

**TCP/TON/3201**



**Final Report**

**NATIONAL MAIZE PRODUCTION PROJECT**

**Financial Assessment**

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**For:**

**The Kingdom of Tonga**

**FOOD AND AGRICULTURE ORGANIZATION OF THE  
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June 2008**

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**(not for publication)**

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Nuku'alofa, Tonga  
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# **NATIONAL MAIZE PRODUCTION PROJECT**

## **Kingdom of Tonga**

### **Financial Assessment**

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#### Conversions

- US\$ = 1.8 TOP
- A\$ = 0.93 US\$
- Hectare = 2.47 ac
- Tonne maize = 40 bushels

#### Abbreviations

- GOT Government of Tonga
- NEDC National Economic Development Council
- MAC Maize Advisory Council
- SARDI South Australian Research and Development Institute
- IRR Internal Rate of Return
- NPV Net Present Value

# **NATIONAL MAIZE PRODUCTION PROJECT**

## **Kingdom of Tonga**

### **Executive Summary**

The Tongan agricultural sector has focused on low cost production of traditional crops to meet extensive social and cultural obligations. Production has been based around an extended fallow period to restore soil fertility supplemented by the extensive grazing of pigs, poultry and, to a lesser extent, cattle. During the 1990's/ early 2000 this system has come under increasing pressure through:

- The increased demands of labour intensive cash crops namely squash
- Increasing demands of an urbanised population for traditional root crops

As a result the fallow period has been reduced. In the absence of a legume base and/or fertiliser applications, increased cropping intensity has placed soil fertility under pressure.

The movement of skilled persons off shore has been compounded by internal migration. While generating a steady stream of remittances external migration has also created high dependency rates and a skills shortage. Internal and external movement of the population has resulted in underproduction of arable land in the outer islands while the introduction of new crops ie; squash has resulted in a decline in the labour available for subsistence food production. As a result agricultural labour rates have increased significantly.

By the early 1990's squash had developed into a major export commodity. Export volume peaked at 20,000 tonnes in 2003 but since then squash production has declined to an annual volume of less than 10,000 tonnes. The export opportunity targets the 6 week interval between domestic production in Japan and the Mexican crop reaching the Japanese market. The volume over this period is estimated at 16-17,000 tonnes.

During the period 1994 to 2000 squash accounted for 40 percent of Tonga's export earnings and more than 70 percent of the total value of agricultural exports. At one stage over 1,500 individual growers were involved in the industry. In 2008 it is believed that only 5 growers will remain producing for the export market. The decline in production can be attributed to

- Consistency of supply allowed Mexico to take a share of the market traditionally supplied by Tonga and New Caledonia
- The high rate of subsidy granted New Caledonian producers
- The failure to develop the South Korean market
- Inconsistent supply and /or over commitment by Tongan exporters

- Inadequate funding of the export crop

The decline in the viability of the squash has led the Agricultural sector to consider other options. Although sweet corn and field maize had been grown as a minor crop within the traditional cropping programme Tonga did not have a history of commercial maize production nor did it have an extensive research base to draw upon. Yet, largely because of its geographic location, maize was considered to have potential as an export crop within the South Pacific area.

In order to pursue this possible strategy a Maize Advisory Committee (MAC) was formed comprising of the Minister of Labour Commerce and Industries as the Acting Minister of Agriculture, Chief Executive Officer Ministry of Agriculture, Director of Agricultural Research and leading producers. The objective of the committee was to

- Undertake limited observation trials
- Based on these trials submit an application to the National Economic Development Committee (NEDC) for start up capital for an export orientated maize industry.

Under Stage I the trials would form the basis of an indicative financial assessment of the maize sub sector. Under Stage II the financial assessment would be used to assist with the formation of an operational structure within which the maize industry could be established and promoted as a viable export alternative to squash production. This report will address the indicative financial assessment of an emerging, export orientated, maize sub sector.

The conclusion drawn from Stage I would suggest that there is sufficient area of either cleared or broad acre in row coconuts for 1,500 to 1,700 ha to be grown during an initial establishment phase of the industry. However in the absences of a legume crop in the rotation ie; soybean the long term sustainability of the industry will be dependent on additional cleared land. Not only must maize provide short term financial advantages over alternative crops but it must generate a return that will encourage small holders to remove coconut trees- a basic crop contributing to traditional household food security. The financial analysis would suggest that

- At a contract price of US\$270 per tonne fob and a national yield of 7.5 tonnes per hectare maize would not be viable
- At a spot price of US\$340 per tonne fob dry season maize would be marginally viable at 7.5 tonnes per hectare. The wet season crop would cover production costs but would barely meet the debt servicing commitment and therefore could not be sustained.
- To be viable the national yield must be lifted to 8.5 tonnes per hectare and the fob price consistent at US\$340 per tonne

In assessing these production parameters it should be stressed that

- The information base relating to domestic maize production is limited to some six observation trials. It is acknowledged that the better, more experienced commercial producers, with access to good soils and mechanised equipment

may achieve yields in excess of 8.5 tonnes per hectare. However small holders, who will be essential if sustained levels of production are to be achieved, may find these levels of production difficult to obtain under wide row coconuts. This will be compounded by the fact that disposable household incomes will benefit from the feeding of export grain to livestock.

- The potential domestic market is assessed at one to two thousand tonnes at a premium price to growers. The growth in this market will be determined by the rate of commercialisation of traditional livestock enterprises
- The Australian grain trade dominates inter regional trade in the South Pacific. The domestic industry will not compete with Australia on either quality or consistency of supply. Any comparative advantage will be gained through a geographical location generating competitive freight rates. A volume market at a Tonga fob price in excess of US\$340 per tonne has not been identified

The sustainability of the maize industry, or indeed any crop diversification to compensate for the decline in squash production, will be dependent on addressing issues relating to soil fertility. To this end

- A research programme should be implemented without delay. The programme to focus on maize production, both for grain and silage, by management techniques
- The integration of soybean and/or Mucuna Bean into a maize based rotation and the impact on yield.
- Based on this research programme the Department of Agriculture would need to embark upon an aggressive extension programme with emphasis on integrated grain/ livestock initiatives

In order to stimulate the production of alternative crops GOT may wish to consider:

- The establishment of a Grains Industry Board to co ordinate, market and actively promote the development of all grains not just maize
- Provide a line of credit through the Development Bank of Tonga specifically targeting the upgrading of the agricultural sectors mechanisation capability thereby allowing the private sector to respond to any initiatives developed through the research programme.

