posed impediments to commercial production.

This report examines the agronomy, supply-chain requirements, product use development, marketing and promotional aspects required for the full commercialization of this new product. This new product may have the potential to develop a new and unique horticultural industry in Northern Australia and give small producers an opportunity to diversify.

The findings have identified methods for improving seed germination, mechanisation of production, plant spacing and legal requirements for seed collection. A large range of products, both fresh and processed, have been developed and a recipe booklet has been published for promotional purposes.

This project was funded from RIRDC core funds which are provided by the Australian Government through the New Plant Products Program, the Western Australian Department of Agriculture and Boabs in the Kimberly.

This report is an addition to RIRDC's diverse range of over 1500 research publications. It forms part of our New Plant Products R&D sub-program which aims to facilitate the development of new industries based on plants or plant products which have commercial potential in Australia.
Most of our publications are available for viewing, downloading or purchasing online through our website:

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Peter O'Brien
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Abbreviations

CALM	Conservation and Land Management

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Background

The first preliminary study conducted on the Australian Boab *Adansonia gregorii* demonstrated that the species has many of the characteristics that make it suitable for a commercial vegetable crop. From the agronomic perspective many aspects of boab production can be mechanised and potentially it can be a fast growing high yielding crop with limited pest and disease issues. From the consumer's perspective boab appears to be a very versatile product that maintains its integrity when cooked, has a good crisp texture and a highly acceptable flavour. The product has high protein content for a vegetable, and is also high in iron and potassium. The leaves also have a very high vitamin C content. From the marketer's point of view, boab is a completely new product that attracts consumer curiosity and the tree has local iconic value which adds widely to its appeal.

What is the report about

The preliminary study identified a number of impediments which need addressing for commercialization including consistent seed germination and market and supply chain development.

Methods used

The current study examined in detail the seed germination issue and has found that the *Adansonia gregorii* seed requires a minimum 25^0 C soil surface (to 5 cm) for any germination to take place. The optimum minimum temperature required is 27^0 C with 30^0 C for maximum germination and plant growth. High moisture content between 80 - 90% field capacity is also required to break seed dormancy. Seed age was found to play an important role in germination and different treatments need to be applied to the seed depending on the age of the material.

Implications for industry

Most aspects of boab root production such as seed extraction, sowing and harvesting of the crop can be mechanised. Uniform seed germination would be a necessary requirement for mechanised harvesting as irregular germination would create excessive waste.

Boab produce is ideally stored and transported at $3\,^{O}$C , though given volumes of production are small, consideration needs to be given to the produce which normally shares the remaining transport load (eg melons stored at $5\,^{O}$C).

Market development has been approached from several different angles including creating public awareness through television, radio and print media; product use development through the catering industry resulting in the development of a recipe booklet on how to use the product, and consumer sampling. The product arouses a high degree of consumer interest although most do not have any idea of how to use it. An ongoing consumer education and promotion program is essential for the product to break in to the mainstream markets.

1 Introduction

Native Australian flora has contributed very little to the range of commercial horticultural food crops currently produced around the world today. The only noticeable exception to this is being the Macadamia nut, *Macadamia integrifolia*. This is somewhat surprising as a great number of Australia's flora species not only constituted a major role in the diet of Aborigines but some such as the quandong have been used non-commercially by Europeans since the time of settlement. However in recent years there has been a growing awareness in the horticultural industry that some of Australia's unique diverse flora has commercial potential. This has initially given rise to a small bush foods industry, which emerged in the 1980's.

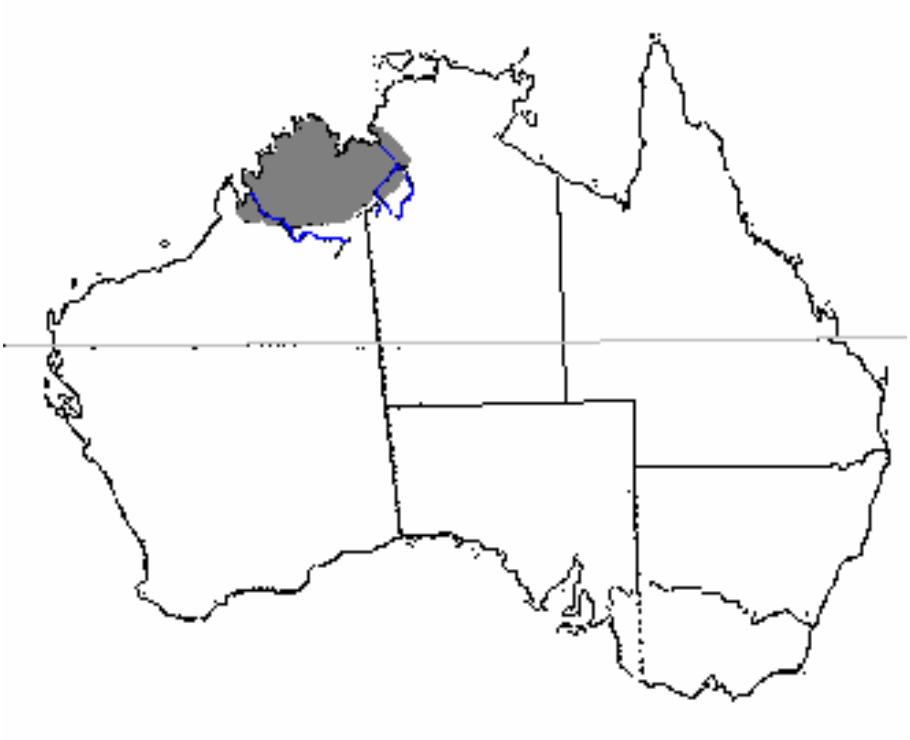
The Australian Boab, *Adansonia gregorii*, is part of the genus Adansonia and is unique in that it is only found in the Kimberley region of Western Australia. The genus contains only eight species – six of which are found in Madagascar and the other one in both Africa and Madagascar.

The fruit of the Boab are woody pods that range in size containing from a few up to hundreds of kidney shaped seeds. The pods are brown in colour with a velvet like layer on the outside. The seeds are covered in a white honeycomb pithy like substance that is edible and quite tart to the taste.

Cultivation of the boab is by seed. Boab cultivation is best suited to tropical climates. The tree is deciduous, being bright green in colour and in full leaf over the wet season from November to April and becoming the iconic stark figure in the landscape over the dry.

Boabs will grow where there is free draining soil, predominantly on sandstone country and along sandy creek beds. It is found from the sandy plains on the Logue River between Broome and Derby, to the Victoria River Basin just inside the Northern Territory border.

Natural Distribution of *Adansonia gregorii*



The initial project on '*The prospect of commercialising the Boab roots as a vegetable crop', (RIRDC 2002)* identified that the crop has potential as a novel and unique new food, and that the leaves were quite edible and tasty. The project looked into starting to grow small plots of the crop and identify what cultural factors were needed to grow it. Initial germination studies were undertaken as the germination levels were poor. Assessment of this new product was undertaken with chefs and the public to assess whether this new crop had the potential to make it in the wider market.

Seed germination
Problems that were encountered within the process of completing the initial project included a poor germination of seed particularly during the dry season. The boab seed normally germinates during the wet season. At the time a number of different seed germination techniques were trialled to break the inhibitor in the seed coat which can prevent good germination rates. From these techniques it was identified that a sulphuric acid dip and manual scarification significantly improved germination percentages. It was also discovered that the SO4 treatment only worked well on older seed. Seed collected in the same year as the seed treatment produced a negative affect. From this trial there was not sufficient information to isolate why this problem occurred. It was concluded that seasonal timing of planting had a major impact on germination percentages, the recommendation was that more work needed to be done in this area to find a solution to the germination problems. This would provide more information to assess the possibility of bringing germination levels up to the point where they would make this crop economically efficient to grow.

Seed collection
The collection of seed was also found to potentially be a problem particularly if a large industry was to form. Seed from the Boab tree currently is only collected from natural stands of trees on crown and pastoral land and from the occasional tree grown on freehold land. Permits are required from the Department of Conservation and Land Management (CALM) to collect the seed as the tree is a native species in Western Australia. The type of permit varies according to where the seed is collected. It was suggested that further evaluation of sourcing seed would be necessary to provide a more efficient collection system. Two areas were investigated to address this issue - the first was looking at encouraging local indigenous communities to collect and sell the seed. This would possibly only cater for a smaller industry demand. The second area that needed further investigation was to look into the licensing requirements imposed by CALM and consultation with them on a better solution for seed collection on a larger scale.

Mechanisation
To make the crop more economically viable it was also identified that mechanisation in the production of the crop needed to be further investigated.

Consumer education
Small scale market testing and consumer evaluation from the initial project created enormous interest in the tubers and leaves from the crop. This led to the inference that increased promotion would benefit this product by gaining wider community exposure, and marketing through the hospitality trade to realise the product's potential. Secondly it was found that there was a need for consumer education for this product for it to be accepted. As it was found that the public is not necessarily keen to try a totally new product especially when they have no knowledge of its uses. Promotion of the product through brochures and a recipe book could allow consumers to have a better understanding of what the product is, its nutritional value, and how to prepare, cook and the best ways to consume it. Packaging the product for selective specialty fresh produce retail supermarkets would also assist in raising the consumer awareness for those that go to their retail outlets looking for new and interesting foods.

In summary, from the first report the following was determined:

- more work was needed to achieve a crop that was both economically and commercially viable to be grown on a large scale.

