FAO SUB-REGIONAL OFFICE FOR THE PACIFIC ISLANDS

FOOD PROCESSING IN POHNPEI

A PROGRAMME TO ENCOURAGE GREATER USE OF FOOD RESOURCES IN POHNPEI ON A SUSTAINABLE BASIS

TECHNICAL MISSION REPORT

RICHARD BEYER

In collaboration with the

ISLAND FOOD COMMUNITY OF POHNPEI

AND

THE POHNPEI AGRICULTURE OF THE DEPARTMENT OF ECONOMIC AFFAIRS

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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Special thanks as always go to Dirk Schulz for his continuing interest and support in the betterment of the food and nutrition security of the People of the Pacific region.

This project would not have been possible without the continuing unfailing enthusiasm of Lois Englberger and Adelino Lorens. So much has been achieved in the promotion of local food consumption and this intervention forms a small part of that overall programme. I thank all the members of the Island Food Community are such willing collaborators in all work in Pohnpei and add special mention of Peace Corps Volunteer Amy Levendusky who contributed so much and who has agreed to be the interim focal point. Herman Semes is a remarkable man with whom it is a pleasure to work.

As usual Jeyom Segaram from Techso Ltd in Brisbane was able to give me such timely indicative costs for equipment and he is to be thanked for his rapid response.

It is however, the people of Pohnpei – in particular the workshop participants - who make tasks such as this so rewarding – many have now become firm friends.

Best wishes and thanks go to all who contributed.

Richard Beyer

Pacific Harbour, Fiji

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EXECUTIVE SUMMARY

This mission was the third in a series of visits (previously funded by the Economic and Social Commission for Asia and the Pacific, 2003, and the Centre for Disease Control and Prevention, 2004) collectively forming a strategy to initiate food processing in Pohnpei. The State relies significantly on imported processed foods with local foods accounting for only 27% of the average indigenous diets. Previous interventions had failed to make a significant impact and rather than repeat the content of previous workshops, demonstration of processing techniques were used to illustrate the manner in which food processing could be used as a basis for profitable (therefore sustainable) business. Indigenous foods were used but the original intent of using bananas as a test-bed for product development was curtailed to a degree by the lack of raw materials and time allotted for the development workshops – other raw products were prepared to compensate. A significant breakthrough was achieved however, using frozen breadfruit as a base for development. This is an enormous practical advantage because breadfruit has a short season in Pohnpei and hence commercial profitability is difficult to realise without extending the season by partial processing. This model can be extrapolated to other seasonal products such as mangoes and papaya.

There is urgency in removing the impediments to continuing activity in the sector. Food processing is most frequently successful when parties cooperate. This has been recognised in the Terms of Reference in which the activity was directed towards engendering cooperation between interest groups. There are a few established food processors in Pohnpei and they are not readily pre-disposed to sharing hard-won commercial advantages with new comers who have yet to prove their commitment to sustainability. While there may be room for cooperation between the groups over such issues as obtaining raw material and packaging, the differences were recognised and separate strategies were developed.

Participants returning to the workshops from the mission held in 2004 were encouraged to define the impediments to progress. These were addressed in some detail and some permanent systems were put in place to ensure that the interest did not wane. Correspondingly the methods for assessing the profitability of a number of items were demonstrated and appear in this report as a permanent record for future reference.

Among the established processors, the Coconut Development Authority (CDA) has the promise to make a significant impact. This organisation which is organisationally linked to the Economic Development Authority (EDA) has no option to relocate. But it has been significantly hampered in exploiting Pohnpei's food resources to the full by its commitment to coconut processing. By relocating to the current (incomplete) building at the EDA site then several issues become resolved. If at the same time the charter is modified to encompass the full range of food resources beyond coconuts, then synergy is possible to challenge the large number of imports with locally manufactured analogues. As requested, this report contains a discussion document for further consideration by EDA, CDA and the appropriate State Departments. At the same time a list of equipment that would empower the CDA to widen its portfolio of products immeasurably has been included.

Specifically the following summary and conclusions have been recorded.

Summary and Conclusions

The workshops in which a wide spectrum of participants was introduced to the economic and nutritional benefits of local food processing were welcomed during 2004. However the level of activity since that time has been disappointing. The spirit of this mission has been refined so that the impediments for future activity have been addressed so that local entrepreneurs and interest groups can progress beyond the interest stage into commercial reality. Two and a half days in workshop format is insufficient time to demonstrate the enormous scope of food preservation and the commercial possibilities that may ensue. It was important therefore to refresh the topic and then to direct efforts to surmounting the impediments to continued activity.

In an environment where a commercial discipline is in its infancy cooperation between stake-holders provides synergy and many economic benefits and the mission was steered in this direction by the Terms of Reference. It is clear however that there is a spectrum of food businesses in Pohnpei and some are more commercially mature than others.

For those already operating food processing operations there is a need to break the deadlock between inadequate exploitation of the local resource and the technology required to process into import-substitution products. A number of strategies were discussed to progress from the current stage. The CDA has significant experience in food processing but has been hampered in realising greater potential by confining activities to value-added products from coconut. Underutilised equipment would be much better served in exploiting a much wider range of local crops. Even more exploitation could be achieved with a range of general purpose processing equipment and a portfolio of equipment is suggested. Indicative prices have been kindly supplied by Techso in Australia but cheaper alternatives may be available from the Philippines.

For the interest groups in the early stages of activity, there is a need to provide on-going technical, infrastructural and marketing support. A number of products were demonstrated but these are only the platform for a much wider portfolio of products that can be processed using local raw materials. This is only the first step in the development process. As a 'roadmap,' for continuing activity a technical document was prepared for general circulation (Appendix 3).

The following conclusions were drawn.

1. Food activity in Pohnpei is broadly divisible into the established commercial food operators and new (nascent) interest groups.
2. The level of activity since the workshops of 2004 has failed to reach expectations.
3. For newcomers to food processing, the impediments to further activity were identified as;

    - Lack of continuing technical support
    - Lack of equipment
    - Unidentified market
    - Unavailability of Packaging
    - Paucity of the raw material supply

4. Structures were put in place to address these impediments;

    - A steering committee to represent the views of newcomers to the industry was formed and will meet monthly.

- A technical manual has been prepared (Appendix 2) and will be distributed to processors as required, by the steering committee.
- A portfolio of small scale equipment has been supplied (Beyer) and the Steering Committee will be the custodian.
- The Chief of Agriculture of the Department of Economic Affairs is a member of the Steering Committee which will create a direct link between the raw material supplies and the processors.
- Professor Semes has agreed to evaluate all prototype products and will sell through his family market centre. The workshop included many supermarket owners who also agreed to evaluate products.
- Plastic packaging and jars can be obtained through ACE Hardware as volumes increase. Recycled jars and the plastic bags supplied (Beyer) will be used in the meantime.

5. Formal discussions will take place between the EDA, CDA and the State Legislator so that the CDA can be relocated to the EDA site.
6. Multipurpose food processing equipment to enable the CDA to process a much wider range of products has been compiled, conveyed to CDA/EDA and appears here as Appendix 3.
7. Frozen, thawed and cooked breadfruit is a very high quality vegetable indicating that it is possible to extend the season.
8. It is possible to establish a year-round breadfruit industry based on frozen breadfruit.
9. The profitable production of jams, vinegar, pickles in vinegar, snack foods and breadfruit patties is possible.
10. The imminent establishment of the Pohnpei Business Development Centre at COM-FSM Pohnpei Campus (Professor Semes) heralds synergistic relationships between food processors and developers with the establishment of formal training for entrepreneurs in food processing.

RECOMMENDATIONS

Two separate strategies to garner cooperation among food processors are recommended. The first is to address the needs of the existing food processors. The second is to address the needs of the newcomers to food processing enterprises.

RECOMMENDATIONS TO ASSIST IN GENERATING MOMENTUM AND COOPERATION AMONG EXISTING FOOD PROCESSORS

It is recommended that the Pohnpei Water Company undergoes a programme of product development to increase the market volume thereby justifying the cost of installing a PET bottle fabrication plant.

It is recommended that Director of the EDA initiates the proposal for the completion of the building situated at EDA to a standard suitable to house the CDA.

It is recommended that the case for the removal of the CDA from its current location to the building situated at EDA is initiated using the discussion document attached at Appendix 3 as a foundation.

It is recommended that the charter of the CDA is revised to include all raw materials currently produced in Pohnpei and that its activities are not confined to commercialising coconut products.

It is recommended that the Sei Organisation undertake preliminary discussions with all other interest groups for collaboration over the purchase of a PET bottle blowing unit.

It is therefore recommended that Professor Semes undertakes further discussions with the CDA/EDA consortium with a view to using the equipment for practical training in food processing, packaging and marketing.

It is therefore recommended that the feasibility of relocating the CDA to the current building at EDA and the purchase of addition processing equipment for general purpose development and processing is considered at future Board Meetings of the CDA/EDA.

RECOMMENDATIONS TO ASSIST SMALL SCALE PROCESSORS IN SECURING COOPERATION FOR CONTINUED ACTIVITY

It is recommended that the small-scale processors and interest groups agree to meet on a regular basis to discuss constraints to processing and to establish future needs.

It is recommended that the Island Food Community of Pohnpei assume responsibility for maintaining the existing collection of processing equipment jointly purchased by Beyer and the IFCP.

It is further recommended that equipment should be available to these interest groups on a lease basis - perhaps including a deposit which will be withheld in the event that the equipment is lost or damaged.

It is recommended that processors take full advantage of the horticultural base within Pohnpei by partially processing plentiful crops at the height of the season and through a closer awareness of the programme of crop diversification conducted by the Pohnpei Agriculture of the Department of Economic Affairs.

It is recommended that a contact point with the appropriate communications experience should be appointed to undertake the role of conduit between food processors and technical experts (eg Beyer and EcoConsult, SPC etc).

it is recommended that the role of contact is point is gradually transferred to a Pohnpei permanent resident so that the function continues beyond the tenure of Ms Levendusky.

It is recommended that the contact point monitors the activity in these 'wet,' products and that the importation of jars is resumed when volumes increase to economic levels.

At some later date, PET bottles for teas and cordials may be fabricated in Pohnpei and it is recommended that the focal point maintains close links with the Pohnpei Water Company and the Sei Organisation to monitor progress. Others users of bottles are to be included in this buying group as they emerge.

THE FUTURE

It is recommended that close liaison is maintained with all overseas stake holders so that further assistance can be provided in controlling quality and meeting the standards necessary for international trade.

TECHNICAL REPORT

1 Background

The major impetus for initiating food-related activity in Pohnpei is the enormous dependency on imported, processed foods. A recent survey sponsored by the Centre for Indigenous Peoples' Nutrition and Environment (McGill University) conducted by Dr Englberger in association with the Pohnpei Island Food Community and the Pohnpei Department of Agriculture has indicated that local foods make up as little as 27% of the total food intake. Not only is this nutritionally undesirable but it is alarming in terms of the foreign trading position of the State. It illustrates that the enormous potential to grow high quality crops in a pristine environment is falling well short of potential. Unfulfilled potential for employment in farming areas results in urban drift and a general downturn in all other aspects of the social framework of the state. This mission is the latest in a series of interventions designed to identify the impediments and to demonstrate to interest groups the advantages that can accrue by adding value to food. The Terms of Reference (ToRs) for this intervention have been refined within the framework of the two prior missions. An initial scoping study was conducted in 2003 under the auspices of the Economic and Social Commission for Asia and the Pacific (ESCAP) in which crops and food products that have the potential to improve the balance of trade in food were identified.

The second mission was sponsored by the Centre for Disease Control and Prevention and administered by the Island Food Community of Pohnpei and was conducted during 2004. During this second visit, larger, private sector organisations were contacted. In addition, a series of workshops were held in which island food communities, cooperatives and interest groups were instructed in the techniques used for value adding of food crops. Considerable interest was generated at that time but there has been no evidence of continuing activity.

The needs of the two groups are different. The established companies have a clear understanding of the essential elements for profitability. They tend to hampered in their quest for expansion by what they perceive as a limited raw material supply base comprising horticultural crops of varying quality and availability.

For the smaller island food communities, most of who are new initiates to food processing, processing the needs are much more fundamental. They have been impeded in early progress by;

- Lack of continuing technical support,
- Lack of equipment,
- Unidentified market,
- Unavailability of packaging, and
- Paucity of the raw material supply

Many of those participants who were enthused during the introductory workshops held during 2004, have found that organising the elements required for sustainability is an onerous task most efficiently undertaken as a group effort during which responsibilities can be divided and delegated. The spirit of this mission has been honed from these earlier findings and the ToRs (Appendix 1) have been refined so that the impediments for continued activity in the future have been addressed. The aim is to remove obstacles to further progress.

2 Activities within the Terms of Reference

2.1 Activity 1: To facilitate the formation of a union of all stake holders for the permanent establishment of food processing in Pohnpei.

Food-related activity in Pohnpei is broadly divisible into that undertaken by a group of established companies with continuing processing activities and a second group comprising loose collectives that have an intention to start small-scale processing. Because the needs of each group are entirely different a single union of all stake holders is inappropriate.

Hence two separate strategies to garner cooperation among food processors are recommended. The first is to address the needs of the existing food processors. The second is to address the needs of the newcomers to food processing enterprises.

The needs of both groups have been addressed separately.

2.1.1 Existing Food Processors

There are a number of established companies in Kolonia. These include the Sei Organisation, the Coconut Development Authority (CDA) the Pohnpei Water Company. These organisations have overcome a number of hurdles to reach the current state in their development. They are hence reluctant to share those with potential competitors. Almost universally they reported that they are hampered in their expansion plans by the lack of raw materials and the generation of ideas for new products. Understandably they are unwilling to invest in equipment and technology that might facilitate future growth until it is possible to define future cash-flow and expansion plans. In the absence of the techniques used for generating ideas for new products, the existing processors perceive a shortage of raw materials. They have not exploited the enormous volumes of breadfruit, mango and banana and have neglected the opportunities to extend the seasons by partially processing - eg freezing. In addition the excellent pioneering work that is being undertaken at the Pohnpei Agriculture of the Department of Economic Affairs' Model Farm that demonstrates the enormous variety of crops that can be grown in Pohnpei has been ignored to a large degree.

Further impediments have been the lack of equipment. The technology currently situated both CDA and the Pohnpei Water Company is highly specialised and does not lend itself to product diversification outside flavoured waters, juices and cordials. An overarching strategy that has garnered support not only from State Government, the tertiary teaching institutions but also the private sector is the establishment of a general purpose processing facilities that can be used for training, development and for leasing during the emerging stages of new products. Precedents exist around the Pacific region for similar facilities and it is a recommendation of this report that the feasibility of establishing such a facility is undertaken once all sectors concur.