# **NATIONAL MAIZE PRODUCTION PROJECT**

## **Kingdom of Tonga**

### **1.0 Country Background**

The Kingdom of Tonga situated between latitude 15 degrees and 23 degrees and longitude 173 degrees and 177 degrees is the most southerly of the Pacific Island groupings. Tonga comprises an archipelago of some 169 islands of which 36 are inhabited. The islands are spread over a total area of 260,000 sq km yet the actual land area comprises only 718 sq km (World Bank Country Profile)

#### **1.1 Climate**

Due to its southerly latitude and exposure to the trade winds Tonga has a cooler climate than the rest of the Pacific Islands. The climatic conditions attributed to the main island groups can be summarised as follows

Vava'u to the north has a mean monthly minimum temperature of 22 degrees, a mean maximum temperature of 28 degrees and an average rainfall of 2,222 mm. In a normal year a dry period of 1 to 2 months may occur between June and September with the eastern areas of the group the most susceptible.

Ha'apai in the centre of the archipelago has a mean monthly minimum temperature of 23.5 degrees, a mean maximum temperature of 25.5 degrees and an average rainfall of 1,680 mm concentrated in the November to March period. Dry seasons and droughts are common June to August

Tongatapu to the south has a mean monthly minimum temperature of 24 degrees, a mean maximum temperature of 27 degrees and an average rainfall of 1,900 mm concentrated in the November to March period. The dry season of moderate severity occurs July to November

#### **1.2 Soils**

The Tongan islands have been formed on top of two parallel ridges to the west of where the Indo- Australian Teutonic plate overrides the Pacific plate in an area known as the Tonga Trench. The western islands are of volcanic origin while the eastern islands are formed from coral uplifted by plate movement and subsequently covered with volcanic ash

The fine grained andesitic ash deposits are well structured, friable and well drained. Despite some mineral deficiencies these soils are capable of growing a wide variety of crops. The soils derived from volcanic rock, are shallow, poorly structured and as such of limited agricultural production other than coconuts

The total area of productive arable land is assessed at just over 27,000 ha with an additional 4-5,000 ha of arable land subject to severe production constraints namely wind erosion and salinity.

Vava'u has a land area of 119 sq km (11,900 ha) of which 8,400 ha or 71 percent of the total land area is deemed suitable for agricultural production. Of the area suitable for agricultural production less than 5 percent is considered to have severe cropping constraints. Non arable land comprises either land too steep for crop production or subject to high wind intensity and the intrusion of salt.

Ha'apai has a total land area of 110 sq km (11,000 ha) of which 4,800 ha or 44 percent of the total land area is deemed suitable for agricultural production. Of the area suitable for agricultural production 25 percent is considered to have severe cropping constraints and is subject to erosion.

Tongatapu has a total land area of 259 sq km (25,900 ha) of which 19,000 ha or 73 percent of the area is deemed suitable for agricultural production. Of the area suitable for agricultural production some 11 percent is considered to have severe cropping constraints. Land to the west has a higher clay content and therefore subject to moisture constraints in the dry season. Non arable land is largely comprised of low lying, salt affected, coastal land.

### **1.3 Population**

The 1996 population census indicated a total population of around 98,000 with a total work force of some 29,500. Nearly 34 percent of the work force, or some 9,900 persons, worked in Agriculture, Forestry and Fisheries, 23 percent worked in manufacturing with 12 percent in public administration and defence. The 2001 Agricultural Census indicated 10,100 households or some 13,600 persons, were actively involved in agriculture.

Given an annual growth rate of 0.4 to 0.5 percent current estimates would suggest a total population in excess of 100,000. The declining growth rate is a reflection of emigration to New Zealand, Australia and America. While generating a steady stream of remittances, external migration has also created high dependency rates and a skills shortage. The movement of skilled persons off shore is compounded by internal migration. The 1996 Census showed that while Tonga registered a net gain Nuku'alofa and 'Eua had a net gain of 0.4 and 1.2 percent Ha'apai and the Niuaus declined by 0.9 and 1.5 percent respectively.

Both the internal and external movement of the population has resulted in under production of arable land in the outer islands while the introduction of new crops ie squash had, until the recent decline in production, resulted in a decline in the labour available for subsistence food production. As a result agricultural labour rates had increased significantly.

## **2.0 The Economy**

### **2.1 The National Economy**

Tongan economy is characterised by a large non-monetary sector and heavy dependence on remittances from Tongans living outside the country. The monetary sector is dominated by the Royal family and the country's elite families while Chinese immigrants dominate the small business/retail sector

Growth in annual real GDP averaged slightly more than 2 percent in the period 2001-04. A sharp rise in public sector wages in 2000-01 and increasing difficulties with tax administration and compliance led to a fiscal deficit of 3 percent of GDP in 2003 (World Bank Country Report). Public debt declined from 56 percent of GDP in 2003 to 45 percent of GDP in 2004. Foreign reserves were estimated to stand at five months of imported goods and services in 2004. It is estimated that 100,000 Tongans live abroad. Officially recorded remittances amount to some 24 percent of GDP in 2003 far exceeding the combined earnings from commodity exports and tourism

## **2.2 The Agricultural Economy**

The agricultural sector represented 27 percent of GDP in 2003. In the financial year June 2003 the agricultural, forestry and fisheries sector grew at 1.9 percent with increases in squash, vanilla and root crop production offsetting a decline in fishing caused by poor regional weather conditions (ADB Country Report) Following the economic collapse of the coconut industry and the decline in the banana and water melon exports to New Zealand due to pest and disease problems, agricultural exports, represent, by value, some 70 percent of total exports. Agricultural exports are dominated by fresh and semi processed commodities namely squash, vanilla, kava and traditional root crops.

Agricultural imports represent around 30 percent of total imports. Meat and dairy imports represent around 40 percent of total agricultural imports. Cooking oil, fats, beverages and agricultural chemicals represent a further 20 percent of agricultural imports and cereal/ cereal preparations a further 12-15 percent. Total agricultural imports are around twice the value of agricultural exports making Tonga susceptible to volatility in world commodity prices

Agricultural imports amounting to some 550 to 600 tonnes milk powder and 5-6,000 tonnes meat supplement domestic production estimated at 370 tonnes milk equivalent, 340 tonnes meat equivalents.

## **3.0 The Agricultural Sector**

### **3.1 Land Ownership**

Traditionally land has been divided into tax allotments of 3.4 ha (8.25 ac) allocated to individual males over the age of 18 years. With the demand on agricultural land many of the tax allotments are subdivided into smaller agricultural holdings or for residential development. As a result, while land may remain under individual household management, the parcels of land are small with over 70 percent of holdings subject to rental agreements.

Over 96 percent of the land classed as arable is managed by individual households. The balance, some 253 ha, is managed by institutions. Of the 10,100 households

involved in agriculture the 2001 agricultural census indicated that 60 percent were involved in subsistence agriculture, 38 percent in subsistence agriculture with limited cash crop production while only 2 percent could be considered as commercial producers.