- to achieve the commercialisation of the crop additional work is required to refine germination techniques and the production windows available. Information generated from this would also be able to be fed into the economic model (Johnson et al, 2002[1])
- some assessment of pre and post emergent herbicides is necessary
- a reliable seed source is needed to be [1]secured which may need some long term planning of parent trees as a seed source.

Once these issues have been resolved a strategic promotional and marketing campaign will be required to introduce the product into the mainstream market. This may not be as difficult as with some other products judging by the wide spread interest the project has generated and the genuine interest of the public in the Kimberley region of Western Australia.

Given the recommendations from the initial project into growing the native Boab, *Adansonia gregorii* as a commercial root vegetable, a significant amount of potential was identified. Preliminary investigations have identified that this product is safe to eat, it can be grown, mechanisation is possible and it is potentially a low cost high return crop. The product has been extensively promoted (although on a small scale) to a wide selection of the community and there is considerable interest from initial end user evaluations.

This report addresses the issues raised in the preliminary boab report and many of the recommendations have been substantially progressed as has been detailed in the report. It is believed that the crop has good potential both in Western Australia and at a national level and for the long term, as a potential export crop.

[1] Johnson, P, Robinson, C and Green E (2002) The prospect of commercialising boab as a vegetable. RIRDC Report 02/020. Canberra

2 Objectives

Objectives of the project are:

1. To follow on from the preliminary studies undertaken in the last funded project for the Boab tuber and,

2 To present the product to be commercialised and start implementing a plan to bring this new unique product to the consumers of Australia.

To achieve these objectives the following goals need to be implemented:

- Identify techniques to improve seed germination to levels that will be viable for commercial production.
- Identify best practice techniques for mechanisation of the Boab crop, including optimum planting densities.
- Liaise with potential industry participants and have them ready to accept the product in the market.
- Market and promote the boab tubers and leaves though marketers, restaurants and other media such as television.
- Make the product known to the public and to gauge the potential market size and interest in the product.
- Work on supply chain development for the new boab root product from the grower through to the end users.
- Publicise the results and information.

3 Methodology

3.1 Seed

3.1.1 Further investigation in collecting native seed

Department of Conservation and Land Management (CALM) should be contacted to identify the requirements of commercial native seed production and whether in future there will be restrictions on the seed collection of the native Adansonia gregorii (Boab) if the numbers of growers increase. Licensing requirements should also be clarified for growers who collect off their own property, who collect off crown or pastoral land or who plant trees on their own property to collect seed from in the future.

3.1.1.1 Detailed seed collection data

Following on from the initial project where it was concluded that on average each pod contains fifty seeds, a more detailed seed extraction count is to be undertaken to estimate potential seed gain in kilograms from a large harvest of seed. This will include number of pods and pod weights, weight of pith and seed then the weight of just the seed once the pith had been removed.

3.1.2 Detailed germination assessment

From the initial project it was determined that germination levels for this crop are not at a viable level for large scale planting and the seed tends to come up staggered over time. This is due to the nature of the native seed having an inhibiting seed coat to suit climatic conditions in the Kimberley region. A couple of different seed sources will be sent to the Department's south Perth site for evaluation into the best pre-seed treatment techniques to increase germination levels and provide a more even germination of the crop.

3.1.2.1 Investigating seed pre-treatments of Adansonia gregorii to enhance germination percentages for commercial application.

A comprehensive matrix seed germination evaluation was set up to test a range of pre-treatment techniques and define the most efficient and practical treatment method for application to commercial production.

The evaluation was undertaken at the Department of Agriculture's Floriculture Native Plant Breeding and Experimental Nursery, South Perth in 2004 - 2005.

Materials and Methods

Seed Source
Three sources of *Adansonia gregorii* (Boab) were supplied for the evaluation.
Seed Source No 1: FW 1 2003 collection
Seed Source No 2: Fox River 2002 collection
Seed Source No 3: Melissa Booth collection

Figure 1 *FW1 2003 seed*

Figure 2 *Fox River 2002 seed*

The Melissa Booth sourced seed was not used as it contained a high percentage of seed coat and ovule damage.

A 1000 seed count evaluation was used to determine percentage of seed viability by sectioning to determine endospermic maturity and seed add mixture contaminants.

Media

Potting media was made "in-house" and consisted of:
2 parts washed and pasteurised coarse river sand
1 part Canadian Peatmoss
1 part Perlite® 500 grade
0.5 part Perlite® 400 grade
2.5 grams per litre 6 -8 month slow release Scotts Osmocote® "Native Plant fertiliser". NPK ratio 19 + 2.6 + 10
2.5 grams per litre 3 -4 month slow release Scotts Osmocote® "Native Plant fertiliser". NPK ratio 19 + 2.6 + 8.3

Seed Treatments

Seeds were pre treated and hand sown into 100 cell seed trays. The cells measured 30 mm x 25 mm x 40 mm deep. *(see Fig 3)*

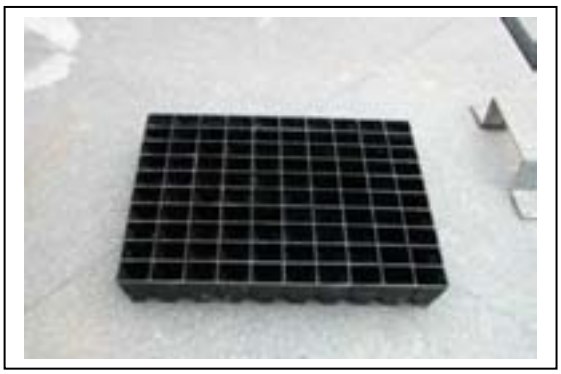


Figure 3 100 cell seed tray 30 x 25 x 40 mm

Treatment details are shown in *Table 1.* One hundred seed per treatment x seventeen treatments were used for each seed source. A matrix numbering system was used to track the additional treatments which were imposed over the base treatments of seed scarification or seed imbibing.

All seed was screened though a 7 mm sieve to remove admix such as small seed, pod fragments and separated pith. *(see Fig 7)*

The base seed scarification treatments 1 – 10 (Matrix Nos 1- 1.9) were performed to remove seed pith and reduce seedcoat density.

A Lapidary polishing machine and modified tumbler was used in these treatments. *(see Fig 4)*

Figure 4 Lapidary tumbler

Figure 5 *Glass paper lined tumbler***.**

The tumbler barrels have the inside surface modified via the insertion of varying grades of glass paper. *(see Fig 5)*

Depending on the intensity of the scarification required, the necessary grade of glass paper was inserted through the screw top opening of the plastic tumblers. The heavy duty abrasive paper adhered to the moulding of the inside wall and no further clamping was required. The seed lines were placed in separate tumblers and "scarified" for 5 hours.

This system will effectively treat upwards of 500 boab seeds per tumbler at one time. More seeds could be treated with the larger tumbler.

<u>Treatment 7 (matrix 1.6) "Smoke Etching".</u>

Aerosol smoke was puffed into the tumblers after approximately 5 hrs of scarification, using a 'bee smoker'.

The seed was removed from the tumblers before smoke induction and sieved to remove the fine dust and pith collections and returned to the tumbler for the smoke etching treatment. The glass paper was also removed, cleaned of residue and re-inserted.

Smoke generated from barley straw was induced into the open tumblers. When the tumbler cavity was completely saturated with smoke the lids were replaced and the tumblers returned to the electric lapidary turner for 1 hour. The treated seed was removed and sealed in plastic bags awaiting sowing.

Treatment 12 (matrix No 3) "Pith Removal, Water Soak and Leachate Irrigation."

The two seed lines were soaked for 24 hours in large beakers. A 0.05% non-ionic wetting agent was added. The seed was irrigated for 5 minutes under a high volume water flow at the end of the soaking period. Seed was placed on a 4 mm sieve for the irrigation process. Any extra pith still retained on the seed coat was removed during this time.

The irrigation process was designed to leach out any chemical inhibitors released from the seed during the prolonged soaking.

The seed was sown into cell trays while in a hydrated condition taking advantage of the softened seedcoat to better assimilate soil moisture uptake.

The treatment was also tested separately for large scale seed-lots. The test was conducted using a cement mixer, sand, non-ionic wetting agent and 7mm sieve. *(see figs 6 & 7)*

Figure 6 *Cement mixer with sieve attachment* ***Figure 7*** *Sieve 7mm*

Separate seed lots were soaked for 24 hrs in the cement mixer. *Important Note* the mixer was fitted with a plastic barrel as standard and the recommendation would be to use only this type of mixer.

A non-ionic wetting agent at 0.05% was also added to aid uptake of moisture to dissolve the pith from around the seedcoat.

At the completion of the soak period, coarse sand was added to the barrel and the machine operated for 20 minutes providing agitation to remove any remaining pith from the seed.

The seed was caught in the attached sieve when the machine was emptied with the sand and water passing through the sieve.

The seed was irrigated while in the sieve for a further 5 minutes.

This test was conducted at a different time of the year to the matrix test. The results are not included for discussion here but were comparable with those obtained from treatment 12.

The methodology for the remaining treatments is briefly explained in Table 1 with reference to the following specific information.

The smoked water solutions (treatments 10, 11 & 14) were made from assayed 98% strength stock solution obtained through Kings Park and is commercially available as a "Native Plant Seed Starter" pack.

The gibberellin and potassium nitrate solutions, where used (treatments 3, 4,5,8 &9) were made from laboratory grade (Sigma) chemicals.

The "Pro-Gibb®" (treatment 6), was a commercially available source of gibberellic acid from 'Valent Bio-Sciences' – active ingredient GA_3 100 grams / litre in methanol solution 742 grams / litre.