The Pohnpei Water Company has adopted a professional attitude towards business but has confined its product range to water with plans to diversify into aerated and flavoured derivatives. Of the current *food* processors the most active is the CDA. This Government-owned facility was commissioned to create markets and add value to coconuts but has equipment that could enable it to manufacture a wide range of other products such as ice-cream, snacks and frozen confections. This is currently the centre of food processing expertise within Pohnpei. The State Government is seeking to privatise CDA – a decision which has been catalysed by the necessity for the factory to relocate. It has emerged during discussions that an alternative to outright sale might be to relocate to the vacant but unfinished building at the Economic Development Authority (EDA)

and to add further equipment to enable it to develop and commercialise the products. As the process parameters are defined the raw material supply and markets are secured then that particular process can be privatised and either sold as a discrete entity or leased to other entrepreneurs.

Pohnpei Water Company

The supply of large containers for water dispensers is the most economical method of operating a water business in the early stages. More profitable however are retail bottles of water which commonly packed in polyethylene terephthalate (PET) bottles of 500ml, 1 Litre or 1.5 Litre capacities. The high profit margin presupposes that the bottles can be fabricated locally. However the volume formed by 'blowing machines,' is far in excess of the local market.

Hence it is recommended that the Pohnpei Water Company undergoes a programme of product development to increase the market volume thereby justifying the cost of installing a PET bottle fabrication plant.

Products such as fruit/tea blends, cordials and nectars can be packed in PET bottles. Once again the total market volumes are not known but a survey of the three supermarkets will assist in assessing imports. The requirement for even more bottles may arise from cooperation with the Sei Organisation which enjoys an expanding ready-to-drink noni industry.

Pohnpei Water Company is a new enterprise. The training manual that has been prepared for workshop participants (Appendix 2) has been sent to the CEO Mr Manlapaz. Electronic communications have been established and further assistance will be provided on request.

The Coconut Development Authority (CDA)

The CDA is a State-owned processing unit that was intended to commercialise and add value to coconut products in Pohnpei. The current ambition of State Government is to privatise this operation. The organisation is committed to the coconut industry, but with dwindling raw material supplies, it might be timely to re-examine the charter. An expanded remit to include a wider range of products would make greater use of the existing equipment and facilities leading to reduced fixed costs per item produced, increased profitability and hence a stronger bargaining position in any privatisation negotiations.

There is pressure to relocate this factory to mitigate the strain on effluent disposal at the current location at the wharf.

There is a historical link between the EDA and the CDA. The ECA is positioned to act as a catalyst for the development of small and micro-enterprises and is an initiative of the Office of the Economic Administrator. The EDA has been constrained in achieving its goals by the lack of facilities for development and suffers the significant disadvantage that it is asked to support conceptual projects that often unsupported with prototypes and working models. During discussions, willingness emerged from both Directors Namio Nanpei (CDA) and Yosua Phillip (EDA) to enter a synergistic relationship to food processing activity based on a more diverse raw material base. The partially-completed building currently situated at the EDA site is of a suitable construction to house food processing equipment. Hence the relocation problem for the CDA could be solved and a convincing case for the completion of the building situated at EDA could be prepared.

It is therefore recommended that Director of the EDA initiates the proposal for the completion of the building situated at EDA to a standard suitable to house the CDA.

It is further recommended that a case for the relocation of the CDA from its current location to the building situated at EDA is initiated using the discussion document attached at Appendix 3 as a foundation.

It is further recommended that the charter of the CDA is revised to include all raw materials currently produced in Pohnpei and that its activities are not confined to commercialising coconut products.

General purpose processing equipment has been identified - indicative costs given in Appendix 4.

The facility could then be used for:

Manufacturing
Product development
Training
Research, and
The one-stop shop for all other would be processors.

Should the facility be unable to cope with increased volumes of new products and its commitment to continuous and continuing product development programmes then products that have been completed and which are part of the routine processing function can be leased or on-sold as profitable business entities to independent entrepreneurs.

Sei Organisation

The Sei organisation has a significant advantage over other organisations in Pohnpei because the products that are processed are sourced from the company farm. Currently the organisation produces pepper which is exported at premium price because of exploitation of the exotic aura associated with Micronesia and the extremely high, hand-selected quality of the product. Future expansion is limited by the current technology. However, Mr Sei has indicated an interest in expanding the volumes of noni by blending with juices and cordials to mitigate the taste.

Mr Sei imports prefabricated PET bottles. If volumes of cordials and noni increase then it may become economical to fabricate the bottles in Pohnpei. This is likely if costs of a fabrication plant are shared between the Sei Organisation and Pohnpei Water Company. The smallest commercial blowing equipment fabricates 1000, 500ml bottles per hour and can be modified to use, recycled PET bottles.

It is recommended that the Sei Organisation undertake preliminary discussions with all other interest groups for collaboration over the purchase of a PET bottle blowing unit.

In addition he has expressed an interest in using the crops from the farm for the manufacture of other items. Mr Sei has been given information on food handling, processing and product development. Further assistance will be available to him on request.

Professor Herman Semes

Professor Semes is an entrepreneur and a member of the academic staff of the College of Micronesia, Pohnpei Campus. Not only has he demonstrated a willingness to engage in food related industry but he has become a focal point for future expansion at the College by attracting funds for the Pohnpei Business Development Centre at COM-FSM Pohnpei Campus - a new Centre for training in management and entrepreneurship. This is a very important breakthrough for Micronesia because it has the potential to act as a focal point for the development of all enterprises in the Nation.

The College of Micronesia, Pohnpei Campus has expressed an interest in undertaking training in food sciences for the benefit of the nation. One option is to equip the college with processing equipment for training. An alternative is to equip the private sector (or quasi-private sector - CDA/EDA) with general purpose equipment that would then be available to the College for training.

It is therefore recommended that Professor Semes undertakes further discussions with the CDA/EDA consortium with a view to using the equipment for practical training in food processing, packaging and marketing.

If the equipment remains in the hands of a profit-responsible organisation then the College will not be burdened with such tasks as repairs and maintenance, the projects that are generated for training will be relevant and wherever possible sponsorship and funding for development may be obtained form commercial organisations

It is therefore recommended that the feasibility of relocating the CDA to the current building at EDA and the purchase of addition processing equipment for general purpose development and processing is considered at future Board Meetings of the CDA/EDA.

2.1.2 Nascent Interest Groups

During the 2004 Workshop participants were drawn from a wide spectrum of Pohnpei society and understandably, there was diversity in the level of enthusiasm for the prospect of generating income from food. In order to narrow the focus, the major workshop during this mission was renamed, 'Running a Food Business.' This was specifically targeted towards those groups and individuals intent on establishing commercial operations. More emphasis was directed towards the major impediments identified by participants and to the economic aspects of food processing. In addition participants were introduced the analytical methods that are used in assessing the profitability of new products (Section 2.3.1).

Participants were encouraged to voice their opinions about the most appropriate means of overcoming the difficulties. A number had attended previous workshops held during 2004. They reported that they had been confounded in their intent to start food business by lack of support on a continuing basis additional comments are included in Section 3.

A shorter (one morning) workshop was held for the Mercedes Women's' Group. This included a number of people at the larger workshop and they were used to act as instructors for others who had not attended. This is encouraging since it heralds less dependency on overseas experts.

There is now a collection of small scale processing equipment permanently available in Pohnpei. Documents relating to formulations and the techniques of processing and product development

had been left in Pohnpei after the intervention of 2004. Unfortunately there has been no available focal point to act as a custodian and contact point. As a result the equipment has remained unused and further assistance not accessed. The formation of a cooperative therefore will assist in the dissemination that data. For small scale groups cooperation can assist in dividing tasks and compensating for members who must temporarily withdraw for family and other personal reasons. In addition, tasks such as raw material procurement, processing and marketing can be allocated on the basis of ability and preference.

The responsibility for maintaining the existing small-scale equipment which can be leased to serious interest groups can be assumed by the focal point. As they emerge as permanent enterprises, so they can purchase new equipment as required assistance to source and procure that equipment will be provided on request.

In order to achieve this, it is recommended that the small-scale processors and interest groups agree to meet on a regular basis to discuss constraints to processing and to establish future needs.

[This group has agreed to meet on Thursday 20th of October and that the minutes of the meeting will be forwarded to Beyer to assist in providing technical data and to advise on the source additional equipment as required.]

It is recommended that the Island Food Community assume responsibility for maintaining the existing collection of processing equipment jointly purchased by Beyer and the IFC.

It is further recommended that equipment should be available to these interest groups on a lease basis - perhaps including a deposit which will be withheld in the event that the equipment is lost or damaged.

2.2 Activity 2: To test-trial and produce a number of products from frozen breadfruit pulp and bananas that fit the criteria for sustainable production and document in a simple manual the necessary procedures and processing steps, including aspects of food safety and quality.

The essence of sustainability in the food industry is profitability. Profitability is most easily achieved if processing facilities are utilised for the maximum time available. This will keep the fixed cost per item to a minimum and hence improve profit margins. It is extremely difficult to base a profitable industry on seasonal crops such as breadfruit. A number of strategies can be used to extend the supply beyond the fresh season.

Breadfruit is an ideal base for value-adding. It is pale in colour, bland and has an excellent texture. In addition it contains fibre, vitamin C, thiamine, riboflavin, niacin, and iron (Appendix 5).

In some Pacific Island Countries (PICs), breadfruit is dried but this is not an option for Pohnpei because the relative humidity of the air in prevailing weather conditions is too high to effect economical air drying techniques. The relative humidity of the air used to dry food has to be reduced either by heating, by removing moisture by condensation (heat pump dryers) or by using a secondary desiccant. Each of these techniques is expensive.

Traditionally breadfruit in Pohnpei is preserved in pit fermenters. Breadfruit is salted which inhibits many spoilage bacteria. It is then stored in pits. Homofermentative lactic acid bacteria

are selected out by the high salt content and generate lactic acid to reduce the pH sufficiently to inhibit dangerous and other spoilage bacteria. Although there is a continuing market for fermented breadfruit the popularity is not high among the younger generation as western foods become more popular. The fermented breadfruit is not a satisfactory base for value-adding because the lactic acid is not easy to remove and will persist though to the finished product.

Freezing breadfruit is an option because there is a reliable reticulated electricity supply in Pohnpei. Furthermore if the breadfruit is frozen in bulk in a well insulated cool store the power consumption is very low. In tropical regions, most commercial enterprises which use frozen raw materials remove one day's production-requirement prior to processing start-up and the freezer remains closed for the remainder of the day.

Heat ingress is given by

$$Q = K \times A \times \frac{(T_1 - T_2)}{t}$$

In which; Q is the rate of heat in-flow,
K is the thermal conductivity of the insulating material.
A is the area of heat exchange
T_1 is the outside temperature
T_2 is the temperature of the freezer
t is the thickness of the insulating material.

Hence good cold stores are fabricated from material with a very low thermal conductivity (K) (eg expanded polystyrene), the surface area (A) of the freezer would be as low as possible (eg cubical design if practical) and the thickness of the insulating material would be as thick as economically possible (commonly 15cm). An unused bulk freezer is situated adjacent to the State Agriculture Offices and can be used for freezing breadfruit and mangoes at season glut. Therefore it is entirely practical to freeze breadfruit (and other seasonal crops) during the season and use as required by the production schedule.

As heat is removed during the freezing process, water in the cellular tissue begins to freeze approximately – 0.5^{o}C. The cellular fluids become more concentrated as water is removed from the system. The resultant concentration of cellular solutes disrupts the delicate cell membranes and denatures proteins. As proteins are denatured they lose their water holding capacity. In addition complex carbohydrates such as starch and fibre begin to associate as interstitial water is frozen. This causes them to retrograde (the reverse process of gelatinisation). The result is that high starch foods often become 'grainy,' in texture when they are subsequently thawed. Potato products do not freeze well and on subsequent thawing must be re-cooked (eg fried or boiled) to re-gelatinise the starches.

These effects are much less evident during freezing of breadfruit and the resultant frozen product has a very good texture closely resembling the equivalent prepared from raw fruit. Indeed it was very difficult to distinguish frozen boiled breadfruit from the fresh equivalent. Hence one product that immediately emerges is simply frozen breadfruit which can be boiled, baked or cooked in an earth oven (Uhmw) as fresh breadfruit. Some samples had a brown discolouration due to enzyme activity as the product was frozen. The polyphenol-oxidase enzyme responsible for browning in all cut surfaces of fruit and vegetables can be inhibited using vitamin C or sodium metabisulfite (200 ppm or 200 mg per Litre of water). Most commercial manufacturers use sodium metabisulfite because it is cheaper than vitamin C, but lime and lemon juices contain

sufficient to prevent browning. Lemon and lime juices cannot be added if the flavour of the finished product becomes unacceptable due to the presence of the citrus juice. Ideal freezing procedures are given in Appendix 2.

Since the performance of the breadfruit after freezing and thawing was so good this indicated that a number of breadfruit analogues of potato products were possible. Breadfruit-tuna patties, breadfruit-cheese patties were prepared and a formulation for breadfruit biscuits using frozen breadfruit instead of flour was given as a basis for further development.

Breadfruit snacks were prepared by boiling frozen breadfruit, mashing and extruding into hot fat. Again the formulation and the method of preparation are given in the training Manual - Appendix 2.

It was not possible to produce four products from banana due to time and raw material constraints. However alternatives products - pickles and jams were made from the raw materials supplied by participants.

During the development of marketable products, many trial samples are made incorporating refinements as dictated by informal and formal taste panels. Participants were instructed in this technique but there was not time to follow this process. Nevertheless working formulations are given in the Training Manual - Appendix 2. Participants will find modifications will produce even more acceptable products.

The details are not given here because Appendix 2 can be detached as a stand-alone manual for use distribution as required. Participants have been urged to keep records of the modifications they make.

2.3 ToR: 3 To establish the practical model for profitable production and marketing of at least four of these products from each raw material.

The following products were selected for development and discussion;

Frozen breadfruit pieces
Frozen breadfruit patties
Breadfruit chips
Extruded breadfruit snacks
Breadfruit biscuits (description only).
Banana vinegar (description only)
Banana chips
Fruit jams including banana
Pickles in vinegar

The steps that are used to predict profitability are:

- *Select the target product.*
- *Define the product formulation.*
- *Confirm that the necessary elements for processing are in place.*
- *Estimate the cost of production*
- *Estimate the retail price.*
- *Analyse the circumstances under which the product is consumed.*

- *Identify the competition.*
- *Define the comparative advantages.*
- *Go or No-go decision.*

Select the Target Product

All workshop participants have been given instruction in generating ideas for new products. This has been formalised into The Processing Manual (Appendix 2) which has been distributed to workshop participants and steering committee members for distribution to aspiring processors.

The products for which formulations have been given can be refined according to individual taste and this has formed the basis of the workshops. The importance of keeping records of trial samples was stressed so that mistakes and unacceptable formulations are not repeated.

Define the Product Formulation

All participants have retained their own records of the development process. From it they have been able to refine products to suit their own preferences and what they perceive as an acceptable product for the market.

Confirm that the Elements for a Successful Food Operation are in place.

The necessary elements for a successful, sustainable food processing operation are:

- A reliable supply of raw materials of the appropriate quality.
- There is access to the appropriate equipment.
- There is a market that it is prepared to pay the price necessary to ensure sustainability.