The 10,100 households operated some 15,000 individual parcels of land with an average size of 1.8 ha. However 18 percent of the holdings are less than 0.4 ha while 80 percent are between 0.4 and 4.0 ha. Less than 2 percent of holdings exceed 20 ha

### **3.2 The Arable Sector**

Root crops are the staple food of Tonga as well as being important for traditional and cultural ceremonies and as a measure of status and prestige. The traditional agricultural system is however under pressure from

- demographic change and
- the importance of squash reflects higher aspirations for a cash economy.

The 2001 agricultural census indicated

- 26,600 ha of agricultural land 22,745 ha where capable of growing arable crops, 2,600 ha where under permanent crops, 835 ha where fallow and 420 ha under of pasture
- the 22,745 ha of arable land nearly 4,600 ha of traditional food crops predominantly Cassava 1,168 ha, Common and American Taro 1,615 ha, Kape 286 ha, Kava 288 ha, Sweet potato 291 ha, Yams 945 ha. plus
- 1420 ha of commercial crops namely squash
- the area under permanent crop is assumed to be coconut production with some 105 ha of vanilla and 356 ha of forest reported

The traditional agriculture system would suggest that around 1,500 to 2,000 ha are brought into a four year rotation each year. As a result 25 to 30 percent of the arable land is under crop at any one time with the balance under regenerated natural vegetation

Crop production is profiled in Table 1. Crop rotation is based around.

- Yams, split over three growing periods are the first crop grown in the rotation
- Yams are followed by Sweet Potato/Kape/Kava then Tarro
- Cassava is planted as the last crop in the rotation on a declining level of fertility

While commercial crops may replace any of the traditional crops in the rotation it is more likely that commercial crops will be planted on land that would normally be under regenerated natural vegetation. The 2001 agricultural census indicated that that less than 17 percent of households used any form of either organic and or inorganic fertiliser. In the absences of a vigorous legume cropping component, a reduction in the fallow period could lead to a decline in soil fertility.

The increasing cost of labour, the pressure on the soil fertility and the increasing need to focus on high value crops that generate a cash revenue have resulted in the need to develop non traditional vegetable and legume cropping options and strategies

### **3.3 The Livestock Sector**

It is estimated that in Tonga there is only

- one commercial piggery
- seven commercial layer operations comprising some 25,000 layers
- two commercial dairy farms

The livestock sector is therefore dominated by subsistence ownership. Based on the 2001 Livestock Census

- 10-12 percent of rural households own cattle with a herd size of 1-2 head
- 6-10 percent of rural households own cattle herds with a herd size of between 2 and 10 head
- 3-5 percent of rural households own cattle with a herd size in excess of 10 head
- 75 percent of all households (including urban households) own pigs with an average herd size of 9.8 head of which 3.6 head are breeding sows. Households that don't own pigs tend to be urban households which face severe restrictions in the grazing of pigs
- 2 percent of rural households own horses with an average of 2 horses per household
- 8 percent of rural households own goats with an average flock size of 3.4 head of which 2.1 head are breeding does with the balance young and or replacement stock.
- 77 percent of rural households own poultry with an average flock size of 23 birds of which 5 birds are layers with the balance under 6 months of age

While Livestock ownership constitutes the principle means by which households accumulate savings the contribution of livestock to the cash economy is limited. Pigs and cattle both live and slaughtered, as well as horse meat, are important in meeting social obligations. Cattle tend to be tethered on fallow land and used to control weeds. The small size of individual tax allotments restrict the development of commercial cattle production.

Traditionally pigs have been allowed to free range and thereby causing significant damage to crops. More recently there has been move to partially enclose small holder pigs. Scavenger poultry are used for household consumption.

### **4.0 Project Rationale**

Established in 1987 squash developed into a major export commodity. Export production peaked at 20,000 tonnes (TOP 13.79 million) in 2003 but since then has declined to an annual volume of less than 10,000 tonnes worth TOP 8.32 million in 2005. The export opportunity targets the 6 week interval between domestic production in Japan and the Mexican crop. The volume over this time is estimated at 16-17,000 tonnes Prices peaked in 1995 at US\$950 per tonne fob but by 2004 had declined to less than US\$350 per tonne fob. While prices per tonne have subsequently improved

losses made on previous years trading and the introduction of a levy to recover the grower losses, have significantly reduced grower payout

Between 1994 to 2000 squash accounted for 40 percent of Tonga's export earnings and more than 70 percent of the total value of agricultural exports. During the early years of development more than 1,500 households produced squash. By the year 2000 the number of growers had declined to less than 800. It is understood that only 5 growers will produce for export during 2008. The decline in production can be attributed to

- A consistent volume sourced from Mexico allowed Mexico to take a share of the market traditionally supplied by Tonga and New Caledonia
- The high rate of subsidy granted New Caledonian producers
- The failure to develop the South Korean market
- Inconsistent supply and or over commitment
- Inadequate funding of the export crop

Being labour intensive squash created significant job opportunities, especially for women, during the planting period (June/July) and harvest period (October/November). As a result casual farm labour rates trebled in the decade 1995 to 2005

The decline in the viability of the squash has led the Agricultural sector to consider other options. Although sweet corn and field maize had been grown as a minor crop within the traditional cropping programme Tonga did not have a history of commercial maize production nor did it have an extensive research base to draw upon. Yet, largely because of its geographic location, maize was considered to have potential as an export crop within the South Pacific area.

In order to pursue this possible strategy a Maize Advisory Committee (MAC) was formed comprising of the Minister of Labour, Commerce and Industries, the Acting Minister of Agriculture, Chief Executive Officer Ministry of Agriculture, Director of Agricultural Research and leading producers. The objective of the committee was, in conjunction with MAFF,

- to undertake limited observation trials
- Based on these trials submit an application to the National Economic Development Committee (NEDC) for start up capital for a export orientated maize industry.

Under Stage I the trials would form the basis of an indicative financial assessment of the maize sub sector. Under Stage II the financial assessment would be used to assist with the formation of an operational structure within which the maize industry could be established and promoted as a viable export alternative to squash production. This report will address the indicative financial assessment of an emerging, export orientated, maize sub sector.

## **5.0 Maize Production**

With no history of domestic production and only two sets of observation trials the setting of realistic domestic levels of production is subject to conjecture. The following should however be noted

- Based on a single trial Vaini Research station anecdotal comment suggested that the favoured cultivar produced 6 tonnes per ha with all other cultivars significantly lower
- Grower observation trials indicate that from three dry season and one wet season sites an average yield of 8.5 tonnes per hectare with a potential of 10 tonnes per hectare was possible.
- FAO Food Indicators Asia-Pacific Region 2002 data would suggest that the average yield in Fiji was 2.55 tonnes per hectare while in PNG an average yield of 5.67 tonnes was obtained.