Treatments specifying seed soaking in solutions under light were placed in glass containers under a single 20 watt quartz halogen bulb, mounted 150 mm above. Solution temperatures were held at 20^0 C.

The light treatment used on extended time soaking could also trigger any light responsive mechanism within the seed biology to break dormancy.

The germination trial was conducted in March – May 2004 within a plastic twin-skinned growth house, under conditions of diffused natural light to 250 - 300 micro-Einstein (µEm-2 s-1).

Climate control was achieved through operation of gull-wing ridge venting and evaporative air conditioning. House day temperatures ranged from 27^0 C to 30^0 C late summer – early autumn. Diurnal variations ranged from 22^0 C to 25^0 C.

Seed trays were placed on thermostatically controlled heat mats with minimum soil temperature recorded at 27^0 C at night and 32^0 C maximum daily temperature.

Irrigation scheduling operated through automated controllers overhead (Netafim® 56 litres per hour pressure compensating) delivering 9 litres in two cycles per day during high temperatures and 7 litres per day during low temperatures < 25^0 C. All calculations were based on an air filled porosity (AFP) of 12% using cell size of 30 mm x 25mm x 40mm.

Table 1 Treatment layout and description

Treatment No	Matrix No	Treatment Descriptions	Treatment Procedures
1	1	seed coat scarification	seeds scarified in tumbler to remove pith coating 5 hrs - sown to cell trays
2	1.1	plus thermal shock & hydration	scarified in tumbler, pre-heat oven to 120 degrees Celsius. Seed exposed to 40 mins @ 120^0 C. Placed in cool water for 1 hour - sown to cell trays
3	1.2	plus KNO_3 @ 2000 ppm & GA_3 @ 20 µM	seeds scarified in tumbler, seed soaked 24 hours post scarification @ 20^0 C under light - sown to cell trays
4	1.3	plus KNO_3 @ 2000 ppm & GA_3 @ 20 µM	seeds scarified in tumbler, seed soaked 12 hours post scarification @ 20^0 C under light - sown to cell trays
5	1.4	plus GA_3 @ 20 µM	seeds scarified in tumbler, seed soaked 12 hours post scarification @ 20^0 C under light - sown to cell trays
6	1.5	plus Pro-Gibb	seeds scarified in tumbler, seed soaked 12 hours post scarification @ 20^0 C under light - sown to cell trays
7	1.6	plus smoke etching	seeds scarified in tumbler and exposed to aerosol smoke - 2 hours - sown to cell trays
8	1.7	plus oven heat 3 days & GA_3 @ 26 ppm soak 24 hrs	seeds scarified in tumbler, pre-heat oven to 70 degrees Celsius. Seed exposed to 56 hrs @ 70^0 C. Placed in GA3 24 hrs post heat treatment - sown to cell trays
9	1.8	minus oven heat, GA_3 @ 26 ppm soak 24 hrs	seeds scarified in tumbler, no heat treatment - placed in GA_3 24 hrs post heat treatment - sown to cell trays
10	1.9	plus soak smoked water @ 10:1	seeds scarified in tumbler, seeds immersed smoked water, soaked 17 hrs - sown to cell trays
11	2	smoked water soak 12 hours - no pith removal	seeds with retained pith - soaked in smoked water 10:1 - 12 hrs - some pith still retained on seed coat when sown wet.
12	3	pith removal water soak & leachate irrigation	soak 24 hours cold water - irrigate seed under water flow 15 mins to remove any chemical inhibitors as leachate – sown to cell trays
13	3.1	plus GA_3 @ 20 µM	soak 24 hours cold water - irrigate seed under water flow 15 mins to remove any chemical inhibitors as leachate - seed soaked 12 hours post irrigation @ 20^0 C under light - sown to cell trays
14	3.2	plus soak smoked water @ 10:1	soak 24 hours cold water - irrigate seed under water flow 15 mins to remove any chemical inhibitors as leachate -seed soaked 12 hours post irrigation @ 20^0 C under light - sown to cell trays
15	4	seed coat acid scarification	seeds soaked 5 hrs 98% H_2S0_4 - rinsed 5 mins under running water
16	4.1	seed coat acid scarification	seeds soaked 10 hrs 98% H_2S0_4 .rinsed 5 mins under running water
17	5	control	seeds direct sown to cell trays - no pith or seed coat removal treatments.

3.2 Crop Production

3.2.1 Mechanisation of the crop

From initial trials it was identified that the crop may be able to be planted mechanically using a cone-seeder. Following on from this further research will be conducted into the mechanisation of planting the boab seed particularly looking at planting densities, row spacing and row densities able to be planted this way. It is also hypothesised that the boab crop could be harvested using mechanisation similar to that used by the carrot industry, so it is proposed to trial this method of harvesting the crop, given the results of the seed germination studies provide a crop that can be of similar age to be picked at the same time. With the problems encountered with weeds in the preliminary project plantings it is proposed to also trial pre and post emergent herbicides.

3.2.2 Optimum plant spacing

As part of the mechanisation trial in using the cone seeder to plant the boab seed, it is necessary to look at the optimum planting density and spacing required to grow the crop given the constraints with machinery and irrigation. This will provide information on required crop spacing for optimum growth, which will provide the best quality tubers and the best yield per hectare possible.

3.3 Grower Input

To undertake the commercialisation of the new product it was imperative that a grower input was involved to work through the commercial practicalities of growing the crop and assist in the setting up of the supply chain and promotion of the product. Growers were required to produce commercial quantities of the product in conjunction with researchers to assist with developing the agronomic techniques involved in the crops production. Grower input is also important in creating links in the supply chain and assisting in the development of the promotional strategy.

3.4 Marketing and Promotion

3.4.1 Promotional material

As the product has no traditional market the consumer is mostly unaware of the product, and how to prepare and use it. Promotional material will be put together to provide consumers some ideas on product versatility and use and its preparation requirements before use. Additional information outlining the products nutritional information/benefits and description of where it comes from has also been found to be of great interest to consumers. Promotional material put together will need to be either targeted towards a certain group of people i.e. consumers or chefs, or made generic to suit everyone's needs in understanding this new crop. Potential material to be put together could include brochures to go with the product, information sheets, posters, recipe cards, a recipe book or packaging for the product with a label.

3.4.2 Multi media promotion

In order to get the product out there in the consumers faces and have the maximum amount of coverage of the product Australia wide it is proposed to source different media outlets to do stories on the boab product and capture different audiences to create interest and hype for this new product. Potentially advertising can be extremely expensive so where possible targeting of media that would find this new product of interest will be the main aim to complete the promotional side of this project.

Where required, strategic paid promotions will be put in place to target specific audience groups.

As part of this phase of the project it is proposed to set up a website to provide information, necessary advice, to act as a point of contact to the grower, and to assist the supply chain development in the early stages of marketing.

3.4.3 Other products and promotional outlets

Identify if processing the product has potential for increasing the usability of the product. Investigate primarily if the product can be peeled and vacuum packed, grated and vacuum packed or cut up into julienne pieces or rounds and vacuumed packed. These trials can be conducted in Kununurra on a small scale.

Identify if there are any industry bodies that have contact with chefs who may be useful for the promotional of boab tuber and leaf. Bodies could include Catering institutes, educational institutions and food expos/ events. Make contact with them and provide samples for use and encourage the use of new products in the market.

3.5 Supply Chain Development

3.5.1 Market promotion – Industry participants/contacts

As part of the supply chain development for this new crop, looking at the conventional system of supply chain management, finding niche markets and fitting the product in to a sector will be the main aim of this objective. Identifying individuals and businesses that have clout in the market and who will be able to promote and push this new product will be investigated. These people could be renowned or respected chefs, media personalities or businesses that could add the product to their repertoire of products already in the public eye.

3.5.2 Restaurants/Chefs

Research of restaurants around Australia starting, in Western Australia, is essential to provide information and samples to chefs to trial and create recipes and gauge customer feedback. Being able to utilise the chef's feedback, expertise and skills to develop uses for the product is seen as a key factor in creating the promotional material requirements for that area of the industry and recipes for a recipe book.

3.5.3 Fresh produce specialty retailers

Provide samples to specialty retailers to trial the product in store to gauge customer needs and sales levels. From this initial assessment determine customer promotional needs and whether there are packaging requirements. Conduct in store demonstrations of the product to educate customers about the product. Identify retailer requirements for stocking the product for small specialty stores and the larger retailer chains. Investigate whether the product will sell as is or if it needs to be processed or packaged.

3.5.4 Market intermediaries

Consult with market agents in Western Australia as participants in the supply chain providing produce from the growers to the stores. Gauge their opinions of the product, which segment of the retail market they think boab would currently fit into and future growth; ascertain the shelf life and temperature requirements of the product with them if they are to be one part of the supply chain for the product.

Identify if there are any specialty providers or market intermediaries that can be used to promote and distribute the product specifically to restaurants other than market agents. The companies targeted will tend to supply restaurants only and are able to provide access to restaurants other than through market agents.

3.5.5 Product shelf life

The optimum storage temperature and duration of storage needs to be determined so this information can be disseminated to consumers and supply chain participants.

A small series of storage trials were designed to hold the produce at ranging temperatures and durations to ascertain the optimum conditions. Temperatures of 3, 7 and 13 degrees Celsius were chosen as this it the range of freight temperatures available to producers in the Ord Valley. The control was stored at room temperature. Produce was held and assessed on days 1,8 and 22 and a comparison of sealed and unsealed produce storage bags.