Raw Material Supply

There has been very little momentum in food processing in Pohnpei which has limited the production of fresh produce. A majority of the crops grown are for subsistence use only. Farmers have relied on traditional supplies of crops to the Kolonia where market demand is known. The ideas proposed during these workshops have been drawn from a much wider market base – that of the supermarkets. Collectively some 10,000 different products are available in Pohnpei and they make up the 73% of overseas products that comprise the indigenous diet. This challenges the existing markets for local crops but concurrently offers huge opportunities to substitute the supermarket products with equivalents or local variations.

Germane to the greater use of local crops is the promotional campaign conducted by Pohnpei Agriculture of the Department of Economic Affairs through its Model Farm, public awareness programmes and contribution to World Food Day and the tireless efforts of the Island Food Community of Pohnpei and its main advocate Dr Englberger.

Through these efforts there is an increasing agricultural base and cultivation of valuable and more novel foods have been demonstrated. The raw material base for processing is therefore much wider than in the recent past. As with most PICs the rate of exploitation will now depend on market demand and income that can be generated.

A number of raw materials are available and this workshop concentrated on one of the major resources – breadfruit which had been previously frozen. Other crops such as mangoes, papaya and pineapples which are also highly seasonal can be frozen at the height of the season for later on-processing into jams, jellies, chutneys and juices.

The banana resource is potentially very rich but supply is fragmented by the wide range of varieties. The raw material base for year-round processing requires careful management. It would be exciting to consider greater exploitation of the karat banana but the supply base is small and yet to reach commercial volumes. This variety is so unique in its flavour, texture and nutritional properties that there is a danger it will be undervalued if it is blended. Once the supplies increase this product could present Pohnpei with a significant comparative advantage for processing.

Strategies are in place for extending the raw material base. Frozen breadfruit is highly acceptable both for direct consumption and as a base for further processing. Most overseas mango processors use frozen pulp as their raw material and in Fiji, local bananas are also pulped and frozen for on-processing into baby foods, jams and desserts and other confections.

It is entirely possible that root crops can be partially processed in an analogous manner.

For other crops for which there is only limited supply, these can be extended during processing using more common cheaper alternatives. For instance limited supplies of fruit for fruit chutneys and sauces can be augmented using pumpkin.

It is recommended that processors take full advantage of the horticultural base within Pohnpei by partially processing plentiful crops at the height of the season and by taking advantage of the programme of crop diversification conducted by the Pohnpei Department of Agriculture through its Model Farm.

The Island Food Community now holds a significant collection of small-scale processing equipment which is sufficient to undertake the initial steps in product development. These are available on a lend/lease basis which will be sufficient to define the product parameters. Larger scale equipment is available and Appendix 4 gives details of larger scale equipment which may become available through CDA/EDA consortium. Once product features and process parameters are known it is relatively easy to secure finance if the cash-flow projections are realistic (Robert De Courteney, Bank of the FSM PO Box 98 Kolonia Pohnpei 96941 bdecourt@bofsm.fm).

The Market

Market volumes can be estimated after careful analysis of the items currently on sale in Pohnpei. Supermarkets operate on such very tight profit margins that they cannot afford to retain stock that sells slowly (Sam Isorena, Truk Trading Coy; Leon Senda, Ambrose and Co). The supermarket operators have adopted a very responsible attitude and there is a willingness to display products on supermarket shelves. For newcomers to the industry however, products must be consistent and the correct quantities delivered on schedule.

Most supermarkets operate on a 20% profit margin. By reducing the shelf price by 20% it is therefore possible to estimate the price that the supermarket is prepared to pay. It was gratifying that all supermarkets visited had a local produce counter to assist local entrepreneurs – testimony to their assertion to assist local entrepreneurs.

It is of paramount importance that all food processors understand consumer's motives for buying their products and the likely point of consumption. Chips for instance are unlikely to be consumed at a full meal. Frozen breadfruit-tuna patties must be cooked and are therefore eaten at home. In so doing then it is possible to identify competing products. There is little discretionary income in Pohnpei so that the success of the product will depend on its perceived 'value for money.' Our products must be chosen in preference to an overseas import. Direct price is not the determining factor alone.

Nascent processors in Pohnpei have a significant advantage over the competition because Professor Semes is prepared to evaluate products as samples are submitted and will sell these products if they are economically viable and the market is established.

Estimate the Cost of Production

The formula for the estimating the cost of production during the early stages of development is to add the cost of the raw materials, multiply by three and add 10%. This estimate (approximately) covers the cost of raw materials, labour and services. Therefore profitability can be calculated:

Cost of production
Add the cost of distribution (transport)
Deduct the price the supermarket is prepared to pay (estimated from the competition).

The balance is the profit.

If the product cannot make a profit then it has to be reformulated using cheaper raw material or some feature must be included (eg more convenient, higher quality) to persuade consumers to buy this in preference to a cheaper alternative.

If this is not possible then the product must be abandoned.

2..3.1 Financial Analysis of the Products Prepared During the Workshop

Breadfruit Products

1. Frozen Breadfruit Pieces

Cost of Breadfruit	$0.30 per lb
Cost of Plastic Pouch	$0.03
Total cost of raw materials	$0.33 per lb
Processing cost (x3 + 10%)	$1.10 per lb

Minimum retail value without transport and profit margin is $1.32 per lb.

It is estimated that this product will be consumed as the carbohydrate portion of a main meal. It is unlikely to compete against rice or ramen noodles. It might compete against imported potatoes, frozen French fries ($6.45 for a 500g bag) and pizza bases.

2. Breadfruit – Tuna Patties

Cost of Breadfruit	$0.30 per lb
Cost of 13 oz Tuna ($1.00 per lb)	$0.81
Cost of flour	$0.01
Cost of Oil (est)	$0.01
Cost of Chicken cube	$0.04
Cost of ingredients	$1.37 per 1lb 15oz
Or	$0.71 per lb
Cost of Plastic Pouch	$0.03
Total cost of raw materials	$0.74 per lb
Processing cost (x3 + 10%)	$2.44

Minimum retail value without transport and profit margin is $2.88 per lb.

It is estimated that this product will be consumed as the protein portion of the meal. This product is unlikely to compete against subsistence fish or pork but is likely to be purchased as an alternative to hamburgers ($7.00 per lb or sausages $5.50 per lb).

3. Breadfruit Extruded Snacks

Cost of breadfruit	$0.30 per lb
Cost of oil (est)	$0.01
Cost of salt	$0.01
Total cost of ingredients	$0.31 per lb
Cost of raw materials per 4oz pack	$0.08 per 4oz pack
Cost of Plastic Pouch	$0.03
Total cost of raw materials for 4oz pack	$0.11 per 4oz pack
Total production cost	$0.36 per 4oz pack

Minimum retail value without transport and profit margin is $0.44per 4oz pack.

This is likely to be consumed as a snack or as an adjunct to barbeques and other social events. The major competition is likely to be Curlies™, which have a retail price of $1.65 for a 4oz pack. It is likely that this product will compete against the imported equivalent based on corn and rice.

4. Breadfruit Biscuits

Cost of breadfruit	$0.30 per lb	
Cost of margarine $2.45 per lb	$1.23	
Cost of Salt	$0.03	
Cost of Sugar	$0.05	(Estimated yield 1lb)
Cost of ingredients for 1lb of biscuit mix	$1.61	

For 8oz pack of biscuits	$0.81
Packaging for 8oz biscuits	$0.20
Total cost of raw materials 8oz pack of biscuits	$1.01
Total production cost	$3.33

Minimum retail cost per 8oz pack of biscuits without transport and profit margin is $4.40

This is likely to compete against existing biscuits which cost $5.45 for an 8oz packet so the manufacture of biscuits will be profitable.

Banana Chips

Cost of banana	$0.35 per lb
Cost of oil (est)	$0.01
Cost of salt	$0.01
Total cost of ingredients	$0.37 per lb
Cost of raw materials per 4oz pack	$0.085 per 4oz pack
Cost of Plastic Pouch	$0.03
Total cost of raw materials	$0.115 per 4oz pack
Total production cost	$0.38 per 4oz pack

Minimum retail cost per 4oz pack of crisps without transport and profit margin is $0.46

This is likely to be consumed as a snack or as an adjunct to barbeques and other social events. The major competition is likely to be potato crisps, which have a retail price of $1.57 for a 4oz pack. It is likely that this product will compete against the imported equivalent.

Banana Vinegar

Cost of bananas 2lb at $0.35 per lb	(for 600ml)	$0.70
Cost of yeast		$0.01
Cost of PET bottle		$0.20
Total cost of raw materials		$0.91
Total production cost		$3.00

Minimum retail cost per 600ml bottle without transport and profit margin is $3.60

Vinegar finds general use and so the competition is likely to be based on price only. Vinegar is on sale in Pohnpei for $1.17 for 946 ml so that this will not compete. However vinegars from using any fruit except raw pineapples is more likely to be made from overripe, reject fruit which may have a value far below $0.35 per lb. This is for the processor to assess. If the cost of the raw

fruit was put at $0.12 then it would be possible to compete with the vinegar currently on the market.

Pickle in Vinegar

Cost of raw material

Cucumber (chillies etc) $0.30 per lb	$0.30
Vinegar (100ml) @ $1.17 for 650 ml	$0.18
Cost of one jar	$0.50
Total cost of raw material	$0.88
Total production cost	$2.91

Minimum retail of 650ml jar of pickle without transport and profit margin is $3.42.

There are equivalent products on the supermarket shelves in Pohnpei for $3.35 for a 650ml jar. It is unlikely that this product will compete with the existing products if premium price is paid for the cucumber (gherkins) and if retail prices are paid for the vinegar. If however the vinegar is prepared on site (see section ((((() and lower prices are paid for the vegetables then it is possible that this product will compete with existing products on the market.

Fruit Jams (including banana)

For jams to set, the finished product contains 60% sugar and the balance is fruit. The yield during jam making is 70% (during boil-down).

For a jar containing 210g (common the most frequent size in Pohnpei) the composition for a 300g starting mix is;

For a 450 jar therefore the sugar content is 126g
The original volume of the jam before boil-down is 300g.
The original weight of fruit is therefore 174g

Hence for one jar of jam of 210g the cost of the raw materials is:

Cost of 174g fruit ($0.35 for 454g)	$0.14
Cost of 126g sugar ($2.10 for 455g)	$0.58
Cost of one jar	$0.50
Total cost of raw material	$1.22
Total Production costs	$4.00

Minimum retail of 210g jar of pickle without transport and profit margin is $4.80.

The cheapest jams found in Pohnpei were $5.17 for a 210g jar. It is likely that locally made jam will be able to compete successfully against the imported equivalent. Local jam was costed at the maximum price for high quality fruit. It is likely that fruit can be sourced at a much lower cost than $0.35 per lb. In addition, bulk supplies of sugar are likely to be much lower than retail costs. This is especially true if groups cooperate to import bulk supplies of sugar salt and oil.

3 Strategies to Ensure Sustainability and Future Development of the Nascent and Micro-enterprises

It was important to establish the reason that the level of activity in food processing among the small scale entrepreneurs remained low and so the workshop was used a forum for the exchange of ideas on the requirements for sustainability.

The emphasis for these workshops was modified toward establishing the elements necessary for commercial food businesses rather than simply preserving and product development techniques. Participants were encouraged to voice the impediments to instigating food activities. These included:

- Lack of continuing technical support
- Lack of equipment
- Unidentified market
- Unavailability of Packaging
- Paucity of the raw material supply

3.1 Lack of continuing Technical Support

Support is always available through all the electronic media, but many rural and village dwellers are unfamiliar with internet, email and even fax. There is therefore natural reluctance to use this form of communication. As groups meet on a regular basis however, participants become more familiar with the resources available and conduits for information exchange more secure.

It is recommended that a contact point with the appropriate communications experience should be appointed to undertake the role of conduit between food processors and technical experts (eg Beyer and EcoConsult, SPC etc).

Ms Amy Levendusky has assumed the role on an interim basis but as a Peace Corp Volunteer her time in Pohnpei is finite.

It is recommended that the role of contact is point is gradually transferred to a Pohnpei permanent resident so that the function continues beyond the tenure of Ms Levendusky.

3.2 Lack of Equipment

There is now an extensive collection of equipment held by the IFCP. This is available to all processors for use in getting started. However, the equipment is only designed for small-scale processing and as products become refined and the volumes increase, these items must be replaced with larger scale items and should be purchased by each enterprise.

3.3 Unidentified Markets

Professor Semes was particularly supportive of the project and undertook to evaluate products as they developed. He has an interest in retail business and as such will provide an outlet for products that are produced by processors. This is particularly valuable because processors will receive immediate feedback about the quality of their products and modifications that might be required.

The supermarkets will include local products once quality is stabilised and delivery schedules become more reliable.

3.4 Unavailability of Packaging

Jars are required for jams, chutneys, fruit in syrup and pickles. The Sei Organisation was using glass packaging which was being supplied locally but as sales of green peppercorns in brine have dwindled the importation has ceased. This local supply however will be reintroduced if the demand increases.

It is recommended that the contact point monitors the activity in these 'wet,' products and that the importation of jars is resumed when volumes increase to economic levels.

In other PICs, entrepreneurs offer a refund (or outright purchase) on the jars. These are then cleaned. For repeat use however, new lids are required for each cycle.

For plastic packaging, 5 micron PE film is available throughout the Philippines and other sources on the internet. Once volumes are known then the ACE Hardware Organisation have agreed to bring in the packaging. Since the contact point now owns two sealers it is possible to fabricate bags of the correct size from film as it brought in.

At some later date, PET bottles for teas and cordials may be fabricated in Pohnpei and it is recommended that the focal point maintains close links with the Pohnpei Water Company and the Sei Organisation to monitor progress. Others users of bottles are to be included in this buying group as they emerge.

The establishment of the single contact point has been a significant development for the small enterprise groups in Pohnpei. This model has facilitated considerable activity in other PICs and now regular contact is possible between enterprises and experts.

It is gratifying that the workshop participants were anxious to ensure sustainability of food processing and willingly agreed to participate in a series of regular meetings. The first of these meetings has occurred and a schedule of monthly meetings has been determined. The group have recorded that they will initiate steps toward becoming a Non-Government Organisation.

3.5 Paucity of the raw material supply

Overcoming the apparent constraints on raw material supply has been discussed in some detail in Section 2.3. In summary;

- The supply of seasonal crops can be extended by partial processing (eg freezing).
- During product formulations scarce raw materials can be substituted with more common alternatives (eg pumpkin for mango or papaya).
- Greater use must be made of the crop diversification programmes undertaken by the State Agriculture Department.

3.6 Product Quality

As food processing industries progress beyond the cottage industry stage, then the quality of the product must be stabilised. A vast majority of the products offered for sale in the retail outlets are hidden from the consumer by protective packaging. The consumer must therefore use experience

in making food choices. Hence it is of paramount importance that products are consistent and unvarying. More advanced food processing workshops would of necessity include techniques in maintaining food quality.

In the event that the food processing industry emerges as a significant source of employment and the industry progresses toward the coveted aim of export, then organisations will be required to fulfil quality standard requirement as laid down by Codex Alimentarius. Training in such issues as Hazard Analysis and Critical Control Points (HACCP) system of quality maintenance may be required at a later date.