This assessment has assumed a base yield of 7.5 tonnes per hectare with a 7 to 10 percent loss attributed to storage and cyclone damage to give an average yield of around 7.0 tonnes per ha.

### 5.1 Potential Crop Area

Based upon the area of squash grown and the considered opinion of the MAC Technical Committee, the potential area classified as being suitable for growing maize can be summarised as follows

|  | Acres | Hectares | %    |
|--|-------|----------|------|
| <b>Immediate Potential</b>   |       |          |      |
| Broad acre cleared   | 1500  | 600      | 13%  |
| Broad acre in row coconut >24 metre  | 250   | 100      | 2%   |
| Broad acre requiring clearing <24 metre                                      | 250   | 100      | 2%   |
| Small holder cleared   | 1250  | 400      | 9%   |
| Small holder in row coconut < 24 metre                                       | 1000  | 500      | 11%  |
| <b>Development Potential</b>   |       |          |      |
| Not cleared but suitable for<br>Maize production after extensive<br>clearing | 7200  | 2880     | 64%  |
| Total Area   | 11250 | 4500     | 100% |

Around 1,100 hectares (600 ha commercial, 100 ha coconuts greater than 24 metres plus 400 ha small holder cleared land) could be planted in maize without any additional land clearing.

Some 600 ha (100 ha commercial plus 500 ha small holder) could be available for maize production but would require limited clearing of scattered coconut trees to ensure 24 meter rows. A further 600 ha (100 ha commercial plus 500 ha narrow spaced coconuts) could be available but would require extensive clearing.

The potential therefore exists to expand the area through the removal of coconut trees on wide spaced coconut areas and thereby allow for the production of an additional 1,200 ha maize under coconuts. The development of this land will however be constrained by

- At an estimated cost of TOP 10-20 per coconut tree total costs to remove scattered trees to a greater than 24 meter row spacing may well exceed TOP 10,000 per ha
- It is estimated that maize production under coconuts may increase cultivation costs by as much as 30 percent
- A reduction in the yield of maize grown under coconuts
- Coconuts constitute an important component of traditional pig production
- Coconuts are an important part of household food security
- Road access to small holder blocks can be difficult and may require extensive maintenance to allow combines to access the crop
- Where land is leased the lessor may claim compensation from the leasee for the clearing of coconuts.
- Uncertainties surrounding maize production and marketing

As a result there was a clear reluctance amongst small holders to clear land for mechanised maize production. Given this reluctance and the possible re emergence of squash as a viable export alternative it is considered that

- a potential of up to 1,100 ha could be sown to meet the immediate demand over the next 3-5 years
- a further 600 ha could be brought into production over the next four to five years with minimal capital investment
- As a result a short term national crop of up to 1,700 ha could be grown
- While limited areas of the more expensive ground maybe developed it is considered unlikely that a sustainable national crop of more than 600 to 800 ha could be achieved over the longer term without a decline in per hectare production
- In the advent that a legume eg soybean, was introduced into the rotation then this maybe increased to 800 to 1,200 ha over the longer term

## **5.2 Domestic Market**

While Tonga may have a small holder livestock sub sector, traditionally maize has not constituted a significant component of the feed resource. Provided a reliable source of quality feed could be grown then the potential exists to expand both the domestic market for maize and the production from the small holder livestock sub sector through.

- Tonga imports some 550 to 600 tonnes of compound feed per annum for commercial livestock producers namely one piggery and 7 poultry farms. Of the compound feed imported 50 percent could be replaced with domestically produced maize the equivalent of some 275 to 300 tonnes of maize grain
- Annex III details the potential expand production from small holder pig producers. If it is assumed that 10 percent of pigs were provided with the

equivalent of 100 kg per head, as suggested in the analysis, this would equate around tonnes 1,100 of maize per annum

- Annex IV details the potential to expand production from small holder back yard poultry. If it is assumed that 10 percent of the poultry were provided with 10 kg per head, as suggested in the analysis, this would equate to just over 170 to 200 tonnes maize per annum.

It would therefore seem reasonable to deduce that a potential domestic market of 1,500 to 1,750 tonnes could be developed. It is also suggested that much of the domestic market would be focused on small holder production

### 5.3 Export Market

Within the Pacific Island nations only Fiji and PNG have a domestic maize industry. FAO Food Indicators Asia-Pacific Region 2002 data would suggest that this amounts to some 1,200 to 1,300 tonnes in Fiji and 2,250 to 2,500 tonnes in PNG. The MAC indicated that a contract for 12-15,000 tonnes per annum at US\$270 fob with PNG could be agreed upon once the future of commercial maize production in Tonga was assured.

The feed grain market within the South Pacific region is dominated by Australia both on price and, subject to drought conditions, consistency of supply. To compete with Australia any potential supplier must be able to provide a constant supply at a price that is competitive with the Australian product. To achieve this objective the producer must enjoy a geographical advantage over Australia and be able to capitalise on that geographical advantage with advantageous freight rates.

In evaluating the contract under offer to the MAC it should be noted that the fob Brisbane price equated to the fob price Nuku'alofa suggesting similar freight rates yet the distance Nukul'ofa/ Port Moresby direct is twice and via Auckland is three times the distance Brisbane Port Moresby.

### 6.0 Enterprise Analysis

Based on available data and the considered opinion of members of the MAC Technical Committee the maize crop assessment was made on the basis a Dry and a Wet Season crop. The production characteristics of each crop can be summarised as follows

|                          | <b>Dry Season</b>    | <b>Wet Season</b>   |
|--------------------------|----------------------|---------------------|
| Planted                  | Jan/Feb to June/July | July/Aug to Dec/Jan |
| Harvested                | May to Oct           | Nov to April        |
| Percentage of Crop:      |                      |                     |
| Dried                    | 20%                  | 60%                 |
| Cyclone Loss             | 0%                   | 10%                 |
| Fungicide Application    | 70%                  | 85%                 |
| Third Weed Spray         | 50%                  | 75%                 |
| Yield tonnes per hectare | 7.5                  | 7.5                 |
| fob Price US\$/tonne     |                      |                     |
| Contract Price           | 270                  | 270                 |

|            |     |     |
|------------|-----|-----|
| Spot Price | 340 | 340 |
|------------|-----|-----|

The Financial Assessment based on these production criteria are detailed in Annex II and summarised below (TOP per ha. ex farm gate) for a crop with a national yield of 7.5 tonnes per hectare.