Produce was assessed for weight loss, appearance and crispness during the trial.

3.6 Freight

Freight from Kununurra can be problematic when dealing with small consignments. A number of different options need to be assessed to be able to deliver product to the major capital cities in a cost effective manner, such as road, air and post to determine the advantages and disadvantages of each system given very small and large quantities of boab root and leaf to be transported.

4 Results

4.1 Seed

4.1.1 Investigation into the licensing requirements

As the boab tree, *Adansonia gregorii* is a native plant in Western Australia, investigation was required to look at licensing requirements to collect seed and grow the plant as a crop. Further investigation into the Department of Conservation and Land Management (CALM) licensing requirements identified that a licence does need to be held to collect seed commercially and to grow seed as a plant.

CALM has two licences that cover the area of collecting boab seed. The first one is a nurseryman's licence which allows the holder to collect boab pods from private (freehold) land. It can be from the holder's own land or another parties land but must have written permission if it is from the other landholder. This licence is held for a year.

The second licence is a commercial purposes licence and this allows the holder to collect boab pods from crown land. Crown land includes pastoral leases and again the licence holder must attain written permission from the leaseholder to collect seed from the trees on their land. This again is held for a year but is much more expensive than the nurseryman's licence.

Both licences have collection limits which restrict the holder to taking only twenty percent of the pods from the tree or off the ground. This is comparable with other native species seed collection in Western Australia.

On top of the licence the boab is a special case native species where there is a fee or royalty imposed on the amount of pods collected. Again this correlates with other native species found in Western Australia. The royalty collected is approximately ten dollars per one hundred pods collected, and given the average pod contains fifty seeds, the royalty is calculated at two cents per ten seeds. The royalty payment only applies to the commercial purposes licence.

Trees that have been planted on privately owned property for seed collection purposes are also under the umbrella of this licensing requirement as they are still a native species.

As an alternative to using native species of boab, it may be possible to utilise the African species, *Adansonia digitata*, or one of the other Madagascan species grown as a seed bank. These plants are not native to Western Australia and therefore do not come under the CALM legislation. However further investigation into the suitability of this species would be required.

If seed collection was to increase in the Kimberley, i.e. several growers growing the crop, CALM would monitor seed collection sites to ensure particular sites were not being 'over-collected'. If indeed this were the case, it may be necessary to implement a boab seed collection management plan. This is possible as at the end of each year each licence holder must submit a return stating how many pods they collected and where they collected from.

A management plan for crown land that could possibly be put in place could be similar to that in place for the genus '*Stirlingia'* found in the south west of Western Australia. This variety has a large commercial market in the flora industry and is managed by CALM to prevent over-harvest due to the large number of licences held, and the limited area in which the genus grows. The licence holders are allocated a particular pocket of land to harvest for the season, they must abide by their twenty percent collection licensing agreement requirement. CALM then monitors the species to ensure the areas are not being over-harvested and that there will be new generations of the plant for the future.

As there a huge population of boabs in the Kimberley region over a vast area, the implications of having a management plan in place will only come into affect if a certain area was being over targeted, a large number of licences were being issued or the amount of seed written on the returns statement was extremely high.

4.1.1.1 Detailed seed collection data

Seed pods were collected as per research licence requirements. The seed was collected (off the ground) from different locations in the Kimberley region. Some of the pods were whole and intact whilst others had broken open. The following figures are a guide only to the extraction of seed from the given pods.

A total of 2619 pods were collected with a weight of 181.12 kilograms. Once the pods were weighed and broken open the pith and the seeds were weighed giving a weight of 99.02 kilograms. The pith was then removed from the seed in a cement mixer with sand to enable a scarification process of the seed at the same time. The weight of the seed at the end of the process was 79.16 kilograms.

The weight of 100 seeds was weighed and replicated to give an average of .45 grams. Therefore in 79.16 kilograms of seed, there would be approximately 176,000 seeds.

4.1.2 Germination assessment

The matrix evaluation, although not balanced throughout all treatment references, was designed to trigger responses which could direct further investigation at a later stage.

The germination results for the FW1 seed line from the matrix test in March – May 2004 are shown in Table 2 and for Fox River 2002 seed March – May in Table 3

The germination counts were recorded over a six week (42 day) period. Any germination noted after 42 days was not included in the data. Germination counts were taken on a 7 day cycle, starting at day 7 from sowing.

Seedling vigour or differences in growth habit were also recorded.

Table 2 FW1 germination results

Treatment	Seed Code	Seed No's	Germination No's	Germination %
1	FW1	100	39	39.00
2	FW1	100	0	0.00
3	FW1	100	56	56.00
4	FW1	100	52	52.00
5	FW1	100	45	45.00
6	FW1	100	35	35.00
7	FW1	100	66	66.00
8	FW1	100	40	40.00
9	FW1	100	52	52.00
10	FW1	100	47	47.00
11	FW1	100	35	35.00
12	FW1	100	81	81.00
13	FW1	100	78	78.00
14	FW1	100	60	60.00
15	FW1	100	43	43.00
16	FW1	100	42	42.00
17	FW1	100	1	1.00

Results varied between the FW1 and Fox 2002 seed lots on a per treatment basis with trends showing a response to seedcoat soakage treatments for the 1 year old FW1 seed and the more aggressive scarification techniques for the 2 year old Fox River 2002.

Adansonia gregorii seed requires a minimum 25^0 C soil surface (to 5 cm) for any germination to take place. The optimum minimum temperature required is 27^0 C with 30^0 C maximising germination and plant growth.

High moisture content between 80 - 90% field capacity is also required to break seed dormancy.

Table 3 Fox River germination results

Treatment	Seed Code	Seed No's	Germination No's	Germination %
1	2002 Fox	100	44	44.00
2	2002 Fox	100	0	0.00
3	2002 Fox	100	64	64.00
4	2002 Fox	100	48	48.00
5	2002 Fox	100	48	48.00
6	2002 Fox	100	50	50.00
7	2002 Fox	100	75	75.00
8	2002 Fox	100	46	46.00
9	2002 Fox	100	56	56.00
10	2002 Fox	100	56	56.00
11	2002 Fox	100	39	39.00
12	2002 Fox	100	66	66.00
13	2002 Fox	100	79	79.00
14	2002 Fox	100	62	62.00
15	2002 Fox	100	45	45.00
16	2002 Fox	100	44	44.00
17	2002 Fox	100	3	3.00

The Fox River seed selections showed a greater germination response to the scarification smoke etching (treatment 7) and the soaking + GA treatment (treatment 13).

Some growth rate changes were noted for all GA treatments where stem elongation was 10% greater measured at day 42 than for all other treatments.

Table 4 Combined FW1 & Fox River germination comparison table

Treatment	Seed Code	Seed No's	Germination No's	Germination %
1	FW1	100	39	39.00
	2002 Fox	100	44	44.00
2	FW1	100	0	0.00
	2002 Fox	100	0	0.00
3	FW1	100	56	56.00
	2002 Fox	100	64	64.00
4	FW1	100	52	52.00
	2002 Fox	100	48	48.00
5	FW1	100	45	45.00
	2002 Fox	100	48	48.00
6	FW1	100	35	35.00
	2002 Fox	100	50	50.00
7	FW1	100	66	66.00
	2002 Fox	100	75	75.00
8	FW1	100	40	40.00
	2002 Fox	100	46	46.00
9	FW1	100	52	52.00
	2002 Fox	100	56	56.00
10	FW1	100	47	47.00
	2002 Fox	100	56	56.00
11	FW1	100	35	35.00
	2002 Fox	100	39	39.00
12	FW1	100	79	79.00
	2002 Fox	100	66	66.00
13	FW1	100	78	78.00
	2002 Fox	100	79	79.00
14	FW1	100	60	60.00
	2002 Fox	100	62	62.00
15	FW1	100	43	43.00
	2002 Fox	100	45	45.00
16	FW1	100	42	42.00
	2002 Fox	100	44	44.00
17	FW1	100	1	1.00
	2002 Fox	100	3	3.00

Table 5 Days to germination FW1

Treatment	Seed Code	7 Days	14 Days	21 Days	28 Days	42 Days
1	FW1	0	5	18	22	39
2	FW1	0	0	0	0	0
3	FW1	5	9	20	25	56
4	FW1	6	18	35	48	52
5	FW1	10	15	42	45	45
6	FW1	0	3	20	30	35
7	FW1	0	10	60	63	66
8	FW1	0	5	24	30	40
9	FW1	3	8	18	36	52
10	FW1	0	6	20	40	47
11	FW1	0	0	10	20	35
12	FW1	12	40	70	72	79
13	FW1	10	18	58	70	78
14	FW1	1	15	31	53	60
15	FW1	0	8	15	32	43
16	FW1	0	6	16	30	42
17	FW1	0	0	0	1	1

Table 6 Days to germination Fox River 2002

Treatment	Seed Code	7 Days	14 Days	21 Days	28 Days	42 Days
1	2002 Fox	0	6	20	36	44
2	2002 Fox	0	0	0	0	0
3	2002 Fox	5	8	22	45	64
4	2002 Fox	5	12	22	48	48
5	2002 Fox	8	18	40	48	48
6	2002 Fox	0	2	20	42	50
7	2002 Fox	0	1	68	75	75
8	2002 Fox	0	2	21	33	46
9	2002 Fox	3	12	25	36	56
10	2002 Fox	4	13	30	48	56
11	2002 Fox	0	0	15	25	39
12	2002 Fox	10	38	52	66	66
13	2002 Fox	9	20	50	68	79
14	2002 Fox	0	10	30	51	62
15	2002 Fox	0	7	18	35	45
16	2002 Fox	0	8	18	22	44
17	2002 Fox	0	0	0	1	3

4.2 Crop Production

4.2.1 Mechanisation of the crop

Both the large scale trial and the smaller staggered trial were planted using a cone seeder. The mechanisation of planting worked well bar a few glitches in the system. The boab seed is rather large and irregular and did manage to block up the shutes on occasion during planting. The cone seeder was used as it was the only seeder that could be manipulated to plant four rows of seed on the one raised bed at a time. The raised bed system is used by the majority of the growers in the region so it was decided to use current industry practices. Once minor adjustments were made to the seeder to prevent the seed blocking in the tubes the seeding process went smoothly.