It is recommended that close liaison is maintained with all overseas stake holders so that further assistance can be provided in controlling quality and meeting the standards necessary for international trade.

4 Summary and Conclusions

The workshops in which a wide spectrum of participants was introduced to the economic and nutritional benefits of local food processing were welcomed during 2004. However the level of activity since that time has been disappointing. The spirit of this mission has been refined so that the impediments for future have been addressed so that local entrepreneurs and interest groups can progress beyond the interest stage into commercial reality. Two and a half days in workshop format was insufficient time to demonstrate the enormous scope of food preservation and the commercial possibilities that may ensue. It was important therefore to refresh the topic and then to direct efforts to surmounting the impediments to continued activity.

In an environment where a commercial discipline is in its infancy cooperation between stake-holders provides synergy and many economic benefits and the mission was steered in this direction by the ToRs. It is clear however that there is a spectrum of food businesses in Pohnpei with some more commercially mature than others.

For those already operating food processing operation there is a need to break the deadlock between inadequate exploitation of the local resource and the technology required to process into import-substitution products. A number of strategies were discussed to progress from the current stage. The CDA has significant experience in food processing but has been hampered in realising greater potential by confining activities to value-added products from coconut. Underutilised equipment would be much better served in exploiting a much wider range of local crops. Even more exploitation could be achieved by more general purpose processing equipment and a portfolio of equipment is suggested and has been priced for further consideration by CDA and its commercial counterpart EDA.

For interest groups in the early stages of progress, there is a need to provide on-going technical, infrastructural and marketing support. A number of products were demonstrated but these are only the platform for a much wider portfolio of products that can be processed using local raw materials. This is only the first step in the development process. As a ‘roadmap,’ for continuing activity a technical document was prepared for general circulation.

The following conclusions are offered for consideration.

1. Food activity in Pohnpei is broadly divisible into the established commercial food operators and new interest groups.
2. The level of activity since the workshops of 2004 has failed to reach expectations.

3. For newcomers to food processing, the impediments to further activity have been identified as;

- Lack of continuing technical support
- Lack of equipment
- Unidentified markets
- Unavailability of packaging
- Paucity of the raw material supply

4. Structures were put in place to address these impediments;

    a. A steering committee to represent the views of newcomers to the industry was formed and will meet monthly
    b. A technical manual has been prepared (Appendix 2) and will be distributed to processors as required by the steering committee.
    c. A portfolio of small scale equipment has been supplied (Beyer) and the Steering Committee will be the custodian.
    d. The Chief of Agriculture is a member of the Steering Committee which will create a direct link between the raw material supplies and the processors.
    e. Mr Semes has agreed to evaluate all prototype products and will sell through his family market centre. The workshop included many supermarket owners who also agreed to evaluate products.
    f. Plastic packaging and jars can be obtained through ACE Hardware as volumes increase. Recycled jars and the plastic bags supplied (Beyer) will be used in the meantime.

5. Formal discussions will take place between the EDA, CDA and the State Legislator so that the CDA can be relocated to the EDA site.
6. Multipurpose food processing equipment to enable the CDA to process a much wider range of products has been compiled, conveyed to CDA/EDA and appears here as Appendix 3.
7. Frozen, thawed and cooked breadfruit is a very high quality vegetable indicating that it is possible to extend the season.
8. It is possible to establish a year-round breadfruit industry based on frozen breadfruit.
9. The profitable production of jams, vinegar, pickles in vinegar, snack foods and breadfruit patties is possible.
10. The imminent establishment of a Business School (Professor Semes) at the College of Micronesia-FSM, Pohnpei Campus heralds synergistic relationships between food processors and developers with the establishment of formal training for entrepreneurs in food processing.

APPENDIX 1

TERMS OF REFERENCE

Consultant in Food Processing

1. Scope of the consultancy

Approximately 2 weeks in Federated States of Micronesia.

2. Background

As a result of an intervention on food product development held in October, 2004, significant interest has been generated in the benefits of food processing in Pohnpei not only as a means of exploiting the rich food resource but also as a means of improving nutritional status. A number of entrepreneurs have continued to progress toward commercialisation and there is now greater use of a number of local crops. At that time the opportunities for further exploitation were unknown prior to the visit. The constraints of raw material supply and technology are much more clearly understood and the effort can be much more focused in its expected outcomes. Nevertheless there are a number of local entrepreneurs who have persisted in their food preserving efforts. These entrepreneurs will form the nucleus of private sector involvement.

It is a requirement for sustainability that tangible benefits accrue to local communities. In most instances this takes the form of a suitable financial reward. For food businesses to be sustainable it is important that they are able to operate year-round and are not based on highly seasonal crops which are available for very short periods.

There is an extensive bibliography relating to bananas and in Pohnpei and it is an obvious raw material base on which a value adding programme can be initiated. Such products as banana-based preserves, snacks and baby foods can be used to substitute expensive imported equivalents and new technologies such as pouching and pulping may be suitable for export.

There are similarities between the technological behaviour of banana and breadfruit. Breadfruit has received little attention for product development. Hence there are a number of opportunities to undertake a development programme to produce analogous products. Breadfruit is highly seasonal and thus frozen breadfruit pulp with the base for development work.

3. Description of position (supervision and duties)

Under the general supervision of the FAO Representative and the direct technical supervision of the FAO Food and Nutrition Officer and in collaboration with national authorities and private sector representatives as appropriate, the consultant will perform the following duties:

Overall Objective: To liaise with all stake holders in Pohnpei to initiate food processing on a focused and sustainable basis.

Specific Tasks:

1. To facilitate the formation of a union of all stake holders for the permanent establishment of food processing in Pohnpei.

2. To test-trial and produce a number of products from frozen breadfruit pulp and bananas that fit the criteria for sustainable production and document in a simple manual the necessary procedures and processing steps, including aspects of food safety and quality.

2. To establish the practical model for profitable production and marketing of at least four of these products from each raw material.

Activities

In order to achieve these aims the following activities will be undertaken:

- farmer-producers, entrepreneurs, NGOs and appropriate Government agencies will be assembled and a programme of activities will be established and endorsed including a continuing system of communication between stake-holders;

- a range of food products based on banana and breadfruit will be developed and test trialled. The process parameters will be recorded.;

- steps for securing the raw material supply, processing equipment and markets will be identified and a list of processing equipment and appropriate suppliers for the production of these products will be prepared;

- stake-holder responsibilities for each activity will be defined and a commitment to undertake each tasks will be determined and recorded for later appraisal;

- participating entrepreneurs will be given training in basic management techniques that are specific for the food industry and a training resource manual prepared;

4. Outputs

The consultancy will produce the following outputs:

1. A concise mission report (max 5 pages) indicating purpose of mission, schedule of activities, a summary of findings, conclusions & recommendations and a mission itinerary.

2. A detailed technical report covering the parameters for processing chosen foods, issues of securing the raw material supply, processing equipment and markets, as well as a list of processing equipment and appropriate suppliers. The report should include an executive summary, and chapters on background, findings, conclusions and recommendations of the consultancy.

All Outputs are to be submitted to FAO in electronic form within 2 weeks of completing the mission.

5. Qualifications

- Advanced University Degree in Food Science and/or Technology.
- Tertiary Qualifications in Marketing.
- Several years experience in Food Processing/Product Research and Development; Experience in conducting training.
- Knowledge of FSM and the Pacific Region

APPENDIX 2

TRAINING MANUAL FOR FOOD PROCESSORS IN POHNPEI

PREPARED FOR FOOD PROCESSORS AND WORKSHOP PARTICIPANTS

RICHARD BEYER

IN COLLABORATION WITH THE ISLAND FOOD COMMUNITY OF POHNPEI

AND

THE POHNPEI STATE DEPARTMENT OF AGRICULTURE

OCTOBER 2005

RICHARD BEYER

beyer@connect.com.fj

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MODULE 1 – FOOD HANDLING

Introduction

Our food comes from the soil (as vegetables and some fruits) from trees (such as nuts and fruits like mangoes and pawpaw) and from animals that we farm (such as chickens, cattle and pigs) or that we catch or hunt (such as fish and pigeons) other foods come from animals such as eggs and milk.

Some of the foods we eat are seeds which are kept from one growing season to another. These foods are nuts, and cereals such as rice and wheat. They will keep well if they are kept dry and very well if they are kept cool and dry.

But most of the foods we eat spoil very quickly - especially at the high temperatures that are found in tropical countries such as Pohnpei. They spoil for two reasons:

- The life processes may continue (fruits and vegetables continue to ripen and then over-ripen).

- They are attacked by life forms that are too small for us to see – **germs**.

Life and Death Processes

All life forms go through a period of growth maturity and ultimately decay and death. Bananas are good example. They grow on the tree, are commonly picked almost green, turn yellow as we keep them and eventually turn soft and black.

We can stop these processes in some foods by chilling or by packing them in a special gas. Tomatoes that come from overseas are chilled as they are transported to Pohnpei and this slows down the life processes so that they are in good condition when they reach Micronesia.

Apples and pears are now kept in good condition all year round by chilling and packing them in a special gas that stops them dying.

Attack by Germs

All around us there are very small life forms, which are much too small to see. They are present in very large numbers and there are many different types. They are called germs or more often - **bacteria**.

Some of these bacteria will grow at high temperatures some at very low temperatures. Some will grow only in air and some will grow only where air is not present. Some are so tough that they are not killed by boiling water.

Bacteria survive well in warm humid conditions. Light does not make a difference so that they grow in the day and in the night or in dark places.

Places bacteria are found in very big numbers are in

- soil
- animal droppings

- human droppings (which we call feces)
- dirty water
- rotten food
- human nose and throat
- hair and all body fluids
- all animals

Although many substances may start off without any bacteria on them (what we call **sterile**) bacteria can quickly get onto them (that is they become **contaminated**).

Although some germs will make us sick, most bacteria are harmless and do not cause us to become ill. However very large numbers of bacteria on foods means that they spoil very quickly. The speed at which foods spoil is dependent on the number and types of bacteria present.

Some bacteria do cause sickness. Not only must we have a responsible attitude toward the welfare of others, but also if our food products cause illness then this is very serious for the future of our food producing activities because others will not eat our food again.

Part 1 BACTERIA THAT CAN CAUSE SICKNESS

Ways in which Food can become Contaminated with Dangerous Bacteria

1. Contamination from the equipment

Some foods are always **contaminated** because of the ways in which they are produced. All vegetables that come out of the soil for instance are **contaminated** with **bacteria** from the soil. Some bacteria from the soil will cause sickness (pathogenic). Many pathogenic bacteria found in soil ultimately come from the droppings of animals but others are naturally present in soil.

Fruits may be contaminated with bird droppings or from soil blown onto them as dust.

Animal foods are **contaminated** with **bacteria** from the field or from their feces or from their guts. Although the inside of meat and fish itself may be **sterile** (free of bacteria), it can become **contaminated** by using knives that have cut the guts and then the meat. In addition, when we put contaminated food such as guts or skin onto a table or cutting board, the table or cutting board becomes contaminated. The same happens with fruits and vegetables. Our finished products may be **sterile** but if it is put onto a table that has been used to cut raw fruit then they will become contaminated.

As we move from the field or garden to the inside of our production area then our shoes and feet will bring **bacteria** into the food preparation area. This is worse in fruit or vegetable processing areas because they come in with soil on them. In addition, workers moving in and out bring soil and therefore bacteria into the preparation area.

Rule 1 Any food that falls on the floor is contaminated and cannot be eaten without either washing carefully or reprocessing.

Food (and peeling and trimmings) that is dropped on the floor also attracts birds, rats, mice and cockroaches. All of these animals may walk through soil or feces and then over tables and will

then transfer bacteria from soil and animal droppings to the table and then to the food and our hands.

Rule 2 Any food that falls on the floor must be removed immediately so that rats mice, insects and other animals will not want to come into the factory.

Rule 3 Dirty areas such as around the vegetable or fruit washing area and the entrances should be washed regularly.

Rule 4 Waste food should be disposed of away from the production area so as not to attract rats mice birds etc. (Wherever possible vegetable waste should be composted).

Rule 4 Movement in and out of the production area should be kept to a minimum and all doors that can be closed should be kept closed at all times.

Rule 5 All foods or items that go into food like salt and sugar must be covered at all times and packed so that insects, birds, rats and mice cannot get into them.

2. Contamination from humans

Factory staff will bring bacteria into the factory on their shoes and feet. But we are all carriers of bacteria in addition to those that we have picked up on our feet. We carry bacteria on our hands from everything we have touched.

So if we have just stroked a dog or cat then we will have many bacteria on our hands because all animals are heavily contaminated with bacteria.

We may have been to the toilet and not washed our hands afterwards. Remember that feces and also the areas around our bodies that are near to the toilet areas are heavily contaminated with bacteria unless we take a shower every time we use the toilet. This is not possible. Bacteria can get through 8 layers of toilet paper and so if we use the toilet we have many, many bacteria on our hands.

Rule 6 Hands must be washed using soap and water after using the toilet – EVERY TIME.

Sometimes there is only one very dirty towel that may have been used by many others. They may not have washed their hands very well after using the toilet. **Do not use it**. Shake your hands dry and don't touch anything else before handling food.

It is the custom in Pacific Island countries to shake hands regularly with friends and people we know. They may have used the toilet and not washed their hands. We may have touched a wooden handle, which has been touched by many others who have not washed their hands. We may have slipped and put our hands on the ground which – as we know has many many bacteria.

Rule 7 Hands must be washed every time we enter the food production area first thing in the morning, after using the toilet, walking outside, smoking, blowing our noses or eating.

Although we carry many bacteria, most of the time they do not affect us. But bacteria belonging to one person may cause sickness in another person. These bacteria can be transferred to others by sneezing when hair falls out and when we touch. There are many bacteria around our noses and throat. If we touch our nose or mouth then we will have bacteria on our hands, which can

cause sickness in others. Smoking is also not allowed in food factories because the bacteria from our noses and mouth are transferred onto our hands – again after smoking we must wash our hands. Cigarette ends are heavily contaminated with bacteria they are unsightly.

Rule 8. Smoking and spitting is not permitted anywhere within the food production area or its grounds. If you go out for a smoke, then you must put the cigarette end in the rubbish bin and you must then wash your hands. Betel nut must be chewed away from the food production area you must not spit any where near the food area. Hands must be washed as you re-enter the food production area.

The same rule applied to eating within the factory because as we put food in our mouths or lick our fingers then those bacteria in our nose or throat are moved to our fingers. It is important that we wash our hands after eating. Because we may spill food on the floor (see **Rule 2)** then we must never eat in the factory areas.

Rule 9 Food must not be eaten in the production area. Hands must be washed after eating.

Sneezing will spread bacteria from our nose over a wide area and if we feel that we are about to sneeze we should move away from the food production area quickly or catch the aerosol (spray) in a tissue or a handkerchief. The tissue must be discarded. Immediately after sneezing we must wash our hands before touching food or anything else.