|                            | <b>Dry Season</b> |      | <b>Wet Season</b> |      |
|----------------------------|-------------------|------|-------------------|------|
| Commodity Price            |                   |      |                   |      |
| fob US\$/tonne             | 270               | 340  | 270               | 340  |
| ex farm gate TOP/t         | 403               | 517  | 348               | 462  |
| Gross Revenue              | 3026              | 3876 | 2612              | 3462 |
| Variable Costs             |                   |      |                   |      |
| Growing Costs              | 2766              | 2766 | 2789              | 2789 |
| Harvesting Costs           | 350               | 350  | 350               | 350  |
| Net Revenue (ex land rent) |                   |      |                   |      |
| Per ha.                    | (90)              | 760  | (528)             | 323  |

The analysis would suggest that

- At the contract price of US\$ 270 tonne fob the dry season crop would break even.
- At the contract price the wet season crop due, to lower farm gate prices caused by higher drying costs and crop losses, would fail to cover growing costs
- At a suggested spot price of US\$340 per tonne fob the dry season crop would generate a surplus of TOP 760 per ha or 20 percent of Gross Revenue
- At a suggested spot price of US\$340 per tonne the wet season crop would generate a surplus of TOP 323 per ha or 9 percent of Gross Revenue
- With inter island freight rates of TOP 70 to TOP 95 per tonne the production of maize for export, at these prices on the outer islands, is considered unlikely

It must be assumed that the producer will be required to absorb all debt servicing costs attributed to working capital commitments up to the farm gate and that all debt servicing costs past the farm gate will be passed back to the producer. Reference to Table 2 and 3 would suggest that these debt servicing costs would amount to between TOP 245 per ha for the dry season crop to TOP 255 for the wet season crop. At 7.5 tonnes per hectare this would

- Make the wet season crop at the spot price unviable and
- Reduce the Net Revenue after Debt Servicing on the dry season crop at the spot price to a level that most growers would find unacceptable

Should the national yield be increased to 8.5 tonnes per hectare then the Financial Assessment can be summarised as follows.

|                    | <b>Dry Season</b> |      | <b>Wet Season</b> |      |
|--------------------|-------------------|------|-------------------|------|
| Commodity Price    |                   |      |                   |      |
| fob US\$/tonne     | 270               | 340  | 270               | 340  |
| ex farm gate TOP/t | 403               | 517  | 352               | 466  |
| Gross Revenue      | 3429              | 4393 | 2997              | 3961 |
| Variable Costs     |                   |      |                   |      |

|                            |      |      |       |      |
|----------------------------|------|------|-------|------|
| Growing Costs              | 2766 | 2766 | 2789  | 2789 |
| Harvesting Costs           | 350  | 350  | 350   | 350  |
| Net Revenue (ex land rent) |      |      |       |      |
| Per ha.                    | 313  | 1277 | (142) | 822  |

Given an unsubstantiated increase in national yield to 8.5 tonnes per hectare then

- At the contract price the wet season harvested crop would remain unviable while the dry season crop would be marginally profitable with a net revenue less than 10 percent of Gross Revenue.
- Given the higher yield at the spot price then maize with a Net Revenue 20 to 30 percent of Gross Revenue could be considered a viable option
- Debt servicing costs of TOP 245 to TOP 255 per hectare could be absorbed and the crop remain viable

The analysis addresses the following constraints

- To be recognised as a viable option in the cropping rotation maize needs to achieve an average yield of 8.5 tonnes per hectare at an fob price of US\$340 per tonne
- The lower return attributed to the wet season harvested crop is due to higher drying costs and increased crop losses. To this end the wet season harvested crop may require a pricing differential of plus 10 percent to equate with the dry season crop and encourage all year round production.
- At the higher yield and a US\$340 per tonne fob price then the wet season crop would breakeven provide no more than 40 percent of the crop was lost to high winds and or cyclones
- If the entire wet season crop had to be dried then the Gross Margin per hectare would fall by 20 percent to just under TOP 670 per hectare (approx TOP 79 per tonne)
- At the higher yield and fob prices a 10 percent increase in the farm gate price of fertiliser would result in an 8 percent decline in dry season maize gross margin and a 12 percent decline in wet season maize gross margin per hectare

## 7.0 Crop Comparison

An indicative comparison between alternative export/domestic crops can be summarised as follows (TOP per ha)

|                  | Squash | Sweet<br>Potato | Dry Season<br>Maize Spot<br>Price |      | Wet Season<br>Maize Spot<br>Price |      |
|------------------|--------|-----------------|-----------------------------------|------|-----------------------------------|------|
| Yield t/ha       | 7.0    | 12.5            | 7.5                               | 8.5  | 7.5                               | 8.5  |
| Gross Revenue    | 4746   | 5350            | 3876                              | 4393 | 3462                              | 4393 |
| Growing Costs    | 4277   | 2830            | 2766                              | 2766 | 2789                              | 2789 |
| Harvesting Costs | 2539   | (1)             | 350                               | 350  | 350                               | 350  |
| Net Revenue      | (2070) | 2520            | 760                               | 1277 | 323                               | 822  |

(1) family labour

The financial analysis of three indicative crops would suggest that.

- The enterprise deficit emphasises the reason for the decline in the area of squash produced.
- That both the Dry and Wet Season maize crop at a spot price of US\$340 per tonne fob could contribute positively to disposable household incomes and become a preferred option to squash
- Traditional crops whether grown for cash or disposal in kind are still a preferred option when produced with family labour.

Should the reduced area of Tongan squash result in an increase in the unit price for squash then

- A 59 percent increase in the fob price to TOP1075 (US\$597) per tonne would allow squash to break even
- A 86 percent increase in the fob price to TOP1260 (US\$700) per tonne would result in the gross margin for squash equating to the indicative gross margin for dry season maize production at 8.5 tonnes per hectare..

## **8.0 Indirect Impact of Maize Production**

In addition to the direct impact on household incomes the indirect impact should be identified

- squash generates around 300 person hours per ha and sweet potato around 825 person hours of employment. Maize, due to the high levels of mechanisation, does not contribute in any significant manner to employment.
- Under grade squash is either consumed within the community or fed to pigs. Assuming that 30 percent of the undergrade squash (estimated at 2.3 tonnes per ha) is utilised by pigs then it is estimated that undergrade squash could produce some 25 to 30 kg LW per ha with an estimated value of TOP 250 to TOP 300
- Maize stover could amount to some 6-7 tonnes per hectare. Assuming 30 percent utilisation of the stover, if fed to large ruminants, could generate some 180 to 200 kg LW. Given the size of the national herd and flock it is unlikely that this resource would be utilised.