Mechanisation of the pith removal from the seed also presented good results. Using the thrasher to remove the pith from the seed and the concrete mixer with sand to scarify the seed saved time and allowed a large amount of seed to be processed efficiently.

A machine similar to a carrot harvester was developed by the participating grower. The machine worked very effectively indicating that the harvesting can be fully mechanised. However to maximise the benefits of machine harvesting a more even germination and maturity is required otherwise the potential wastage could be high.

Pre and post emergent herbicides were trialled in an effort to control the rampant weed growth within the crop. Although roguing of weeds is the best method of eliminating all weeds commercially it would be a high cost to the grower. The main issue in effective weed control was the high number of broadleaf weeds which makes the use of selective herbicides very difficult. Initially glyphosate at label rates was used to clear the planting area pre planting and during the first two weeks prior to seed germination. This was followed by the selective use of gramoxone (a knockdown herbicide) post emergent herbicide. This was trialled on one half of six rows of the static trial to assess its knock down potential on the weeds and if there was an affect on the boab seedlings. It was found that the treatment helped control the stand of weeds but it did also have an effect on the evenness and levels of germination. ‘Fusilade®’ (0.5kg/ha plus 2Lts DC Trate) was also trialled as a post emergent herbicide and showed good results on monocotyledon weeds. Good control of the broad leaf weeds was able to be achieved using glyphosate as a leaf wipe on the broad leaf weeds in between the boab seedlings. However, this technique proved to be very labour intensive. Pre-emergent herbicide Surflan® was used in an earlier planting which showed good results, however when used on a second planting it appeared to have an impact on germination.

The boab plants were able to out-compete the weeds once they achieved a certain size, although the sites that had achieved good weed control throughout the development of the crop achieved higher yields due to a reduced level of competition.

A large scale planting trial was set up in 2004 to be a demonstration trial and to assess possibilities and problems that may be encountered with commercial sized plantings. The trial area was 0.5 hectares and was watered using drip irrigation which previously had given good results and helped minimise weed growth, with no fertiliser application as per the preliminary result findings. It was used to assess mechanisation procedures and to supplement the trial grower’s crop for promotional work.

A trial that adopted staggered plantings was established in late 2004 and early 2005 to access continuous production over a number of months. There were five plantings of three rows each staggered over the wet season and into the dry season. This trial was used for promotional work in the form of samples, to assess maturity and to trial different herbicides.

In the first two plantings poor germination rates was attributed to planting too deeply. Once this was corrected in the remaining plantings the germination rate and the evenness of the germination improved.

The following table identified for the first three staggered plantings: planting dates; sample weights of marketable tuber size and; germination levels

Table 7 Germination and development of staggered plantings.

Planting Date	Sampling date	Days to sampling	Average weights (tubers only) grams kilograms	Germination (%)
22/10/2004	10/02/2005	111	0.102	13%
4/11/2004	10/02/2005	98	0.100	23%
18/11/2004	17/02/2005	91	0.076	27%

Figure 8 *Crop without post emergent weed control*

Figure 9 *With post emergent weed control*

Figure10 *Drip irrigation system adopted for trials*

4.2.2 Optimum plant spacing

With the cone seeder being found as an effective mechanisation tool for planting, plant spacing and densities were trialled to gain the best possible stand of boab over the site. The common use of raised beds in the region was followed as this is standard industry practice and the required machinery is readily available. Plants were originally planted in two rows on this raised bed system. It was proposed to trial four rows per bed such as that used by the carrot industry to achieve a higher yield over a smaller area. This system worked well so all other trials completed used the four rows per bed system.

The optimum plant spacing was proposed to be one seed every five centimetres, 200-250mm between rows on beds which are 1.8 meters apart. This spacing would provide a good stand of plants and prevent over crowding in the rows. Consideration needs to be given to what the harvesting machines requirements are when selecting a plant density.

4.3 Grower Input

The project has worked closely with a grower to help keep a commercial focus on the work. The property located at Weaber plains on the fringe of the Ord River Irrigation Area. The soils are classed as cockatoo sands with a pH between 6.5 and 7 are ideally suited for root vegetable production. Boabs are found extensively on this soil type under natural conditions. The farm is working towards organic production. Boabs fit very well into this system with their minimum fertilizer requirements and low pest and disease status.

On top of producing commercial quantities of the crop the growers have had significant input into developing the packaging, marketing and promotional program which has included several television segments filmed on the property. They have experimented with processing and have developed a range of processed products including chutneys pickles and marmalade's made from the boab root, as well as developing a web site www.boabsinthekimberley.com.au.

Figure 11 *A range of processed boab products* (Photos courtesy boabs-in-the–Kimberley)

The growers have also worked on designing and modifying existing farming implements for boab production.

4.4 Marketing and Promotion

4.4.1 Promotional material

Promotional material was put together to help educate the public about this new boab product, what it is, its nutritional values, how to prepare it ready for use and how to use it and how to cook it. Initially information sheets were put together and sent out with the product. From the information sheets a colour brochure was developed with more information and recipes. As more recipes were developed a recipe book was produced as a promotional tool. The recipe book included information on the product and the various recipes collected from chefs and locals.

Packaging and presentation of the product is critical to its successful marketing. Five and ten kilogram produce boxes are adequate for sending to restaurants and for sample boxes. It was determined from initial in store promotions that the product would need to be sold in packages with some product description and recipes for use. Several types of packaging and labels were developed. A 350 gram sized unit was chosen as it provided customers with enough product to try at a reasonable price and the packaging would be large enough to incorporate information about the product and a recipe.

Figure 12 *Examples of promotional and retail packaging being tested.*

4.4.2 Multi media promotion

To raise public awareness of the product a number of multimedia promotion tools were used. The newness of the product and people's curiosity and enthusiasm saw that initially it was able to receive wide spread coverage relatively inexpensively.

Several interviews were conducted on the ABC radio with an initial interview on 'what is this new product' and then a follow up on how it was progressing. Interviews were also conducted with the local grower.

Television presented a great medium to get people to look at the product, see what it was and how to use it. It was presented on channel nine "Postcards" (*WA program*) towards the end of stage 1 of the initial project in conjunction with the head chef from the Hyatt. From this boabs received a high profile and several other programs picked it up to run stories on "The Good Food Lovers Guide" on SBS who came to Kununurra to shoot a segment which went national. The ABC "How the West Was Won", came to Kununurra to shoot their segment "Talk of the Town" on the boab tubers. Interest has also been expressed from "The Garden Gurus" to have the product on their show but want an established market before they will have it as they want their viewers to be able to get a continuous supply of the product.

Magazines have also been an area that has taken interest in the product. The Perth based "EatDrink" magazine that caters for restaurants did a 'What's Hot' article. A freelance reporter based in Broome wrote an article for a travel magazine found on airlines and was keen to get an article in the magazine "Outback". The Australia wide "Organic Gardener" magazine is currently writing an article for their next edition. "Scoop" magazine has done an article earlier this year. "Vogue Lifestyle" ran an article as well as the "West Australian" daily newspaper.

Multi media has been a very effective tool for exposure of the product to the wider consumer markets and a large number of the enquiries have resulted from this. A website www.boabsinthekimberley.com.au was created by the grower to assist in market development.

4.4.3 Media awareness

Mass media is an effective method to create consumer awareness of the new product. Fortunately with boab and its perceived novelty value the media has been quick to pick up on the product and run a series of articles and programs. Below is a list of some of the media outlets used.

ABC' television's "How the West was won"
ABC local radio "Country Hour"
Channel Nine "Postcards".
The West Australian
EatDrink magazine
Organic Gardener
SBS Television's "Food Lovers Guide to Australia"
Vogue Lifestyle magazine
Kimberley Business & Lifestyle
Interview on ABC Perth radio - Breakfast show
ABC Radio "Country Hour"

4.4.4 Other products and promotional outlets

A range of other promotional outlets that have a range of different contacts have been identified and have proven beneficial. These include

The Catering Institute of Western Australia - Influential and respected amongst many key industry people through out Western Australia. They also organise chefs awards and festivals such as the Fine Foods Perth.

Fresh Finesse - a fresh produce marketing company in Perth has provided a number of contacts as well as providing promotional work.

Vince Garreffa - is a Perth butcher that has regular radio time. He also runs a once a month fresh produce market at his shop where he is keen to get new and interesting products in for people to buy.

A range of processed products which included chutneys pickles and jams have been developed by the growers as shown in 4.3. Trials with vacuum packaging were successful although the product did not look as presentable in this form compared to the plastic trays.

Experiments with mechanical peeling did not prove successful with the particular machine trialed. The blades did not appear to be suitable for removing all of the skin, however it is believed that mechanical peeling is technically possible.