Rule 10 We never sneeze onto food and if we sneeze into a tissue it is thrown away immediately and if into a handkerchief we must wash our hands immediately.

If we have a boil or sore on our bodies, it is full of bacteria, which will certainly cause illness in others. It must be covered with a dressing in such a way that it cannot leak. If this is not possible, then your tasks for the day must not be anywhere near food.

If you have a running tummy, then you should not enter the factory and should stay at home. If it is only a mild case then you should tell your supervisor who will give you jobs away from food.

Rule 11 If you have any illness at all report it to your supervisor.

Parts of our bodies fall off all the time. Skin and hair are falling without us knowing about it. So we must cover our hair, feet and wear clean clothing – usually white so that we can see how dirty it is. In Pohnpei many people wear towels on the head – these will have many bacteria on them from our hair and during use to dry our hands and face. These towels should be removed before entering the food production area in case they drop into food or we use them to dry our hands without thinking.

Rule 12 Head towels should be removed before entering the food production area.

PART 2 BACTERIA THAT CAN CAUSE DAMAGE TO FOOD ITSELF

Not all bacteria will cause illness. But any food that we eat, can also be used by bacteria. When bacteria use food they make chemicals which may be sour or which may smell bad. If we leave meat, fish or milk out of the fridge it starts to smell very quickly. This process is called **spoilage.**

We can **stop spoilage** by any one of the following methods:

- Freezing
- Packing in a can and heating it so that all the bacteria are killed (canning)
- Drying

Foods preserved this way will keep for a long time (up to 2 years)

We can **slow** down **spoilage** by:

- Cooling in the fridge.
- Salting.
- Storing in vinegar (pickling).
- Adding sugar (jam, and crystallised fruits and ginger).
- Adding a preservative.

Foods preserved this way will keep for a short time only.

The time that these foods keep will depend on how many bacteria are present at the time we finish processing them.

It is very important for our food items that we try very hard to keep bacteria out. So in addition to washing our hands every chance we get, we must also make sure that we look after the food at every stage of the process.

That means that we wash every surface that the food touches. Our tables and scales must be cleaned so carefully that we can see no dirt on them. Our knives have to be clean. We must make sure that no dirt from splashed hoses can touch our food. At the end of the shift we must work on a cleaning system that makes sure that bacteria cannot grow over night.

If household bleach (eg Chlorox) is diluted 20parts water to 1 part bleach, it makes an excellent rinsing solution so it can be used to sterilize hands after washing with soap. It can be used for surfaces and utensils after they have been washed properly with soap and other detergents.

Tables can be rinsed with this solution and left to dry by itself. High risk items such as knives and chopping boards can be soaked in this solution overnight.

MODULE 2 FOOD PRESERVATION

Traditional preserving techniques

Historically, processing has been confined to practises that will preserve foods, to reduce waste and to extend the period over which they can be eaten (shelf-life), particularly for foods with very short seasons. Traditionally, foods have been preserved using techniques that exploit environmental factors. Sun drying has been used extensively as a means of extending shelf life because of the high ambient temperatures in Pohnpei. The process is benign - fish, occasionally pork, vegetables and fruits are merely sliced and laid on racks to dry. If prevailing conditions permit, the foods reach a final moisture content that will stop mould growth and the products are edible although not always appetising. In many cases vegetables turn brown, mould may grow before the drying process is completed – or occasionally later if the dried food takes up water if the humidity rises during storage. Other products may bleach and become tough.

A number of readily available 'chemicals' have been used to stabilise foods. Salt obtained by sun-evaporation of seawater has been smeared onto root crops to prevent bacterial and mould growth during drying. In other cases, the vegetables are dipped in seawater prior to drying and the salt concentrates during the drying process. Sun-dried lime segments and evaporated lime juice have been used to increase the shelf lives of some root crops and bananas – the vitamin C and acidity both acting as preservatives. Dusting with wood fire ash has been used to prolong the shelf life of breadfruit and yams. In this case, the alkalinity is hostile to moulds and other bacteria.

Many of these traditional preserving techniques continue to be appropriate for the preservation of many crops in the rural areas. Traditional food preservation techniques remain relevant but the end products are losing popularity, particularly among the young. Some of these traditional products continue to appeal to older members of the community and to older expatriates now living in Australia, New Zealand, Canada and the USA. In some cases these products have been exported. So foods preserved using traditional methods used in the Federated States can be exported but they have to be safe and the same every time they are made.

Modern Techniques for Preserving Foods.

Dehydration

Recent innovations in dehydration and drying are directed towards reducing the relative humidity of the air used for drying by removing the water vapour rather increasing its temperature. So-called heat pump dryers pass heated air, which has previously been used for drying, over cooling coils. The water vapour in the drying air condenses on the cooling coils and thus the relative humidity is reduced. The same air is used repeatedly on this drying cycle. The low temperatures used in this technique cause less oxidative damage and food dried by this means is usually much higher quality. The heat pump dryers are used in some PINs for products where ultimate retail price advantage justifies the capital expenditure and the running costs, which in turn depends on the cost of electricity. Unless markets for high quality markets are secured for foods dehydrated by this means it is unlikely to be economically sustainable. In Pohnpei some processors are finishing the dried product in air conditioned rooms – this has the same effect because moisture will condense on the cooling coils. This is an expensive method of dehydration.

Throughout the tropical island nations, some success has been achieved in early trials using secondary air dryers. Secondary air dryers rely on drying an intermediary component –

commonly coconut husk using wood-fired drying kilns. Ambient air is then circulated around the pre-dried coconut husk, which removes the water vapour. This reduces relative humidity of the air that is then passed over the food. The food – particularly in the latter stages of drying is not subjected to high temperatures and therefore suffers less deterioration. Modern processing techniques have been applied to a number of products including dried cassava dalo, fruit slices and some thinly sliced fish.

Canning

Dalo, cassava and breadfruit some local vegetables (eg duruka) and fruits have been canned and exported for some 12 years. Unfortunately canned products such as vegetables go mushy during canning and are not all like the fresh item. Generally these products are not popular because they do not taste the same as the fresh item. Some products canned in coconut milk are a bit better and sales figures are higher but coconut milk supplies are inconsistent.

Canned fish (tuna) is the largest single item of canned food produced and exported from the pacific region with very large factories in Fiji, American Samoa and the Marshall Islands with smaller factories located in Tonga and Manu Samoa.

An alternative technique is a multiple pasteurisation technique. Foods are packed in polyethylene/nylon bags and vacuum-sealed in such a layout that the products are not touching and that heat can reach every food surface. They are then immersed in boiling water for sufficient time for the heat to penetrate through the bags so that the surfaces of the foods reach at least $80^{o}C$ for 15 seconds. The pouches are then cooled using cold water to prevent over cooking.

In low acid foods, this is sufficient to destroy the vegetative cells of bacteria but not the spores of heat-loving (thermophilic) bacteria. However the heat shock is sufficient to encourage germination of the spores. These are then destroyed by pasteurising again 24 hours later by immersion in the boiling water bath for enough time for the temperature at the surface of the vegetable to reach $80^{o}C$ for 15 seconds. As an extra insurance measure, the package is heated in the same way on a third day. This is sufficient to destroy surface bacteria. With carefully handled vegetables, the deep tissue will be sterile. Thus this technique should result in pack sterility. In the event that the packs are still not sterile – which would be manifest by blowing – the product can be reheated for a fourth time since the heat penetrates to the same depth each time and damage to the product is still confined to the outer surface. The technique means that relatively little heat is applied to the surface of the vegetable and the damaging effects of the heat penetrate only a short distance into the tissue. The vegetable has the appearance texture and taste of fresh vegetables.

Freezing

In the short period of 30 months preceding May 2000, an export industry in free-flow frozen root crops was established in Fiji which peaked in February of 2000. At its maximum volume, 66 tonnes/month of frozen cassava were being exported to Australia (Beyer 2000). Much smaller volumes were destined for New Zealand. Trial shipments were also sent to Japan, but large scale exports were not possible because of cyanide levels that exceed Japanese standards. An unexpected demand has arisen for frozen root crops however, and production level is well below market demand. Other island nations including Tonga, Vanuatu and Samoa are now exploiting this market and there is room for other producers including Pohnpei. Recent trials with breadfruit indicate that the product is extremely good after it is thawed and cooked. Furthermore,

there are good freezing facilities in Pohnpei. However, freezing will be confined to urban centres where electricity supply is consistent.

Fry drying

There is now a large number of small fried snack root crop and plantain producers throughout the PINs. Products are becoming commonplace and some are emerging as export products. Entrepreneurs are encouraged to use these products as a basis for increasing market depth and width through product development programmes described as more appropriate technology and products. Cooked root crops can be mixed with wheat flour. Excitingly frozen cooked breadfruit will produce excellent snacks. These can then be extruded into hot oil. By mixing into dough there are many opportunities to:

- Extend using other ingredients.
- Improve acceptability by adding flavours.
- Improve nutritional value by adding other ingredients such as carrot and tomato (vitamin A).
- Add improvers to extend shelf life.
- Produce more consistent product.

The cooking medium can have a significant bearing on the acceptability of the final product. Commonly soya bean oil is used since it is the cheapest of the frying oils. The viscosity of oils is temperature-dependent. Oil temperature should be high as the product is removed. At high temperature, the oil is mobile and drains from the product easily. At low temperature, the oil adheres to the product thereby increasing costs (oil is commonly very expensive in the PINs). Fried snack foods with high oil contents are more prone to rancidity during storage, they are nutritionally less desirable and the mouth-feel is poor.

Oils used for cooking should therefore be heated to temperatures a little below the smoke point and relatively small quantities of product added to it, to prevent excessive cooling. Used oil should never be topped up with fresh oil. Thus used oil should be stored and allowed to settle. It may be washed with water and the (more dense) water layer drained. The used oil pooled in such a way can be used for several processes after it would normally have been discarded.

Spoilage of oils and fats are accelerated by sunlight and certain types of metals. Thus we use high quality equipment to process such products and then we pack them in packaging that will stop light getting through.

Preservatives

Lime juice contains citric acid, which is not a preservative in its own right but which will reduce the pH of foods to which it is added. Most troublesome bacteria grow well at pH values in excess of 4.2. If the pH of foods can be reduced during their formulations to values below 4.2, then microbial growth is confined to yeasts and moulds. The yeasts and moulds are very susceptible to heat and are easily destroyed during mild heat treatment such as pasteurisation (72^{o}C for 15 seconds). It may not be possible to reduce the pH to these values because citric acid is sour and the flavour that it produces may be unacceptable. However, any drop in pH away from the neutral pH values of the root crops and plantains will assist in extending keeping characteristics.

Other environmental factors such as reduced water activity a_w or salt or sugar will have greater preserving effect if the pH is shifted away from neutral. Lime juice can thus be used successfully as a preservative in combination with other preserving agents.

Lactic acid is another acid that is used as a preservative. It is rarely found in pure form but is commonly allowed to form as a result of homofermentative lactic fermentation of sugar but lactic organisms either added as starters (cheese) or allowed to grow naturally during fermentation in pit stores. This is the traditional method of preserving breadfruit in Micronesia.

Salt has been used as a preservative since recorded history. Above a total concentration of 10% no bacteria will grow. Unfortunately, this level of salt is unacceptable and is not consistent with current nutritional guidelines. As with the acids even low levels of salt will inhibit some types of bacteria. Three percent salt is sufficient to inhibit some bacteria and is not too high to be excessively salty. Such concentrations are used to inhibit competing organisms so that more desirable homofermentative lactic organisms can grow and produce lactic acid. The combination of salt and lactic acid is sufficient to preserve some products such as saurkraut, silver skinned onions and dill pickles.

Vinegar contains approximately 5% acetic acid, which is commonly used as a pickling agent. When used in the production of sauces and pickles, it must be concentrated by boiling down or by using one of the other locally available preservatives (sugar salt etc).

As with other additives even small quantities of salt will assist in extending the shelf life of labile products.

Sugar has been used to preserve food since the first century AD (the roman scholar Pliny the Younger, AD 61 – 113, has described sugar as having been brought from India). Concentrations over 35% are sufficient to preserve foods. Unfortunately, this concentration is very sweet but it is used for preserving fruit as jam and conserve. Sugar serves to reduce the water activity.

As with other locally available additives, even small concentrations of sugar will extend the shelf life of labile products. Again when used in combinations with acids and salt it will assist in prolonging shelf life.

Unheated pineapple juice contains a very active protein-hydrolysing enzyme (protease), bromelain, which is capable of attacking the cell walls of some bacteria. It is also capable of hydrolysing the proteins found in other foods but has little effect on the starchy staples. Unpurified pineapple juice will impart the characteristic pineapple flavour to foods.

MODULE 3 – PRODUCT DEVELOPMENT

WHAT PRODUCTS SHALL WE MAKE?

If we are going to preserve foods then we have an opportunity to change them and to add other ingredients to make them more attractive of convenient for those who (we hope) will buy those foods. How do we decide what products to make?

We all have experience of eating so that it is possible for us to think of products that we like, and that others might enjoy – more importantly pay for. It is not always quite as easy as that because basing an industry on only small quantities of fruits, nuts, fish or vegetables means that we cannot make very much. In addition, if there is only a short season, then for much of the year we will not be able to make anything. This means that the industry will not be profitable and therefore not sustainable. It is usual to find out what raw materials can be used for processing, how much there is of it and how long the season is.

While a constant flow of raw material is crucial, the most abundant raw materials are not necessarily the best sources of new ideas. Shortages of other raw materials may be overcome by diluting raw materials with larger volumes of imported ingredients (eg wheat flour or corn grits for extruded products). Fruit juice can be 'extended,' by adding sugar and lime juice. In addition, raw material may not be fresh but may have been frozen or preserved using by drying when supplies at the height of the season when supplies are plentiful. In Pohnpei we have shown that lovely products can be made from breadfruit that was frozen at the height of the season when it was cheap.

Processing in depth may involve the total destruction of all the characteristics of the raw material such as texture, flavour and appearance. The new product is then rebuilt often with the aid of other components (additives) and other ingredients. There are opportunities for blending several varieties or cultivars of crops and adding other, cheaper ingredients or ingredients which are imported and thus available in greater volume. The permutations and combinations are endless and there are opportunities for novelty and uniqueness.

However, having established that there is a reliable and plentiful supply of raw material to support a processed food industry (either locally or as a cheap import) then the development process may begin. Carefully designed product development programmes are staged processes conducted in such a way that the project can be abandoned or redefined should there be sufficient negative indicators to warrant it. In so doing, unnecessary expense can be minimised.

Idea generation in product development

For some, ideas tend to be generated on the basis of experience (what do we, our families and friends like) or from simply a good idea. For others, the process of establishing a new product portfolio is more a process of deliberate thought and systematic examination of existing, successful products. A number of simple techniques can be used to generate ideas.

Fundamental to generating ideas is an imagination of the times and events at which products are consumed. Sometimes we can think of an idea making a better type or version of a similar product.

Ideas come from a variety of sources - many ideas will not reach commercial reality. The process of idea generation must not stop. Simply by observing what consumers buy in markets and supermarkets and noting the eating habits of others, ideas begin to arise. There are a number of ways of generating ideas.