There are significant benefits to be generated from the feeding of maize to small holder livestock. (see Annex III and IV). Preliminary analysis would indicate that

- 550 kg maize fed to a 2 sow herd would have the potential to increase disposable household income either in cash or in kind by TOP 1,900 per annum

- 210 kg maize fed to 20 backyard layers which if enclosed would have the potential to increase disposable household income, either in cash or in kind, by TOP 1,600 per annum
- 370 kg maize fed to 20 traditional birds would have the potential to increase disposable household income, either in cash or in kind, by TOP 110per annum

The targeting of 10 percent of the local pigs and poultry could create a domestic market of some 1,500 tonnes. The development of the domestic market would provide valuable support to the ongoing SARDI Project. The project aims to assist small holder livestock production

## 9.0 Household Impact

The household analysis is detailed in Annex II Tables 12 to 14 and summarised below (TOP per household)

|   | Maize Only |       | Maize plus Pigs | Maize plus Poultry |
|---|------------|-------|-----------------|--------------------|
| Yield (t/ha)                                  | 7.5        | 8.5   | 7.5             | 7.5                |
| Incremental Net Revenue Before Debt Servicing | 2753       | 5203  | 4221            | 4470               |
| IRR   | 4.9%       | 27.6% | 29.7%           | 24.2%              |
| NPV at 12%                                    | -2602      | 5203  | 5723            | 4658               |

The household analysis would indicate

- Given consistent yields maize production in isolation is only marginally profitable
- Given that the deposit rate at the Tonga Development Bank is 12 percent then it would appear that maize/ livestock households could justify an investment of between TOP 4,600 and TOP 5,700 per hectare in the clearing of scattered coconuts.
- For a household with no interest in livestock improvement to justify this level of investment a yield of at least 8.5 tonnes of maize per hectare must be achieved
- The analysis also indicates that it is in the small holders “best interest” to divert maize from the sale of maize as an export crop into incremental livestock production.

## 10.0 Policy Implications

### 10.1 Policy Indicators

Maize production is evaluated using the following key policy indicators

## **Nominal Protection Coefficient (NPC)**

The Nominal Protection Coefficient (NPC) or the ratio between domestic (financial) prices and border (economic) prices

## **Effective Protection Coefficient (EPC)**

The Effective Protection Coefficient (EPC) is the ratio of the value added in domestic (financial) prices to the value added in border (economic) prices taking into account output prices and traded inputs simultaneously. Whereas the NPC can be measure at any level of the production consumption chain the EPC refers specifically to protection at the farm level, processing and marketing and is therefore a more encompassing assessment of the protective structure of any intervention policies.

## **Domestic Resource Costs (DRC)**

The Domestic Resource Cost (DRC) compares the opportunity cost of domestic production to the value added that it generates.

### **10.2 Policy Impact**

Based on the data presented in Annex II Financial Assessment the policy indicators can be summarised as follows

|                          | <b>US\$/tonne<br/>fob</b> | <b>NPC</b> | <b>EPC</b> | <b>DRC</b> |
|--------------------------|---------------------------|------------|------------|------------|
| <b>7.5 tonnes per ha</b> |                           |            |            |            |
| Dry Season Crop          | US\$270                   | 0.99       | 0.82       | 0.94       |
|                          | US\$340                   | 0.99       | 0.89       | 0.57       |
| Wet Season Crop          | US\$270                   | 0.98       | 0.75       | 1.33       |
|                          | US\$340                   | 0.99       | 0.86       | 0.72       |
| <b>8.5 tonnes per ha</b> |                           |            |            |            |
| Dry Season Crop          | US\$270                   | 0.99       | 0.87       | 0.72       |
|                          | US\$340                   | 0.99       | 0.91       | 0.47       |
| Wet Season Crop          | US\$270                   | 0.98       | 0.82       | 0.96       |
|                          | US\$340                   | 0.99       | 0.89       | 0.58       |

The analysis would indicate

- A low level of GOT intervention in the agricultural production process
- The ability of export maize production to generate foreign exchange
- The ability to generate foreign exchange is enhanced with yield and price increases

### **11.0 Capital Requirements**

Should GOT proceed with a commitment to the establishment of an export maize industry then indicative capital requirements need to be assessed. The assessment assumes two planting strategies, a seasonally adjusted plant schedule favouring a dry

season harvest, and a constant monthly planting. The assessments are detailed in Table 2, Seasonally Adjusted Planting Schedule, and Table 3, Constant Planting Schedule. The following assumptions have been made

- The project would be phased in over two years
- Under both planting schedules 960 ha would be planted in PY 1. Under the Constant Planting Schedule 640 ha would be harvested at a yield of 7.5 tonnes per hectare. Under the seasonally adjusted planting schedule 720 hectares would be harvested. A total of 4,200 tonnes (600 tonnes per month) of maize would be exported commencing 6 months after the initial planting.
- At the end of 12 months the constant planting schedule would have 240 tonnes in store while the seasonally adjusted planting schedule would have 780 tonnes in store
- Under both planting schedules 1,700 ha would be planted in PY 2. Under the Constant Planting Schedule 1,450 ha would be harvested at a yield of 8.5 tonnes per hectare. This area would produce 12,325 tonnes less losses and under grade crop estimated at some 1,250 tonnes. Exports could be lifted from 600 tonnes to 1,000 tonnes per month by mid second quarter of PY 2.
- This being the case then the carry over stock at the end of PY 2 is estimated at 945 tonnes or nearly one months export cover
- Under the seasonally adjusted planting schedule 1,660 hectares would be harvested. A total of 14,100 tonnes less losses and undergrade crop estimated at around 820 tonnes would be produced. Exports could be lifted from 600 tonnes per month to 1,000 tonnes per month by mid second quarter PY2
- This being the case then the carry over stock at the end of PY 2 is estimated at 3,700 tonnes or nearly four months export cover

A comparison of the two production strategies can be summarised as follows

|                             |        | Seasonally Adjusted Planting |       | Constant Planting |       |
|-----------------------------|--------|------------------------------|-------|-------------------|-------|
|                             |        | PY 1                         | PY 2  | PY 1              | PY 2  |
| Area Planted                | ha     | 960                          | 1700  | 960               | 1700  |
| Area Harvested              | ha     | 720                          | 1660  | 640               | 1453  |
| Total Production            | tonnes | 5400                         | 14100 | 4800              | 12350 |
| Volume Sold                 | tonnes | 4200                         | 10000 | 4200              | 10400 |
| Carry over Stock            | tonnes | 780                          | 3700  | 240               | 945   |
| Undergrade/Losses           | tonnes | 420                          | 1200  | 360               | 1250  |
| Working Capital Requirement | TOP' m | 1.65                         | 3.45  | 1.15              | 2.03  |

The assessment would suggest that the losses and undergrade grain attributed to the seasonally adjusted planting strategy at 8.5 percent of the total crop harvested are lower than the 10.1 percent losses and undergrade grain attributed to a constant planting strategy. However

- The storage requirement for seasonally adjusted planting strategy carry over stock is some 3 to 4 times greater
- The working capital requirement in PY 1 is 43 percent higher
- The working capital requirement in PY 2 is TOP 3.45 million for a seasonally adjusted planting strategy compared with TOP 2.03 million for the constant planting strategy.