4.5 Supply Chain Development

4.5.1 Market promotion – Industry participants/contacts

As boab is a new crop there is no existing supply chain in place, making it necessary to create one from the beginning. This process starting with the end user, creating a demand and then working back along the supply chain. It required identifying and then developing the necessary partnerships for the product, so it is able to be delivered in its best possible condition at a reasonable price.

4.5.2 Restaurants/Chefs

Through word of mouth and direct contact with chefs the boab tuber and leaf has been received enthusiastically as a totally new product with no culinary boundaries. Chefs were excited by the product once they worked with it and would often ask for more when they do promotional events and special dinners.

High profile chefs were targeted, those who are respected and have industry clout and product was sent to them to aid the product to be more widely used.

Chefs such as Chris Taylor from the Kings Park restaurant and Simon Naber who used to cook for the Kimberley True North cruise ship and has a restaurant in Cottesloe – Barchetta were selected.

Boabs were also selected as a feature product at a major media function organised by SBS at the prestigious Quay's restaurant in Sydney, proving to be very popular.

4.5.3 Fresh produce specialty retailers

Specialty fresh produce retailers were targeted and visited with samples to get some feedback on the product and if they would be willing to trial it in their stores. These select stores are all located in Perth, Western Australia, they were selected because of their reputations for stocking the best quality fruit and vegetables that deals with a cliental that has a willingness to try something new. The stores also provided an environment to trial the product and identify any additional needs that may be required by the consumer. Initially stores targeted were Herdsman Fresh Provisions in Shenton Park, Boat Shed Fresh in Cottesloe, Morley Fresh Markets in Morley and Fresh Provisions in Mt Lawley.

The response was positive though more information on the product was needed. From there the recipe book and packaging concepts developed. Both Herdsman and Fresh Provision are keen to stock the packaged product and have some in store promotions of the product for consumer experience and education.

4.5.4 Market intermediaries

In order for the product to be received, stored and distributed to customers it is necessary to form a relationship with a business that is able to perform these tasks. The market agent at the Canning Vale markets was chosen to assist the project to undertake these tasks. Including the receival of the product some of the technical information in regards to storage and distribution was developed. They also have a large network of buyers so potentially open up some opportunities for new buyers. Currently all the freight services leaving Kununurra go to the Canning Vale markets so establishing the distribution point there seems the most logical way forward. Initially with the supply of the product low from a restricted production base some degree of control of the market is possible, and single desk marketing may present an opportunity.

In New South Wales, a specialty food company expressed a willingness to undertake this task. PRIAM foods wanted to help with the marketing of the product. They provide fresh produce to the restaurants in the country areas around Sydney. They have been participating in the distribution of trial shipments to various restaurants around New South Wales.

4.5.5 Product shelf life

A trial was undertaken to identify how long the boab tubers would keep their freshness and crispness, and to identify the best temperature to transport it at and store it. The tubers were washed and the tops were removed. They were then placed in a sealed bag or a bag with holes in it. The tubers were then weighed and placed in a range of different temperature environments and stored over a number of days.

Table 8 Results from storage trials

Shelf life and temperature trial					
Temperature	Bag type	Day 1 Weight on initial day (grams)	Day 8 Intermittent weight	Day 22 Weight on final day	Weight lost (%)
Room	sealed bag	350	345	340	2.9%
Room	bag with holes	495	465	430	13.1%
13 degrees	sealed bag	455	455	440	3.3%
13 degrees	bag with holes	410	395	380	17.1%
7 degrees	sealed bag	405	400	400	1.2%
7 degrees	bag with holes	335	325	300	10.4%
3 degrees	sealed bag	325	325	325	0.0%
3 degrees	bag with holes	345	340	335	2.9%

The bagged boabs lost the least weight overall. The room temperature boabs had the hair roots start to grow on them. The three degrees boabs tended to be the best of the trial at the end as they retained their crisp texture and had good appearance. The room temperature boabs were also crisp but did not have as good appearance.

Figure 13 *Boabs stored at room temperature.*

13^0C 7^0C 3^0C

13^0C 7^0C 3^0C

Figure 14 *Boabs stored at 13, 7 & 3^oC*:

4.6 Freight

The boabs freight very well using the freight infrastructure that already exists in the Kimberley. Although the temperature of the load is determined by the main produce being carried which is usually melons during the dry season. Depending on other produce being transported, temperatures can range from 3^{O} to 13^{O}C. To freight effectively it will be necessary to consolidate consignments with other producers to be cost effective.

The logistics of moving the small amounts of produce to the eastern seaboard has proved a little more difficult as regular services are not always available. Sending small consignments on their own can be expensive, yet whilst developing the market in the east coast it is necessary to send small consignments. As the market develops and volumes increase consigning produce to the east coast markets will become more cost effective.

5 Recommendations

5.1 Seed Germination

Discussions and Recommendations

On examination of the 1000 seed evaluation, twenty percent 20% was considered damaged or unviable in the FW1 selection and eighteen percent 18% for the Fox river 2002 selection.

Figure 15 shows a scarified seedcoat. Note that the integument has reduced in certain areas assisting in moisture penetration. Figure 16 shows the microscopic groves developed in the seedcoat which also allows better retention of moisture. Image taken from the aerosol smoke etching treatment.

Figure 15 *Image of a scarified seed*

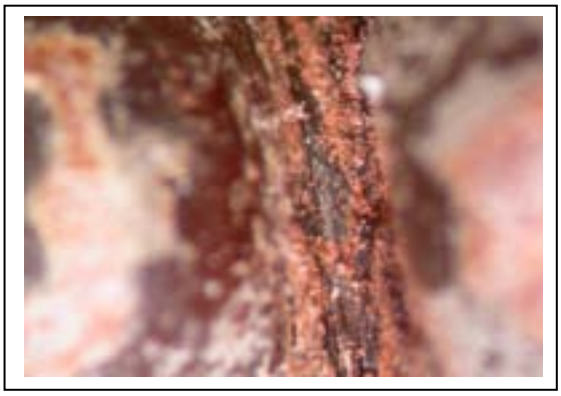


Figure 16 *Microscopic image of a scarification grove*

As part of the management package, more aggressive techniques would be required to reduce seedcoat thickness on older seed >2 years.

Water soakage for pith removal and seedcoat softening is a satisfactory treatment for fresh seed or seed <2 years old.

The inclusion of a GA treatment would also appear to be beneficial.

The Sulphuric acid treatments while yielding 30% less than the smoke etching treatment are considered important seed pre-conditioners for older hard seed source.

It is important to understand where seedcoat integrity is compromised, acid will penetrate the ovule and the endosperm will be dissolved thus rendering the seed sterile. Technically the seed will have imbibed the acid.

For commercial operations, some form of mechanised grading of the seed-lines would improve germination rates by removing damaged, undersized and immature light seed. This could best be achieved over a gravity table, after the pith removal, but satisfactory results could be obtained by running the seed through 7 and 8 mm screening sieves. The other alternative would be to increase the seeding rates by the same amounts. (see fig 17)

Rapid imbibing of the solutions from any of the seed soakage treatments will also cause reduced germination due to spoilage of the ovule.

The thermal shock and hydration treatment was not successful (treatment 2). This treatment has been used successfully on other species. The treatment may have been compromised by a subsequent

inspection of the exhaust flue temperature probe which only registered 100 degrees Celsius while the oven probably reached a temperature of 200 degrees Celsius in that time period.

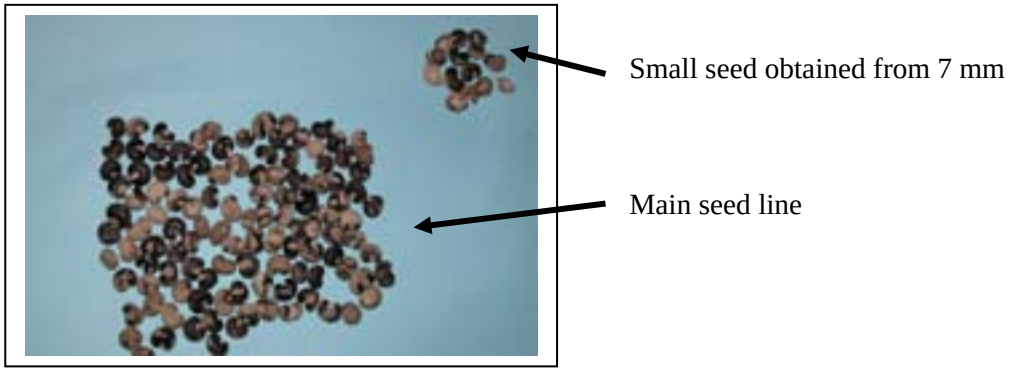


Figure 17 Sieved seed

- Subsequent seed germination results were also influenced by the following:

- Limited tests, using best treatment practice indicated that environmental factors such as moisture and temperature influenced germination outcomes to a higher degree than initially was supposed.

- *Adansonia gregorii* seed requires a minimum 25^0 C soil surface (to 5 cm) for any germination to take place. The optimum minimum temperature required is 27^0 C with 30^0 C maximising germination and plant growth.

- High moisture content between 80 - 90% field capacity is also required to break seed dormancy (Figures 18 & 19 show emerging radicles at day 7 Treatment 13).

Figures 18 & 19 Boab radicle

- Generally, the boab seedlings developed well under growth house conditions. Seeds sown into larger cell packs 50mm x 50 mm x 80mm (132 cells) produced a well structured rootlet. Subsequent potting on showed no transplant shock.