A Copies

Copies or 'me too,' product development is simply a copy of an existing product. There is a huge number of products that can be copied. Frozen sweet potato, breadfruit, coconuts in all forms and the fruit jams, chutneys, jellies and juices are now established products. Direct copies can be made of those products. For the entrepreneur embarking on a food industry, there must be markets for theses existing products – the challenge is persuading the existing consumers to change allegiance. Consumers are familiar with the product so that less expenditure is required for launching and educating consumers than it would be for an entirely new product. Examples of direct copies include:

Jams
Jellies
Fruit leathers
Chutneys
Root crop chips

B Smart Copy

This is simply a modification of a product that is already successfully established in the market.

Local versions of existing products are a rich source of ideas for product development. For the PIC entrepreneur, all the potato and cereal products are potential templates for the production of similar products made from root crop, plantain or breadfruit. They may indeed be products that are essentially the same as the template product with a partial replacement of one or two of the ingredients. .

Such products have the advantage that they use local products in forms that have proven market acceptability. Since they are already familiar to consumers, they do not require the advertising support of totally new products. Furthermore, they reduce the dependency on imported foods.

C Making a product that is easier to use – more convenient

Frequently existing products are not as successful as they might be, because they are inconvenient. The root crops, for example, are far from convenient. They are heavy, sometimes dirty and require peeling and cooking. Yams may be very large, taro is difficult to peel and the latex from breadfruit may give it an unfortunate appearance. Many products have been more successful than their competitors because some steps in the kitchen preparation have been undertaken. Coconuts are very inconvenient, and bananas can be used as a base for such items as vinegar and thus pickled products.

As a simple exercise, those seeking ideas are invited to survey a market and examine the vast number of products that they do *not* purchase. Work out the reasons which make you buy something else. Using this idea, it becomes possible work out what changes are needed in that product in order to make it more convenient and thus encourage more frequent use. Convenience can be added by;

- Altering the package size (single serve, family pack etc).
- Altering the packaging design to improve convenience (re-sealable pack, ring pull can opener etc).
- Peeling and preparing difficult and dirty vegetables (root crops).

- Mixing a variety of raw materials that would require several shopping stops to simulate in the home.
- Adding an exciting flavour that is not readily available to the consumer.
- Partial cooking to save time and encourage impulse consumption.

D Traditional product or dish modified for commercial sale

Many products are consumed throughout the pacific region are cooked in coconut milk. These have been successfully reproduced in a can. Although there is a small export trade for these commodities, the canning process causes significant damage to both texture and taste. Also the equipment necessary to can successfully is expensive and requires high volumes to justify the cost.

Improved results are now possible with root crops packaged in coconut milk that are subsequently frozen. The products so produced can be thawed, and cooked (if necessary) using a microwave and are thus appealing to western consumers. This is especially true for consumers who rarely join the family dinner table and eat who 'on the run.'

Some products have been produced for expatriate communities now residing in the United States, Australia and New Zealand but there is mounting evidence that western consumers are consuming them.

E Varieties

Once an industry is established, it is a simple process to increase sales by increasing the market width and depth by developing *varieties*. Banana chips for instance, can be made in a single flavour, or spices and colourings can be added to give an alternative variety. Varieties are very common in the food industry because the same equipment can be used for a number of products. This increases the throughput rate, which assists in reducing the fixed cost element that must be recovered per unit item sold.

F Technology-driven product enhancement

There are two aspects of technology-driven product development.

- Technology in the home.
- Technology in the food industry.

Technology has made a significant difference to our daily lives. The use of refrigerators in the home and now in rural areas throughout the region has extended the shelf life of previously perishable products. Products which had a marginal shelf (such as pickles and sauces) now have unlimited shelf life if they are kept at low temperatures. This represents a significant advantage for the Pohnpei processor because there is a good supply of power throughout the State and many homes have refrigerators. Not all PICs have such facilities.

The formulation of recipes depends very much on the expected shelf life. Bulk packs of frozen foods are now possible which were not possible a generation ago simply because the product will retain its freshness for the period of consumption of the pack. Frozen cassava, breadfruit and sweet potato French fries are now possible and are displacing frozen potato french fries that are imported in large volumes into the PICs.

For the export trader, there is increasing use of microwave ovens in Australia, New Zealand and in the USA use of the microwave oven is beginning to extend to the car. Trends would indicate that communal dining is in decline as leisure activities occupy evening time and the family unit becomes less permanent. The microwave encourages expedient eating and thus single serve products.

A number of technologies within the food industry have opened up a range of products that were not previously possible. Extrusion has for instance made possible a range of products that have totally different characteristics from any product previously produced. Such products include the open textured honeycomb expanded products such as snack food Curlies™ Twisties™ and Bongos™.

Such technology has been used in many Pacific Island Nations for the manufacture of a range of extruded snack food based on the starchy staples. Cassava, taro, breadfruit and sweet potato have been extruded and have a bright future as a base for a whole new range of snack foods.

G Responding to a fashion or a fad

The food industry is the subject of a great number of fads and fashions. The range of confections particularly directed at the young is commonly aligned to the latest cinema or television releases. For instance, such fads as space travel results in rocket shaped confections. Computer games such as Pacman™ was followed by an extruded puffed snack food with the same name.

Other more sophisticated trends include the latest nutritional fads. Many products today are produced with reduced fat, low salt, monosodium glutamate-free and cholesterol free. The processor must be aware that the scientific validity of such fads is irrelevant - the market perceptions define the buying patterns. Nut consumption is increasing around the world and the health benefits of nuts is become more widely acknowledged.

H Reducing the cost

Once products have been launched on the market, successful companies undergo constant re-appraisal of the formulation. Most attempt to reduce the cost of the raw materials by substituting or extending the expensive components with cheaper alternatives. There have been many instances of fraud and mal-practise based on watering milk and fruit juices and much of food analysis research has been stimulated by the requirement to police such activity.

Codex Alimantarius to which Pohnpei aspires is a series of standards that dictate the ingredients required and the additives that are permitted in foods. Many foods sold today are hidden from the view of the customer in opaque packaging. Even after preparation it is difficult to estimate the contents and thus quality, of foods such as hamburger, sausage and fish sticks. Codex Alimentarius is designed to protect consumers from excessive substitution and fraud.

In the case of fresh or frozen starchy staples, there is no opportunity to substitute cheaper components since the items are clearly visible and any additive is immediately obvious. Once these vegetables are used in a less recognisable formulation such as soup base or snack food, then it becomes possible to substitute and extend. At this stage it becomes important for the developer to understand the specifications for the product that are laid down by Codex Alimentarius or by the importing country. For exporters those standards and specifications laid down by Codex Alimentarius and modified by the importing country are sacrosanct.

To improve the performance of foods, a range of substances are added to food that will improve appearance, taste, texture, safety and keeping quality. Other publications are available which detail the use of these additives and the information they contain will not be duplicated here.

There are a number of ingredients, which can be incorporated into foods that have the same roles as additives. These items have the advantage that they are natural foods and therefore may appear on the label as food ingredients – not additives. By using these components the PIN entrepreneur gains another comparative advantage.

I Completely new

There are still opportunities for the development of completely new products that are entirely innovative. Of the items with enormous potential are the use of breadfruit as a source of latex and the entire range of starchy staples as a source of specialty starches for confections and as sources of novel ingredients in the food industry.

The removal of water for the production of flour is expensive. In most instances the flour is used as an ingredient to which water or other fluid is added. Thus it is economically sound to produce shelf stable root crop, plantain and breadfruit products that are equally useful to consumers as an ingredient but which does not have the production expense of dried flours. Starchy staple pastes can be produced and packaged in resealable tubes (similar to tomato paste tubes), for example. Snacks can be formulated and packed in tubes as paste for the consumer to simply squeeze into hot fat as required.

Having established the ideas for new products, then the exact features of that product must be defined. Such aspects as flavour, taste, shelf life, convenience, appearance including packaging all contribute to the success of the product.

What are the Best Products for Pohnpei?

This is now up to you to decide – your ideas are as good as anyone else's. But remember if it doesn't sell – stop making it and change it or move onto something else.

MODULE 4

FORMULATIONS

INTRODUCTION

- These formulations are only a guide – you can add any flavours that you think will give you a comparative advantage over competing products.
- The final product formulation with which you are happy – must not change. The consumers must know that your product is the same every time.
- You must write down the quantities and the method that you use to make your products. There is nothing worse than making a good product and finding that you cannot do it again. A book is preferable to paper because paper gets lost.

1.1 Fried Chips and Peanuts

Oil is the most expensive ingredient in fried snack foods. It is therefore imperative that as much oil as possible is retained during frying. In addition, the oil must be kept in as good a condition as possible for repeat use. The viscosity of oil is dependent on temperature. Hence at the completion of frying the temperature should be as high as possible so that it drains away from the product.

The chips should be cut as evenly as possible to avoid overcooking the thinner ones and leaving too much moisture in the thicker ones. A range of simple hand slicers are available to ensure slice consistency.

Cassava is not suitable for making chips because the texture is too hard once fried. However it can be cooked and mixed with an equal quantity of wheat flour and the dough extruded into hot fat. Flavours can be added.

It is normal to assess the temperature of the fat (160^{o}C) but thermometers are unavailable in Savai'i so a simple trick is to add a little water to the oil (WITH GREAT CARE). If the oil is sufficiently hot then the water will boil immediately and splatter. Salt and chicken stock can be sprinkled over the chips during cooling.

Once the manufacture of chips has been undertaken for some time old oil containers should be retained. Old oil should not be added to new oil but all used oil can be pooled. It can be washed with water and the sludge will settle on the bottom of the container in the water layer. The oil layer can then be poured off and re-used.

1.2 Important Points

- The frying time and temperature should be as consistent as possible from batch to batch.
- If the crisps are not crispy they are not sufficiently dry for long term storage.
- The crisps should be allowed to cool after frying to ensure that no condensation forms on the inside of the plastic pouch after sealing. Condensation means that the chips will go soft and ultimately support mould growth.
- Taro should be peeled sliced and soaked in 3% salt (3 tsp salt in two cupfuls of water) over night, drained before frying.

- Vitamin A is not destroyed during frying so that red/yellow sweet potato (kumala) is more nutritious than imported potato chips.

2.1 Cordials and Teas

Fresh juice squeezed from local fruits (limes, oranges, lemons)
To two cups of juice add two cup of lime juice and one cup of sugar.

Bring to the boil and add fill into bottles when sufficiently cool.

Dilute 1:3 immediately before use.

Using glass bottles and filling and sealing while boiling the cordial will last for three to four months.

A nectar can be prepared by blending 2 kg of pawpaw (or mango or pineapple)
Add 3Kg of sugar and 1 litre of lime juice.

Bring to the boil and pour into clean jars or bottles. Screw on the cap and invert immediately.

Reinvert when cool
Refrigerate after opening.

Dilute 1:4

2.2 Important Points

- The cordial will need to be refrigerated after opening.
- Jars, bottles and their lids must be exceptionally clean – boil before use, rinse in Chlorox and use when the smell of chlorine has dissipated.

2.3 Teas, Spice and Herb Extracts

For extracts of vegetables (cinnamon and other spices) a similar cordial may be prepared but these spices do not contain sugar or acid. Furthermore they are often heavily contaminated with high numbers of bacteria. It is important that these items are washed thoroughly before use.

These products are made the same way but prepared using syrup as follows:

Use two cups of sugar to three cups of water.
Add two heaped teaspoonfuls of citric acid.(or 1litre of lemon juice).
If this is too sour add more sugar – do not reduce the citric acid or lemon juice.

3.1 Jams and Marmalades

There are three requirements for jam to set – acid pectin and sugar at a sufficiently high concentration to make the soluble solids content to 65%. This is generally achieved by adding

the same quantity of sugar as fruit followed by boiling down the volume by approximately one third to two thirds of the original volume.

There are exceptions to this formula depending on the fruit used. Some are very low in pectin (eg strawberries and possibly some indigenous fruits). In this case, a ready source of pectin is available from the albedo (white layer) of citrus fruits. In order to avoid adding too much water as the citrus fruit is added it is common to cut in pieces and to sprinkle salt over the citrus fruit. When left overnight, the salt draws moisture from the citrus fruit by osmosis. The fluid that exudes is drained away and any residual salt is removed by rinsing three times. The citrus however cannot be left in water because it will simply re-absorb water.

If the taste of citrus fruit is undesirable then the pieces can be large thereby making them easy to remove during subsequent boil-down. If however the jam has a mild taste only, then the citrus rind can be cut very finely.

3.2 Jam Made from High Pectin Fruit.

The procedure for preparing jams using fruit with high pectin content (oranges, bush limes, lemons):

1. Wash and peel the fruit (where appropriate).
1. Remove seeds if not required in the final jam.
2. Measure the volume of fruit prepared using a cup or bowl or jug.
3. Heat the fruit slowly over a fire and stir continuously
4. Measure an equal volume of sugar but do not add to the pot.
5. Boil the fruit stirring continuously until the volume is reduced by about a quarter.
6. Add the sugar.
7. Boil down until the total volume is reduced by another quarter.
8. Pour jam into jars while still hot (if glass jars are used) and invert to sterilize the inside of the lid.

Pawpaw is not a very acid fruit so add an equal volume of lemon or lime juice and boil down to half the initial volume.

3.3 Jam Made from Low Pectin Fruit

The procedure for preparing jam using fruit with low pectin content (eg bush ‘cherries,’ pineapples, pawpaw, mango):

1. Cut two cups of any citrus fruit (orange, cumquat, lime, lemon, pomello) into large pieces (quarters) and place in a bowl.
2. Sprinkle with salt so that all the fruit is covered.
3. Cover and leave overnight.
4. The following day remove the fluid that has gathered and rinse with water three times to remove the salty water. Do not immerse in water but drain and let any rinse water drip away.

The low pectin fruit is prepared as follows:

- Wash and peel the fruit (where appropriate).
- Remove seeds if not required in the final jam.

- Measure the volume of fruit prepared using a cup or bowl or jug.
- Measure an equal volume of sugar but do not add to the pot
- Heat the fruit slowly over a fire and stir continuously.
- Add the drained citrus fruit prepared in steps 1- 4 above.
- Boil the fruit stirring continuously until the volume is reduced by about a quarter.
- Add the sugar.
- Remove the large pieces of citrus fruit using a spoon.
- Boil down until the total volume is reduced by another quarter.
- Pour jam into jars while still hot (if glass jars are used) and invert to sterilize the inside of the lid.

Lids must remain depressed once the jam is cool.

If glass jars are used with metalised caps then the jam will keep for at least one year (unopened).

4.1 Chutney and Sauces

Chutneys are an excellent means of adding interest to normally bland food such as cassava, yam, kumala and taro. In addition if items such as yellow sweet potato (kumala) are used as a base this is an excellent mechanism for adding vitamin A to the diet. Any base can be used and success was demonstrated with green pawpaw but pumpkin, pineapple, mango and marrow can be used. It can be substituted with up to half with red kumala. The following is a basic recipe but can be altered by adding other locally available spices and herbs and spices such as ginger, turmeric, cinnamon, and any other spices.