It is therefore apparent that while on farm production may favour a dry season harvested crop capital constraints favour a constant planting strategy

## **12.0 Issues**

### **12.1 Input Costs**

To the best of the missions knowledge recent input pricing has been used with the exception of NPK fertiliser. Updated costing was requested but at the time of preparing this report was not available. It is believed that any price adjustment to NPK fertiliser will not effect the general conclusion drawn from this report

### **12.2 Planting Strategy**

The working capital assessment emphasised the conflict between on farm production which clearly favoured a dry season harvested crop and issues relating to the capital requirements which favoured a constantly planting each month. Having identified the issue it is strongly suggested that, under Phase II, the services of a grain storage expert be sought.

### **12.3 Grain Drying Location**

The suggested site is situated between a liquid gas storage facility and a tank farm. The site needs to be carefully re considered. Alternative sites include

- Situated on the wharf. Any site may well be subject to restricted vehicle movement
- The Tractor Services yard. While central and providing a workshop facility the site is low lying and therefore not ideal
- Other sites have been suggested and require further evaluation

### **12.4 Mechanisation**

It is understood that cabinet has approved the sale of the Tractor Services Group. It must be assumed that any prudent sale would involve an exclusivity clause that would prevent GOT establishing a new tractor services company in competition with the entity under discussion. This would prevent any direct GOT involvement in mechanised maize production

While the national tractor fleet may be run down the considered view was that the capability existed, within the agricultural sector, to establish and maintain a maize crop during the establishment phase. The industry would however need to purchase one and possibly two harvesters and invest in storage and drying facilities

To address this issue and indeed enhance diversification within the arable sector it is suggested that GOT provide a line of credit through the Development Bank of Tonga that would allow the private sector to make the appropriate investments

### **13.0 Constraints**

The fragile information base is considered the major constraint to sustained maize production in Tonga. Coupled with the depleting affected of continuous maize production on soil fertility and the fact that no restorative crop has been identified then the high yields needed to justify financially viable maize production are difficult to substantiate.

It is suggested that, irrespective of the GOT policy towards commercial maize production for export, a pro active but accountable research programmes needs to be embarked upon. This programme needs to assess.

- Maize production, both for grain and silage, by management techniques
- The integration of soybean and or Mucuna Bean into a maize based rotation and the impact on yield.
- Issues relating to dry and wet season harvested crops, in field drying and minimising crop losses
- Based on this research programme the Department of Agriculture would need to embark upon an aggressive extension programme with emphasis on integrated grain/ livestock initiatives

GOT may also wish to consider the establishment of a Grains Industry Board to co ordinate the development, marketing and promotion of all grains not just maize. If acceptable to GOT then under Stage II of this project the services of a specialist in this area could be sought.

## **Annex II**

### **NATIONAL MAIZE PRODUCTION PROJECT Kingdom of Tonga**

#### **Financial Assessment**

##### **Background**

The Financial Assessment of maize production in Tonga is based upon field studies and discussion with interested parties during June 2008. Given that there is no history of maize production in Tonga any such assessment must be deemed indicative and subject to review as experience is accumulated.

##### **Methodology**

The data detailed in the attached tables will address the following criteria

- The grower return ex farm gate per tonne and per ha
- The net revenue per tonne and per hectare after a deduction for growing and harvesting costs
- These returns will be expressed in both financial and economic (excluding taxes, duties, levies,) terms.

The assessment recognises that

- maize production will replace a declining squash sector. For this reason a Financial and Economic assessment of commercial squash is undertaken
- a distinction between maize harvested over the dry season ( May to October) and the wet season (November to April). A separate assessment of the wet and dry season maize crop has been undertaken
- The Australian market dominates the feed grain industry in the South Pacific. Any fob value must be related back to the Australian price for feed wheat

In assessing the wet and dry season maize crop the following key variables have been recognised

- the percentage of the harvested crop that will require drying to 14 percent moisture
- the percentage of the crop lost due to high winds / cyclones over the wet season. This is expressed as a percentage loss of growing costs
- the percentage of the crop that may require a third weedicide application
- the percentage of the crop that will require a fungicide application

##### **Assumptions**

##### **Physical Inputs**

In the absence of any rigorous trial data key assumptions reflect the comments/ opinions of both, producers, MAC and Vaini Research Station. Key assumptions include

- The assessment has used a basic yield irrespective of season of 7.5 tonnes per ha.
- Percentage of crop that will have to be dried Wet Season 60 percent, Dry Season 20 percent
- Percentage of crop lost to high winds/cyclones Wet Season 10%, Dry Season nil
- The percentage of crop requiring a third weedicide application Wet Season 40 percent Dry Season 20 percent
- The percentage of the crop requiring a fungicide application Wet Season 85 percent Dry Season 75 percent

The analysis has used an extensive pre planting cultivation programme including 2-3 discings, a ploughing and a pass with the roto crumbler. It is acknowledged that some of the additional costs attributed to the Wet Season crop may in fact reflect inadequate pre planting cultivation.

### **Financial Inputs**

The Maize Advisory Committee advised that

- Fiji and PNG had been identified as potential markets within the South Pacific area
- An fob Tonga contract price of US\$270 per tonne for 14 percent moisture grain has been received to supply the PNG market.

### **fob Brisbane**

Based on a forward price of A\$364 per tonne for milling grade wheat when adjusted for quality this would relate to a fob value ex Brisbane of US\$265 to US\$ 270 per ton (Annex II Table 1)

### **cif Port Moresby**

Given the Brisbane /Port Moresby freight rates of around US\$0.065 per tonne per km then the cif value of Australian feed wheat landed Port Moresby is around US\$410 per tonne

To compete with Australian feed wheat Tongan maize at a contract price of US\$270 per tonne fob, the freight rate Nuku'alofa Port Moresby would have to equate with the freight rate Brisbane Port Moresby

Given that the distance Nukul'ofa/ Port Moresby direct is twice and if via transhipped Auckland is three times the distance Brisbane Port Moresby then the short haul Brisbane to Port Moresby rate would have to equate to the long haul Nuku'alofa direct freight rate. If the container had to be transhipped via Auckland then the additional freight rate may place the contract fob value of the maize under pressure.

### **cif Suva**

Given the Brisbane / Suva freight rates of around US\$0.065 per tonne per km then the cif value of Australian feed wheat landed Suva is around US\$450 per tonne. With

freight rate of US\$0.074 per tonne per km Suva / Nuku'alofa the fob value of Tongan maize adjusted for quality is assessed at US\$350 per tonne. In order to gain entry to the Fijian market Tonga may have to accept a discount until such time as consistency of supply is recognised.