Possible pre-germination in glass house conditions and transplanting to field could be investigated for feasibility for vegetable production and economic evaluation.

Conclusions Seed germination

Many Australia native plant species rely on seedcoat density and or chemical inhibitors to delay total commitment of germination to a single event. The Boab *Adansonia gregorii* is no exception. *(see fig 20)*

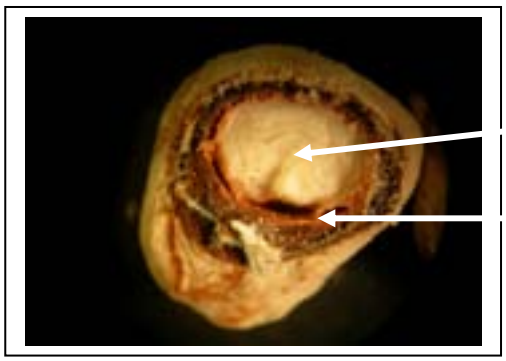


Figure 20 A sectioned boab seed showing seedcoat density

The capacity to persist in the landscape through varying seasonal conditions, importantly, where that species is an obligate seeder, relies wholly on its ability to conserve genetic material over many seasons.

Many native plant species require the development of symbiotic relationships, such as the presence of fungi, microbial or rhizobium bacterium, in order to germinate and grow successfully.

Overcoming seed dormancy in a given species is often complex, involving many factors which will influence a given result.

Environmental conditions, such as available moisture, light, temperature and suitable growing media, soil pH, nutrients have to be taken into consideration.

For a species to be developed commercially, a minimum requirement of 90% germination is the optimal rate. For this to be achieved, the following statement requires appreciation.

> "It is not enough to scrape some seed from the ground each year, apply some form of pre-treatment and expect consistent high germination yields".

Often poor germination is the result of low seed viability, insect or fungal attack, adverse seasonal conditions at time of seed set or poor nutritional effects as well as the overriding dormancy issues. No pre-treatment conditioning will overcome the adverse effects of these issues.

It is a recommendation from this study that consideration be given to the development of an *Adansonia gregorii* seed orchard and further research into:

- Seed harvesting,
- Seed cleaning,
- Seed maturation,
- Seed storage techniques,

as part of the management package to improve the germination and commercialisation of the boab as a root vegetable.

A further recommendation would be to investigate the possibility and practicality of pre-germinating the boab in cell trays, under glass house conditions and field planting the seedlings mechanically (seedling planter) as an aid to:

- control weed problems in field – pre planting control,
- provide evenness to maturing crop,
- provide extended growing season opportunities.

Figure 21 Even germination in a cell pack

5.2 Crop Production

With improved seed germination and trialling of pre germinated seedlings, the crop can be fully mechanised and grown for relatively low cost. This offers the potential for high margins for the crop over the next few years.

Further work needs to be conducted with weed control and trialling of pre germinated seedlings to realise this benefit.

5.3 Market Development

Starting with an entirely new product has proven difficult keeping up the momentum with market development. Although boab could be used as a substitute in some dishes such as water chestnut it currently has no specific or cultural uses that require it for an ingredient. This has meant the growth in sales is directly linked to consumer education and promotion. Initially the catering trade was targeted with the view of it being able to create the uses for the product. To many degrees this has been successful. But the reality is that the exposure to the wider consumer market is very small through this method. Where the product has had its uses demonstrated to consumers it has proven very popular such as in store demonstrations. To create market growth there will be an ongoing need for an education and promotion program far beyond the scope of this current project. It will require a larger business or company to follow through with this. This could prove very lucrative for such a company as the product will have for the near future a restricted supplier base, and opportunities for single desk marketing. The longer term growth potential looks promising with interest shown in all major domestic markets and several international markets including China.

Good and appropriate presentation and packaging of the product is essential for the successful marketing of the product. The packaging needs to be large enough to accommodate information and recipes as well as having an eye catching label. Without this the product can look rather unattractive and deteriorate prematurely.

Key supply chain partners are essential for its success. They must not only have the logistic network and infrastructure to handle the product but must also have a keen willingness and enthusiasm to develop the potential.

Appendix 1

Eat Drink Magazine article

turn washrooms into posh rooms

Ever been into a five star establishment and been totally insulted by the washroom? All it takes is a rusty paper towel dispenser or a noisy hand dryer to disappoint. A five star establishment needs a five star hand towel. Allan Green from Hygenex says they have just the thing. "Our new Prestige Hand Towels are a new 'posher' product. In fact, they turn washrooms into 'posh' rooms." These beautifully embossed Prestige Hand Towels are thicker, softer and whiter than ordinary hand towels. According to Allan, this is what makes them more absorbent and virtually lint-free. They're also quarter-folded so they look quite elegant in the new bench-top stainless steel dispenser." Yet Prestige Hand Towels are completely disposable," adds Allan, "so you can say goodbye to all of that costly laundering." They don't look like the usual paper hand towel. Allan agrees, "Most people tell me they're almost too good to throw away."

Direct enquiries to Allan Green@xxx.com

veges for all seasons

Farmfresh Fine Foods has developed an extensive range of specialty vegetables including chargrilled or roasted vegetables such as red, yellow and green capsicum, tomato, eggplant, pumpkin, sweet potato, onion, zucchini, garlic, mushroom, semi-dried tomato and antipasto blends. With world class technological processes and Quality Management System ISO 9001:2000, Farmfresh can offer a number of processing methods including pasteurisation, IQF (Individually Quick Frozen) and other shelf stable methods, with a variety of cut sizes, to suit individual customer's needs. Earlier this year, Farmfresh Fine Foods was awarded a quality endorsement by Les Toques Blanches Queensland, an international chefs association for its chargrilled red capsicum, chargrilled yellow capsicum and chargrilled mushroom retort pouch pasteurised products.

Farmfresh Fine Foods specialises in tailor-made processed vegetables for the Australian and International Foodservice, Retail and Industrial markets and uses only freshly harvested vegetables. Farmfresh supplies an extensive customer base including the largest industrial manufacturers in Australia with a range of processed vegetables. Contact Farmfresh Fine Foods Sales Office on 07-5554 5848.

WHAT'S HOT

WITH JENNY MANN

new! try boab

Here's something trendy for your next menu. The Boab is a new product grown in Kununurra in Western Australia from the Boab, the iconic tree of the Kimberley region in the northwest of the state. The Boab seedling tree is grown for around sixteen weeks then harvested to use the tuber.

The root is crisp and sweet and very similar in texture to a water chestnut. It can be eaten raw or cooked. The grated tuber can be used in cakes and quiches. The young leaves are also used, and again they can be eaten raw or cooked and have a sweet, nutty taste.

Currently there is a moderate, year round supply being grown and production is ready to increase with demand. Try boab in Boab with Barramundi and Crayfish, Boab Lakes, Boab and Pineapple Cake or Boab and Carrot Muffins. For stockists, call Boabs in the Kimberley 0417 184 563.

all the condiments you need

An extensive range of good quality condiments is a must in any foodservice establishment, and Rintara has delicious condiments to provide characteristic flavour to enhance or accompany a vast variety of cuisines. For a sauce base, soup stock, flavour enhancer, dip or filling base, the Rintara range of condiments has what it takes to add zest to your dishes.

The ever-expanding Condiments range includes Capers, Worcestershire Sauce, Mint Sauce, Soy Sauce, Sweet Mustard Pickles, Minced Garlic, Tomato Paste and Fruit Chutney.

Denis Sideras, head chef of multi-award-winning 'Pie in the Sky' Cafe, says, "Rintara's Fruit Chutney is one of my favourites as it provides excellent texture and its subtle flavour doesn't overpower our unique ingredients. As all our pies have won gold awards and are renowned for their superior taste, it is important that all ingredients are of premium quality, which is why I use Rintara products. I also find Rintara's extensive product range enables me to be creative with free extensions such as our gourmet and Asian varieties. People travel hundreds of miles for these!"

Try the recipes on Rintara's website www.mountrobservice.com including their mushroom frittata. For further information call Rintara Foods on (03) 9764 3622.

'Pie in the Sky' Cafe phone (03) 9751 2128.

portion control for Oreo Cookies

I remember travelling through Asia years ago and finding a very familiar, very welcome packet of Oreos at a pokey shop. Instant recognition! Oreo is the number one cookie brand in the world, and foodservice operators now have the opportunity to offer this favourite treat in two convenient portion control sizes.

For those not lucky enough to have tried Oreos yet, Oreos are uniquely crunchy chocolate cookies with a delicious soft cream filling.

Oreo Cookies are available in two foodservice pack sizes: a one-piece portion control, ideal for a small treat with coffee for café's, catering and functions or conference venues; and a three-piece pack, a perfect snack size for mini bars, top of counter and vending machines.

Oreos come individually wrapped and sealed for hygienic handling and convenience, meeting the strictest HACCAP requirements.

As a recognised global brand, Oreos are ideal for tourist destinations. They look good, taste good, allow for easy inventory and cost control, and reduce waste and handling.

For more information contact Kraft Away From Home on 1800 810 442.

Our Quality Protects Your Reputation

do it for the team!

Looking for a different work challenge? Try a team building session at a cooking school near you. Your team will have a great time, and have a good feed!

The eastdraft team recently enjoyed a team event at the James St Cooking School in the James St Market in Brisbane's Fortitude Valley. We cooked up an storm with kangaroo steaks and fried rice balls.