1. Wash, peel, cut and seed three green pawpaw (or alternatives given above) into large pieces and sprinkle with three teaspoonfuls of salt.
2. Cover and leave for three hours.
3. Add three teaspoons of salt to one and a half cups of chillies and pound into a paste.
4. Pour off the liquid from the fruit or but do not rinse.
5. Add, one and a half cups of sugar and one full cup of vinegar and the pounded chillies.
6. Boil down to two thirds of the original volume.
7. Fill into glass jars hot and invert as described with the production of jam.

Lids must remain depressed once the jam is cool.

4.1 Fruit in Syrup.

Most fruits can be preserved in syrup. Preservation is achieved by using acid from the fruit which is strengthened by adding citric acid. Acid alone will not stop fruits from going mouldy so it is usual to add some sugar to reduce the water activity. At the same time the fruit and syrup is heat to destroy any moulds that were on the surface of the fruit.

1. Fruit is washed peeled and cut as appropriate.
2. It is then filled in jars to 1 cm from the top.
3. Syrup is prepared by adding one cup of sugar and half teaspoonful of citric acid to three cups of water.
4. The syrup is boiled and added to the fruit (still boiling if the jars are glass until the jars are overflowing.
5. The caps are screwed on tightly and the jars inverted.

4.2 Important Points

- It is important that the syrup is boiling at the time it is added to the jar of fruit.
- The jars must be filled to overflowing.
- The jars must not be touched until the jar is cool because any bacteria on the hands may get sucked into the jar as the contents contract during cooling.

Lids must remain depressed once the jar is cool.

5.1 Pickles in Vinegar

Vegetables such as young cucumber (gherkins) onions, green mango and papaya can be pickled in vinegar. It is similar to the technique of keeping fruit in syrup.

1. Fruit or vegetables are cleaned and prepared as necessary.
2. They are cut into conveniently-sized pieces.
3. Jars are filled to within a quarter of an inch of the top of the jars.
4. If sugar is to be added to the product (vinegar is very sour) it can be added in dry form to the jar.
5. Vinegar is boiled and added to the jar of prepared vegetables until it is overflowing.
6. The jar is sealed and inverted.

5.2 Important Points

1. Any spices can be added to the jar of pickle but they are usually higher in bacterial numbers than fruit. So add them to the vinegar so there is no doubt that they are heated to boiling point.
2. Do not under any circumstances add water to the vinegar – if the product is too sour, add extra sugar.

6.1 Frozen Breadfruit Patties

Tuna

1. Cook frozen breadfruit until soft.
2. Measure 450 g (1lb into a bowl)
3. Cook two cups of tuna (13 oz) of tuna and flake. Alternatively add two cans of tuna in oil (standard cans of tuna are 6.5 oz with 1oz of oil).
4. Add 2g (1/2 teaspoon of salt and one chicken stock cube.
5. Mix in 50 g (1/4 cup) of flour.
6. Form into patties and freeze.

Cheese

1. Cook frozen breadfruit until soft.
2. Measure 450 g (1lb into a bowl)
3. Grate 12 oz (2 cups) of cheese
4. Add 2g (1/2 teaspoon) of salt and one chicken stock cube.
5. Mix in 50 g (1/4 cup) of flour.
6. Form into patties and freeze.

6.2 Important Points

Once the flour has been added do not over mix the patties – chop the flour in to the mix and then form into balls. Pack into the plastic bags and flatten.

Other flavours can be curry or onion or mixes of the two.

7.1 Breadfruit biscuits

Basic mix	100g Margarine (1/2 cup) 200g of cooked frozen breadfruit pulp (1cup) 5g salt (1 teaspoon) 10g Sugar (2 teaspoons)

Mix together until if forms a thick even paste. Roll out into an even sheet using a stick to check the thickness is the same for each batch.

Commercial biscuits are baked (usually in a travelling oven) at 200^{o}C (390^{o}F) for 45 minutes but a standard oven will be sufficient.

For sweet biscuits honey or extra sugar can be added as required. Karat banana can be added for extra taste and colour

For savoury biscuits, cheese chicken stock cube and extra salt can be added to taste.

7.2 Free-flow Frozen Root Crops (Including Breadfruit)

- Excess soiling is removed from the crop prior to entering the factory (bird droppings, soil and latex are removed from breadfruit)
- The root crops are peeled (breadfruit is de-seeded), cut into convenient-sizes and rinsed
- The root crops are immersed in a solution contain 200 ppm (200 mg per Litre) of sodium metabisulfite for three hours.
- The crops are drained but not rinsed
- The pieces are packed in convenient sized plastic pouches
- The product is frozen in a reefer container.

APPENDIX 3

DISCUSSION PAPER FOR EDA/CDA

A FUTURE FOR THE COCONUT DEVELOPMENT AUTHORITY AS A GENERAL PURPOSE FOOD PROCESSING FACILITY

For Further Consideration by the CEOs of the Coconut Development Authority and the Economic Development Authority

1.0 Introduction

This is a document which is designed to be used as a basis for further discussion about the opportunities that might arise if the current CDA is located to the unfinished building currently located at EDA. The CDA is committed to relocation in any event and it may be appropriate to consider a small modification to the charter to widen the raw material base from coconuts to include all raw materials found in Pohnpei.

Pohnpei's agricultural base is largely based on crops well known to the Western Markets mixed with some low value crops for the local markets. However a number of indigenous crops have been largely ignored but have enormous potential to earn precious foreign exchange.

The agricultural base of the entire Federation is extremely small. Hence it is impossible to manipulate and control supply - and therefore prices - in the same way that larger producers have in the past. If the State and indeed the nation intends to trade in common items such as bananas, breadfruit and spices (and lower value fish species) prices will continue to fluctuate at the whim of overseas trading partners and will never be controlled by Pohnpei.

The future of products based on such common items might be in value-added derivatives which are unique and which have an innovative component which incorporates a comparative advantage. Examples might be a range of breadfruit products that mirror the enormous range of potato products (crisps, reformed snacks, frozen patties and baby foods). More compelling might be the exploitation of karat banana which has unique taste, textural and vitamin properties. Other products might be a range convenient, attractive products based on the enormous range of root crops. The major impetus for the importation of rice and noodles (ramen) is the convenience, price and attractive meals that can ensue.

Pohnpei's geographic location and excellent air services offer a comparative advantage over other pacific island nations (PINs). While there may be a commonality among the horticultural profile than other PINs, Pohnpei has a pristine environment which lends itself to organic certification and relatively easy protection against disease and pests.

Extruded snack foods (Twisties™, Bongos™) based on Pohnpei's well known starchy crops (dalo, breadfruit, yams and more recently kumala – sweet potato) have been demonstrated during the workshops of 2004 and 2005 – they await further refinement to meet commercial standard but if nothing else can offset the enormous volume of imported analogues.

2.0 The Opportunities

2.1 Pohnpei's crops – Fruit and Vegetables

Tahitian Chestnut, Ivi

The process for the preservation of ivi nuts was established four years ago using a multiple pasteurisation technique (Beyer) which means that pouches of ready-to-eat ivi were shelf stable without refrigeration for approximately six months. One group was exporting from Rewa but it was difficult to source the appropriate equipment during the latter part of 2000. There is a continuing demand among expatriate communities living in Australia and New Zealand although the market was established originally in Las Angeles.

2.2 Analogues of existing products using Pohnpei's raw materials

Extruded Snack Foods

Extruded snack foods have been described. The raw material required for the process is semi-dried taro, breadfruit or sweet potato paste to replace the broken rice/corn that is used buy overseas corporations. Raw material can be frozen in bulk during the season and defrosted in manageable aliquots as required by later production schedules.

Assistance with planting schedules, planting materials ensure a continuous supply of raw materials is required of the Pohnpei State Agriculture Department.

Sweet Potato French Fries

The technology for the production of sweet potato French fries has been determined – once again this process is simple and particularly well suited to entrepreneurs with only limited experience of food processing and handling. Currently there are $USD 2.5 million spent on the importation of frozen potato French fries. This is set to rise as the tourism industry expands. Previous reports have indicated that the characteristics of these fries are not as attractive as potato but they do add variety to the food choice. If red varieties are used, the fries have a nutritional advantage (Vitamin A, fibre) over potato equivalents.

An analogous organisation in Tonga has indicated that 10% of the potato market was easy to penetrate.

Root Crop and Breadfruit Crisps

These products are currently being manufactured by a number of women's groups but they are unable to access international markets because of the cottage style facilities in which they are prepared.

2.3 Unique Products

Spice pastes

The spice industry in Pohnpei is under-exploited. Approximately 20% of the restaurants in the UK serve Indian, Pakistani or Asian foods and there is a continuing and continuous demand for high quality spices particularly in usable form. During drying, spices lose their aroma and it is

therefore a marketing advantage if the spices can be kept fresh. Spice pastes such as turmeric, ginger, chilli, vanilla and curry pastes have been developed but using semi-dried spices and in the form of an emulsion. They have been packed in tubes for easy storage and dispensing. The current manufacturer is unable to satisfy the market.

Other, more convenient products include minced and sliced ginger vacuum-packed and sterilized for immediate use.

Vacuum Pouched Fruits

Pouched pineapples were produced some eight years ago. Interest has been generated for portion-controlled packs of pizza-cut pineapples. One sachet would be sufficient for one pizza so that the pizza manufacturers are not burdened with opened A10 cans awaiting final use.

But this technology can be extended to include processed fruit salads using Fijian fruits specifically designed for the tourist resorts. Once involved in the fruit processing industry then such items as lime marmalade, jams, ice-cream topping and leathers require similar technology and can be packed in bulk for resorts.

Further exploitation of the karat banana will provide the State with an enormous

2.4 Fisheries

The bigeye, yellowfin and albacore tunas are commanding excellent prices in Japan and there is little opportunity to add value to this foreign exchange earner. Perhaps there is a need for continuous and continuing training in such areas as post harvest handling and in HACCP compliance.

The major issue for the fishery is by-catch and for skipjack which is too small to can economically. The by-catch can be massaged into a number of items including reformed 'crab-meat,' (surimi) and a variety of ready-to-eat products such as fish sticks (fingers) and composite meals such as fish in sauces (of a variety of flavour), and reformed 'burgers'.

The small skipjack tuna will massage into a smoked salmon analogue commanding a much higher price than that obtained for canned fish.

The fishmeal plant has the potential to be the fountainhead of a number of industries including pig farming, chicken processing, biogas production. Previous reports (Beyer, Tonga 2001) have indicated that the minimum size for the economical production of frozen chicken is 500,000 birds. Fishmeal can be used for up to 60% of the feed. The remainder is corn and other biomass which can be readily grown in Pohnpei. Further studies are required but the current import of frozen chickens into Pohnpei amounts to $2.67 million.

3.0 The Vehicle for Exploitation

Other models among PINs have advocated a general purpose food processing facility. The Features of this facility were recommended to be high quality and the building constructed to ISO standards. The equipment would be the latest design to ensure that all products, samples and prototypes were produced to international standard in line with Codex norms and standards.

Although the manipulation of food from raw materials to finished retail product (eg breadfruit to 'Curlies™)'the sequence of events is constructed from a number of quite simple steps known as unit operations. From these unit operations most products can be prepared. Hence many of the products suggested here can be manufactured by assembling a complex line from a number of simple steps. The common unit operations in the food industry are as follows:

- Heat exchange
- Size reduction
- Mixing
- Separating
- Conveying/Filling
- Packaging
- Sealing (can seaming/pouch heat sealing)
- Forming and moulding

The facility would then be used for the following functions.

3.1 Refinement of Products Described

This would include the products described here – many of which have already been developed but require final refinement. The process line would be constructed so that process parameters can be defined.

Once the process has been established and the product features defined in accordance with market requirements, then the process critical control points will be established in line with HACCP requirements in readiness for technology transfer for local entrepreneurs.

3.2 Commissioned Product Development

There are many entrepreneurs in Pohnpei who have excellent ideas for quite unique food products but do not have the equipment to produce them. In addition, they are unable to afford the premises suitable for food production. Hence they are trapped in a cycle in which they cannot produce for the mass market because they do not have the facilities and they are unable to source funding because they cannot provide proof of the product's success.

Hence this general purpose food processing facility would be available for them to produce prototype products for market evaluation and during the development process they would have hands-on access to the stages in the development process. Once the product becomes ready for manufacture, then the entrepreneur will be in a position to provide financial projections in order to raise finance.

3.3 In-house Product Development

Ideas generated by staff within the facility would be developed to the prototype stage and the process parameters and product features would be defined. This would then be spun off as a separate (probably subsidiary) company for full scale manufacture.

The development facility would retain an interest so that product development programmes can continue to increase product width and product depth.

3.4 Training

The College of Micronesia Pohnpei Campus has expressed an interest in using such a facility to augment their Management and Entrepreneur Training Schemes. This is timely because work is due to commence shortly on a Government-sponsored training school which will be administered by Professor Semes. Thus there are a number of opportunities for this facility to generate income through training in;

- Enterprise Management
- HACCP compliance,
- Generating ideas for new products,
- Food service catering for the hospitality industry,
- Post harvest handling and partial processing in rural areas

3.5 Contract Consulting

There are a number of funding agencies which commission projects throughout the region and it is envisioned that staff of the centre will become involved in projects such as this, not only to generate income but also to widen expertise and rationalise issues common to the region.

4.0 Sustainability

The sustainability of the Facility will rely very much on the ability to generate income. It is anticipated that the Facility will become self sustaining after four years. Income will be generated from a number of activities.

4.1 Manufacturing

The normal production of consumable items will be used to maintain cash flow. However as normal production interferes with development work, it will be transferred to its own operating entity. The Facility will remain an interested party assisting in further development and retaining a shareholding in the satellite manufacturing entity.

4.2 Royalties

Intellectual property is a valuable commodity and it is reasonable that there should be shared rewards for successful products. Royalties come in many forms but the most feasible for a new start-up enterprise is a payment based on volume sales. In this way all parties retain an interest in maintaining quality and other marketing features.

4.3 Fees For Training

Fees can be charged for training at all levels of food handling. While it is important to cover costs of training, the element of training required under the licencing system for mooted food legislatin must be very low so as not to endanger the livelihoods of the smaller operators.

The larger industries and specialised training such as that required for HACCP can be inflated to subsidise the costs of training to the newcomers and financially disadvantaged. The fee structure requires detailed analysis

4.4 Contract Consulting

There are a considerable number of strategic projects which are funded by the aid agencies. There is considerable expertise and experience in conducting these projects and this work will continue. The fees obtained will be use to fund the Facility. Furthermore the fees for consulting are expected to rise because capacity to undertake this work will increase as other staff becomes proficient.

Location

The incomplete building situated in the forecourt of the existing EDA building in central Kolonia is an ideal location for a reformatted CDA operation. The building has an excellent location for delivery of raw material and dispatch of finished goods with only short distribution lines between production and the local market.

Capital for equipment and facilities to be sourced from:

- Corporate sponsorship
- Grant and aid
- Re-alignment of Government expenditure
- Tuition and training fees
- Contracted work

APPENDIX 4

SUGGESTED EQUIPMENT FOR GENERAL PURPOSE FOOD PROCESSING

(COURTESY OF JEYOM SEAGARAM, TECHSO, BRISBANE, AUSTRALIA

Re: Plant & machinery for processing jam, jelly, & chutney

We refer to our meeting in Pohnpei regarding the processing method and required plant and equipment for the above products.

As we discussed;

- All the equipment will be installed at Pohnpei under one roof for the development of products
- One set of equipment suitable for versatile processing (interchangeable) for the development of products at initial stage at Pohnpei.
- After the development of products at Pohnpei, the projects (plant & equipment) will be tailored depending on the capacity of the production to each island by the entrepreneurs.

Products to be processed:

- Jam
- Jelly
- chutney

Plant and equipment recommended during our discussion;

A Jams, Jellies and Chutneys

1. Inspection table
2. Washer
3. Tank (500 Litres) fitted with heater, stirrer and lid
4. Filler (maximum 1 Litre).

(A1) Receiving Storage tank

2 units – 500 litres capacity toddy receiving stainless steel tank round shape covered with lid, inlet and out let connection with valve.
Price : A$ 2,700-00/each ex. Stores, Brisbane

(A2) Mixer for receiving tank (interchangeable)

1 unit – Anger type portable mixer with universal swivel clamp coupling arrangement to mount the mixer to the side walls of the tank. Mixer made out of S.S shaft and propeller unit suitable for blending and dissolving.
Price : A$ 1,500-00 ex.stores, Brisbane

(A3) Filter pump (Transfer pump from receiving tank)

1 unit – Stainless steel pump complete with motor, capacity 6 litre/min (2880litre per 8 hour shift) Price: A$ 1,400-00 ex. Stores, Brisbane

(A4) Filter (1 micron particle) single pass

Option I

1 unit – Cartridge filter with stainless steel housing, take a pleated 1 micron polypropylene
Price: A$ 600-00 ex. Stores, Brisbane (replacement cartridge cost-$90-00/each)

Option II

Stainless steel horizontal type filter press
One unit – Horizontal type filter press designed for clear filtration of liquid in the pharmaceutical, food, beverage industries etc. Unit consisting of disc type filter plates, perforated stainless steel screens and interlocking cups. The filter press, s.s transfer pump all mounted on a trolley with castors.
Price: A$ 4,800-00 ex. Stores, Brisbane

(Note: If we are selecting this filter press unit, we can avoid transfer pump between the collection tank, filter press, and pre-concentration tank as we are mounting the pump on the trolley and it can be used as filter pump and transfer pump between the tanks)

(A6) Transfer pump (variable speed) from pre-concnetration tank to rotary dryer (drum dryer)

1 unit – Stainless steel pump with variable speed to adjust the flow to roller dryer, able to pump 30% brix high viscosity liquid at 60^{o}C.
Price: A$ 2,800-00 ex. Stores, Brisbane

(A9) Tanks for final products

2 units – 500 litres capacity final product storage tank, stainless steel, shell with external mild steel jacketed barrel for hot water and steam circulation, crutcher with pedal type stirrer.
Price: A$ 4,650-00/ each ex. Stores, Brisbane

(A10)Volumetric filler

One unit – Semi automatic stainless steel volumetric liquid filling equipment, table model, positive displacement to fill by range of liquid into PET bottle. The capacity varies from 100ml to 1000ml.
Price: A$ 5,630-00 ex. Stores, Brisbane

One unit – Cap tightener, suitable for standard temper evident cap PET bottle
Price: A$ 3,700-00 ex. Stores, Brisbane

(A11) One set of complete s.s piping and fittings

One set – Complete s.s piping, valves and fittings to inter-connect receiving tank, filter pump, filter, pre-concentration tank, rotary dryer, or evaporating tank and final product storage, filling equipment and Thermo fluid heating system, valves and fittings etc.

Price: A$ 5,550-00 ex. Stores, Brisbane

B Chutney/ Sauces and Breadfruit Puree

(B1)Washing and blanching tank
As we discussed in Brisbane, we are offering fruit washing and sterilizing the fruits in one equipment (rather than washing tank with tilt arrangement)

One unit – Washing and blanching equipment consisting of 3 stainless steel tank with 3 perforated stainless steel basket. Main tanks are jacketed for steam heating for blanching operation and same tank equipped with water jet spray arrangement and air agitating system for washing operation of fruits (fruit will be loaded into perforated basket and placed inside the tank for blanching operation or washing operation). All the contact parts are made out of stainless steel.

Price: A$ 5,000-00 ex. Stores, Brisbane

(B2) Filter (de-water) mesh baskets – (included in the above washing tank equipment (B1))

(B3) Boiling tank
One unit – 200 litre capacity fruit boiling tank, made out of stainless steel, shell with external mild steel barrel for hot water and steam circulation with stirrer and tilting mechanism.
Price: A$ 7,000-00 ex. Stores Brisbane

(B4) Pulper
One unit – Junior pulper, body and contact parts are made out of stainless steel with one sieve and centre shaft, complete with motor and electrical.
Price: A$ 4,800-00 ex. Stores, Brisbane

(B6) Collection tank with pump
1 unit – S.S fruit pulp collection tank with S.S transfer pump to collect and transfer the fruit pulp into cabinet dryer trays.
Price: A4 3,700-00 ex. Stores, Brisbane

(B11) Hand sealer for metal container
One unit – Semi auto round, hand operated can seamer.
Price: A$ 1,950-00 ex.stores, Brisbane

(B12) Hand sealer for Plastic sachets
One unit – suitable hand sealer for plastic bags
Price: A$ 860-00 ex. Stores, Brisbane

C Vinegar

(1C) Fermentation vessel with oxygen trap, heater and stirrer
One unit –Fermentation vessel with insulation, heating & stirrer arrangement, oxygen trap etc.
Price: A$ 6,400-00 ex. Stores, Brisbane

(2C) Holding tanks (already included – Item no (A1))

(3C) Filter press (already included - Item no (A4))

(4C) Batch still – 50 Litre
One unit – Stainless steel batch distillation system complete with distillation vessel, distillation cooling column, condenser tank, collection vessel, etc.
Price:A$ 18,200-00 ex. Stores, Brisbane

(5C) Holding tank (included - Item no(A1))

(6C) Liquid filler (included - Item no (A10))

Jam, Jelly & Chutney

(D1)Inspection table
3 units – Stainless steel working table approx 8' long x 3.5' wide
Price : A$ 930-00/each ex. Stores. Brisbane

(D2) Washer – Included Item No (B1)

(D3) Tank – Included –Item no(A5)

(D4) Paste filler
1 unit – 200g to 1kg single head paste filler, motorized for jam & jelly
Price: A$ 5,000-00 ex.stores, Brisbane

Other site infrastructure facility

(E1) Water treatment plant (for potable water)
As we are using town water supply, we can use 2 different system to convert the water into portable water (System with RO system OR normal cartridge filter system)

Option I (cartridge filter system)
System capacity – 200 to 300 litre per hour

- Stainless steel water storage tank
- Suitable SS pump, 250 litre per hour (5 bar) ½" inlet and outlet
- Water softener suitable for the system
- Housings stainless steel or food grade plastic for cartridges

- Cartridges;
  a) 10u nominal polypropylene wound media and core
  b) 5u cellulose/Melamine
  c) 1u Cotton Wynd for removal of Giardia and Crytosporidium cysts
  d) Activated carbon filter
  e) Ultra violet sanitization (kill rate at 25/min)
- Portable water s.s collection tank

All these equipment connected with piping, valves, and fittings and mounted on skid and ready for the operation at site.
Price A$ 12,700-00 ex. Stores, Brisbane

Option II (reverse osmosis system)
System capacity – 200 to 300 litre per hour

- Stainless steel water storage tank
- Suitable SS pump, 250 litre per hour (5 bar) ½" inlet and outlet
- Water softener suitable for the system
- Multi media filter
- Micron filter
- Carbon filter
- RO system with pumping arrangement
- Ultra violet sanitization (kill rate at 25/min)
- Portable water s.s collection tank

All these equipment connected with piping, valves, and fittings and mounted on skid and ready for the operation at site.

Price A$ 22,500-00 ex. Stores, Brisbane

(E2) Thermic fluid heater
One unit – Thermic fluid heater consisting of; outflow, return flow, check valve, strainer, oil circulation pump, isolating valve, header, shut off valve, drain pipe, drain tank, air expansion pipe, air vent, expansion tank, pressure relief valve, air vent., fuel tank, piping etc mounted on skid and ready for operation at site.

Price: A$ 16,000-00 ex. Stores, Brisbane

OR

Steam boiler

(E3) Air compressor
1 unit – air compressor with necessary piping arrangement, suitable capacity to operate the volumetric filler and capping equipment and agitation to fruit washing tank.

Price : $ 1,450-00 ex. Stores Brisbane

The above prices are ex. Stores Brisbane only. The freight cost, handling, and export docs are additional to the above prices.

The fabrication and supply takes approx 8-10 weeks.

F Fried Snacks

F1 Deep Fryer

Cost Ex Brisbane $4,000
Flavour/Salt Tumbler $ 1,000
Semi – Automatic volumetric Filler $5,000

Appendix 5 Composition of the starchy staples[a]

	Sweet potato	Taro C. escu-Lenta	Taro X. sagitti-follium	Giant taro A.macro-rrhiza	Giant swamp taro C. chamis-sonis	Elephant foot yam A.campa-nulatus	D. alata	D. escu-lenta	D. nummu-laria	D. bulbi-fera	D. penta-phylla	D. rotun-data	D. trifida	Cassava M. esculentum
Moisture %	71.1	69.1	67.1	70.3	75.4	77.8	77.3	74.2	71.9	81.7	82.5	65.7	80.7	62.8
Energy(KJ/100 g)	438	480	521	449	348	336	347	406	443	258	266	550	284	580
Protein %	1.43	1.12	1.55	2.15	0.51	2.24	2.15	2.06	2.04	1.94	1.65	1.42	1.52	0.53
Starch %	20.1	24.5	27.6	21.5	16.8	16.6	16.7	19.3	23.2	11.7	13.9	30.2	14.2	31.0
Sugar %	2.38	1.01	0.42	0.96	1.03	0.14	1.03	0.55	0.22	0.20	0.12	0.32	0.23	0.83
Dietary fibre %	1.64	1.46	0.99	1.85	2.78	1.45	1.88	1.15	1.84	1.42	0.66	0.63	1.02	1.48
Fat %	0.17	0.10	0.11	0.10	0.16	0.06	0.08	0.06	0.06	0.05	0.03	0.09	0.04	0.17
Ash %	0.74	0.87	1.04	0.92	0.67	1.36	0.81	0.82	0.95	0.69	0.76	0.73	0.70	0.84
Minerals (mg/100 g)														
Ca	29	32	8.5	38	182	97	8.2	7.5	6.5	8.4	13	4.6	8	20
P	51	70	53	44	16	67	38	39	40	27	26	28	38	46
Mg	26	115	27	52	21	47	17	26	20	19	23	17	15	30
Na	52	1.8	6.6	30	72	4.1	3.3	3.1	8.6	2.7	6.1	4.7	2.9	7.2
K	260	448	530	267	67	622	318	303	448	346	374	361	350	302
S	13	8.5	7.9	12	3.3	12	12	16	15	9.0	13	12	8.2	6.4
Fe	0.49	0.43	0.40	0.83	0.61	0.51	0.60	0.75	0.38	0.56	0.44	0.60	0.54	0.23
Cu	0.17	0.18	0.19	0.07	0.11	0.18	0.15	0.17	0.34	0.21	0.25	0.12	0.13	0.14
Zn	0.59	3.8	0.52	1.57	2.3	1.05	0.39	0.46	0.50	0.31	0.36	0.30	0.35	0.48
Mn Al	0..0.11	0.35	0.17	0.62	0.69	0.31	0.04	0.24	0.04	0.13	0.05	0.03	0.03	0.060.
B	0.10	0.09	0.09	0.10	0.09	0.17	0.09	0.07	0.05	0.10	0.17	0.08	0.11	0.07
Vitamins (mg/100 g)														
Vitamin A (ret.+B-car./6)	0.011	0.007	0.005	0	0.005	0.07	0.018	0.017	-	-	-	0.8	-	Tr
Thiamin	0.086	0.032	0.024	0.021	0.025	0.06	0.047	0.045	-	-	0.036	-	-	0.05
Riboflavin	0.031	0.025	0.032	0.018	0.019	0.05	0.030	0.028	-	-	0.018	-	-	0.04
Nicotinic acid	0.60	0.76	0.80	0.48	0.46	1.2	0.38	0.41	-	-	0.33	-	-	0.6
Pot.Nic. Acid=Trp/60	0.32	0.19	0.33	0.46	0.07	-	0.44	0.66	-	-	-	-	-	0.07
Total vitamin C (AA +DAA)	24	15	14	17	16	3.8	28	20	-	-	Tr	6-12	-	15

	Banana	Plantain	Breadfruit	Breadnut
Moisture %	73	68	72	11.5
Energy(KJ/100 g)	426	513	430	
Protein %	1.3	0.9	1.5	13.3
Available CHO	24	30	24	62.8
Dietary fibre %	0.8	0.7	2.5	2.5
Fat %	0.4	0.2	0.4	6.2
Ash %				3.7
Minerals (mg/100 g)				
Ca	11	18	25	70
P				36
Mg		36	24	100
Na	29	4	1	1.6
K	241	489	480	162
S				
Fe	0.6	0.6	1	0.87
Cu				0.7
Zn		0.1	tr	0.12
Mn Al				.045
B				
Vitamins (mg/100 g)				
Vitamin A (ret.+B-car./6)	0.08	0.18	0.24	N/A
Thiamin	0.07	0.15	0.1	N/A
Riboflavin	0.08	0.06	0.06	N/A
Nicotinic acid		11	20	N/A
Pot.Nic. Acid=Trp/60				N/A
Total vitamin C (AA +DAA)	17.3	11	20	N/A

	Banana	Plantain	Breadfruit	Breadnut
Moisture %	73	68	72	11.5
Energy(KJ/100g)	426	513	430	
Protein %	1.3	0.9	1.5	13.3
Available CHO	24	30	24	62.8
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Fe	0.6	0.6	1	0.87
Cu				0.7
Zn		0.1	tr	0.12
Mn Al				.045
B				
Vitamins (mg/100 g)				
Vitamin A (ret.+B-car./6)	0.08	0.18	0.24	N/A
Thiamin	0.07	0.15	0.1	N/A
Riboflavin	0.08	0.06	0.06	N/A
Nicotinic acid		11	20	N/A
Pot.Nic. Acid=Trp/60				N/A
Total vitamin C (AA +DAA)	17.3	11	20	N/A

a **Bradbury, HJ., and Holloway, WD.,** (1988), Chemistry of Tropical Root Crops: Significance for Nutrition and Agriculture in the Pacific, ACIAR, ISBN 0 949511 61 7