The James St Cooking School offers both practical and demonstration classes on different cuisines and styles of cooking. Corporate team building is a vital part of any business and the school offers a flexible format for groups up to 20 people. Demonstrations are followed by a practical class, finishing in a banquet style meal matched with Australian wines. Healthy Eating seminars and cooking demonstrations are available for larger groups, catered at the school or in-house at your workplace.

For more information, inquiries or bookings call 3252 8850 or join the e-mail list for class schedules on www.jamesstcookingschool.com.au

Mushroom Fritatta

Appendix 2:

SBS Food Lovers Guide to Australia.

print

Feature : Boabs

For thousands of years the Aborigines used every part of the tree – the bark for twine, the porous trunk for moisture and the fruit for medicine. The hard fruit pods are also useful as bowls and utensils. The thick, furry pod containing dry segments of fruit, a little like dried apple in texture. The fruit is very high in vitamin C (10 times that of an orange, it's believed) and has an almost citrussy flavour. The roots are fresh-tasting and crunchy, a little like a radish or waterchestnut.

Now some enterprising locals in the Kimberley town of Kununurra are developing boab products as a mainstream food.

Boab fruit

Melissa Boot has spent the last couple of years collecting boab fruit … visiting some of the most picturesque parts of the far north of Western Australia to harvest it. At first Melissa used the pod to make decorations. Then she decided to try and use the fruit commercially. To do this, though, she needed to get it formally accredited as a food, despite its traditional indigenous uses.

It's also incredibly healthy, as she explains. "Our Kimberley Indigenous people have been eating boab for centuries. They comment on how the fruit can help when you are feeling crook in the tummy. The Aboriginal people would grind the fruit into a flour like powder and make a pancake which they cooked on rocks, add water and bush honey to make a delicious dessert and even the seeds inside are said to make a coffee-like brew when boiled. Today the boab fruit has been used in many adventurous cooks' kitchens. With the unique citrus flavour and the dry texture, boab fruit has been turned into an interesting array of culinary delights such as boab chocolate, boab bread, boab muffins and cakes and even as dry-roasted chunks sprinkled on a salad."

Principally, Melissa uses the fruit in chocolate and has built up a successful business. See contacts for product purchase information.

Boab roots and seedlings

On the outskirts of Kununurra, another boab food product is being cultivated from boab seedlings. The Western Australian Agriculture Department, in conjunction with two local growers, Peter Fox and Denise Hales, has been trialling young boab plants as a new vegetable. The Department's researchers believe the boab root is very easy to grow and has great potential to be accepted as a conventional vegetable rather than branded as exotic "bush food". So far they are selling about 30 bunches a week through local fruit shops and off the farm. The juicy roots taste a little like a radish or water chestnut, while the leaves have a pleasant peppery taste.

The growing of a seedling Boab as a vegetable was taken from a Madagascan source and was trialled in the Kimberley by locals and now on a larger scale by local growers Denise Hales and Peter Fox. The trial has taken place with the assistance of funding by RIRDC and Department of Agriculture Western Australia who identified the potential of this crop. In undertaking the trialling of this vegetable it has been identified that the succulent young leaves of the plant are an additional find as they are edible and have a new and very distinct flavour that is great cooked up or in salads.

The crop is grown from the Boab seed and depending on the time of year it is grown for six to ten weeks. The plant is then ready for consumption. The texture of the root is crisp and the young leaves are tender with a distinct flavour of their own. The root of the plant is very versatile in what it can be used for and can be served raw such as in salads or cooked up in any way you desire, as it does not have an overly strong or dominant flavour.

Culinary uses

Kununurra chef Richard Horan has been experimenting with the young boab plants – boiling, pureeing and roasting them. He says the root when roasted has a sweet parsnip-like flavour. He also uses sliced boab root in a paperbark parcel to top steamed fresh barramundi, and some fresh boab diced with mango and doused with Bacardi for an accompanying salsa.

A list of boab recipes is below.

More on the boab

The Boab is an iconic tree to the Kimberley region of Western Australia. Related species of this tree are also found in Madagascar and Africa where the tree has been used for centuries a food source by the local people. Documented evidence suggests that native Australians also use parts of the tree for food and fibre.

The boab tree flowers in the wet season. The flowers only open at night and look like a large tulip. This tree is also well known on other continents – Africa and India, for example. Its botanical name is Adansonia, while the Kimberley or Australian variety is Adansonia Gibbosa and Greggerii. Common names also include baobab, bottle tree, monkey fruit tree, cream of tartar tree, sour gourd tree and upside-down tree.

The earliest recorded consumption of the fruit dates back to the ancient Egyptians. Although the tree is not native to Egypt, the fruit has been reported to have been found in Egyptian tombs.

On Australian soil the boab has been used traditionally in many ways. The tree itself is remarked as a traditional sacred tree. It has brought its people not only shelter but also a main source of food. Along with its medicinal uses, the bark is used to make twine and the interior of the trunk holds moisture which can be cut out and sucked. The wooden exterior of the fruit is used for collecting water, berries, grubs and roots.

BOAB FRUIT NUTRITIONAL ANALYSIS

Appendix 3
Promotional poster

Australian Baby Boabs

As a Vegetable Root Crop

The Boab is a new food product grown in the Kimberley Region of Western Australia and represents unique contemporary Australian cuisine.

Both the tubers and the young leaves can be eaten. The tuber can be cut into straws for salads, dips and stir fry's and can be used in soups. The texture is similar to water chestnuts. The leaves have a nutty flavour and can be used in salads or as a garnish.

Nutritionally, the Boabs are high in iron and potassium, with a high level of protein (for a vegetable) and fibre and a relatively low fat content. The Boab leaves are quite high in vitamins A and C.

Contact Details for the Baby Boab roots
Peter Johnson
Department of Agriculture Western Australia
PO Box 19
Kununurra, Western Australia
Australia 6743
Phone 61 08 9166 4000
Fax 61 08 9166 4066
Email pjohnson@agric.wa.gov.au

Confectionary and Tableware

The BOAB TREE grows in the Kimberley Region of Western Australia. These remarkable trees grow a fasinating fruit seed pod with a wooden exterior which has been turned into usable Tableware and Bush Tucker taste sensations.

Contact Details for Boab Tableware and Boab Chocolates
Melissa Boot
Kimberley Boab Kreations
PO Box 1379
Kununurra, Western Australia
Australia 6743
Phone/Fax 61 08 9168 1816
Mobile 0407 055 145
Email w.mboot@bigpond .com

Unique Hand Crafted Tableware Made from the Kimberley Boab Nut

Spicy Chickpea and Boab root salad

Coriander seeds (ground)
Cumin seeds (ground)
1 small dried chilli (crushed/ground)
pinch salt
ground pepper

1 can of chickpeas washed and well drained (until dry)
Boab roots peeled and sliced fine lengthways (julienned) - cut up just prior to use
Boab leaves finely chopped
Olive Oil
Lemon juice

Grind all the dry spice ingredients together (mortar and pestle, or you can just buy pre -ground spices and mix together).
Heat up a wok or small fry pan with some olive oil then add the spice mixture, for just a few minutes and don't burn.
Add the chickpeas and stir around heating through, so they are coated with the spice mix and oil.
At the last minute add the Boab root and leaves and warm through for just a minute or so.
Then a quick squeeze of lemon or lime juice over the top.

Can be served as a side dish with steak (kangaroo) and cous cous.

Recipe from the Frangipani Kitchen

BOAB

The exciting new taste sensation

From the Kimberley

Boabs in the Kimberley

Organically grown produce from the Kimberley Region of Western Australia

Peter Fox and Denise Hales
PO Box 1285
Kununurra WA 6743
Telephone: 0417 184 563

Boab

Adansonia gregorii

This new food product is organically grown in the Kimberley Region of Western Australia and represents unique contemporary Australian cuisine.

Both tubers and young leaves can be eaten.
The tuber can be cut into straws for salads, dips and stirfry's and can be used in soups.
The taste and texture is similar to water chestnuts.
The leaves have a nutty flavour and can be used in salads or as a garnish.

Asian soup (Laksa) with Boab roots

Good laksa paste (from Asian supermarkets)
Coconut milk
Fish/Chicken/Vegie stock
Rice noodles
White fish piece (not cooked) or shredded cooked chicken
Asian vegies (bok choy or pak choy) - shredded
Boab roots (peeled and finely sliced/julienned)
Red chilli - finely sliced
Fresh herbs (coriander, mint)
Lime

Heat a little oil in a pot, then fry off a couple of tablespoons of laksa paste. When paste is sizzling a little add a can of coconut milk and an equivalent amount of stock. Let simmer for 10mins.
Soak rice noodles in boiling water until soft then drain. Heap the noodles into a bowl and pile the fresh greens, boab roots, cooked chicken and chilli on top. Pour the hot soup into bowls to cover the noodles and vegies (which will steam in the hot soup). Garnish with lots of fresh mint/coriander and a big squeeze of lime.

If you are using fish, add the fish pieces to the broth while simmering (for about 5mins) to steam the fish, then pour over noodles and vegies.

Recipe from the Frangipani Kitchen

Preparation

There is little preparation involved getting the Boab products ready for use. The young leaves can be used as they are, and the young Boab tubers need the skin removed and this can be easily rubbed or peeled off and they are best used fresh after peeling and cutting.

Nutritional Value

The Boab tubers are high in iron and potassium, with a high level of protein (for a vegetable) and fibre and a relatively low fat content. The Boab leaves are quite high in vitamins C and A.

Storage

The Boab tubers and leaves keep well if they are immediately cooled after harvest. The product is at its best if kept refrigerated and will keep fresh and crisp for up to two weeks.