The analysis will therefore assume two possible price scenarios

- A long term contract price of US\$ 270 per tonne fob in line with the offer already received and
- A forward price of US\$340 per tonne fob

### **Foreign Exchange**

A foreign exchange rate of 1 US\$ to TOP 1.8 has been used. In the advent that there is no obvious Tong Reserve Bank support for the TOP both the financial and economic exchange rate are deemed to be the same.

### **Crop Inputs**

Where possible current fertiliser and chemical retail costs have been sourced. The costs used therefore reflect both the volatility in commodity prices and increasing transport costs

### **Taxation Duties etc**

Other than a TOP 0.10 per kg levy on squash there are no taxes duties or levies on agricultural imports or exports. A 10 percent handling commission on maize exports has been assumed

All vehicle inputs however are subject to a 15 percent Consumption Tax (CT) while businesses are subject to a 25 percent income tax. The Social Conversion Factor for agricultural inputs is therefore assessed at SCF 0.95 and for machinery, freight drying costs a SCF of 0.85 has been used

### **Labour Cost**

The production of maize is fully mechanised and therefore will not require additional casual labour. However squash is a significant user of casual labour. Given relatively high unemployment, casual labour has been included at the current rate of TOP 6.00 per hour including food but with a SCF of 0.75 for the economic analysis

### **Financial Evaluation**

For comparison purposes the Tongan maize data is compared with an indicative costing for maize grown in the Waikato (NZ MAF), Tongan squash (MAFF data) and Sweet Potato (MAFF data) as representative of traditional Tongan crops. The Waikato maize and Tongan squash is an estimated 2008 costing The Sweet Potato costing is a 2007 estimate.

The Financial Evaluation for a 7.5 tonne per hectare crop detailed in Tables 2 to 5 is summarised below in TOP per hectare.

|   | <b>Maize Waikato New Zealand</b> | <b>Squash Tonga</b>  | <b>Sweet Potato Tonga Family Labour</b> | <b>Maize Tonga Dry Season</b> |                  | <b>Maize Tonga Wet Season</b> |                  |
|---|----------------------------------|----------------------|---|-------------------------------|------------------|-------------------------------|------------------|
|   | <b>Financial</b>                 | <b>Financial</b>     | <b>Financial</b>                        | <b>Financial</b>              | <b>Financial</b> | <b>Financial</b>              | <b>Financial</b> |
| <b>Yield per Ha. (tonnes)</b>           |                                  |                      |   | <b>7.5t/ha</b>                | <b>7.5 t/ha</b>  | <b>7.5 t/ha</b>               | <b>7.5 t/ha</b>  |
| <b>Price per tonne (US\$/tonne fob)</b> |                                  |                      |   | <b>US\$270</b>                | <b>US\$340</b>   | <b>US\$270</b>                | <b>US\$340</b>   |
| Seed                                    | 567                              | 610                  | 500                                     | 423                           | 423              | 423                           | 423              |
| Fertiliser                              | 660                              | 1680                 |   | 1000                          | 1000             | 1000                          | 1000             |
| Chemicals                               | 189                              | 755                  | 1050                                    | 255                           | 255              | 278                           | 278              |
| Cultivation                             | 486                              | 1232                 | 1280                                    | 1088                          | 1088             | 1088                          | 1088             |
| <b>Total Growing Costs</b>              | <b>1902</b>                      | <b>4277</b>          | <b>2830</b>                             | <b>2766</b>                   | <b>2766</b>      | <b>2789</b>                   | <b>2789</b>      |
| Harvest                                 | 452                              | 380                  |   | 350                           | 350              | 350                           | 350              |
| Processing/<br>Drying/Losses            | 559                              | 1985                 |   | 469                           | 565              | 958                           | 1054             |
| Freight                                 | 199                              | 174                  |   | 150                           | 150              | 75                            | 75               |
| <b>Total Harvesting Costs</b>           | <b>1210</b>                      | <b>2539</b>          |   | <b>969</b>                    | <b>1065</b>      | <b>1383</b>                   | <b>1479</b>      |
| <b>Total Costs</b>                      | <b>2305</b>                      | <b>6816</b>          | <b>2830</b>                             | <b>3735</b>                   | <b>3831</b>      | <b>4172</b>                   | <b>4268</b>      |
| <b>Gross Revenue</b>                    | <b>5434</b>                      | <b>4746</b>          | <b>5350</b>                             | <b>3645</b>                   | <b>4590</b>      | <b>3645</b>                   | <b>4590</b>      |
| <b>Gross Margin</b>                     |                                  |                      |   |                               |                  |                               |                  |
| <b>Total</b>                            | <b>3128</b>                      | <b>(2070)</b><br>(1) | <b>2520</b>                             | <b>(90)</b>                   | <b>760</b>       | <b>(527)</b>                  | <b>323</b>       |
| <b>TOP/tonne</b>                        | <b>272</b>                       | <b>(295)</b>         | <b>202</b>                              | <b>(12)</b>                   | <b>101</b>       | <b>(70)</b>                   | <b>43</b>        |

(1) Excluding cost recovery levy of TOP 0.10 per kg

The following conclusions can be drawn

- The negative gross margin for squash only underlines the reason for the decline of the Tongan squash industry
- The return to Sweet Potato as an indicative traditional local crop would suggest that neither the wet nor dry season harvested maize at 7.5 tonnes per hectare could compete with traditional crops in the rotation
- At 7.5 tonnes per hectare the crop is marginally profitable at the spot price. It is unprofitable at the contract price to PNG
- The higher Financial Return to maize grown in New Zealand is a result of higher yields. The Waikato has a proven record of 10 to 12 tonnes pre hectare while the subjective yield in Tonga has been assessed at 7.5 tonnes per hectare

The Financial Evaluation for a 8.5 tonne per hectare crop detailed in Tables 6 to 9 is summarised below in TOP per hectare.

|                                  | Maize Waikato New Zealand | Squash Tonga         | Sweet Potato Tonga Family Labour | Maize Tonga Dry Season |             | Maize Tonga Wet Season |             |
|----------------------------------|---------------------------|----------------------|----------------------------------|------------------------|-------------|------------------------|-------------|
|                                  | Financial                 | Financial            | Financial                        | Financial              | Financial   | Financial              | Financial   |
| Yield per Ha. (tonnes)           |                           |                      |                                  | 8.5t/ha                | 8.5 t/ha    | 8.5 t/ha               | 8.5 t/ha    |
| Price per tonne (US\$/tonne fob) |                           |                      |                                  | US\$270                | US\$340     | US\$270                | US\$340     |
| Seed                             | 567                       | 610                  | 500                              | 423                    | 423         | 423                    | 423         |
| Fertiliser                       | 660                       | 1680                 |                                  | 1000                   | 1000        | 1000                   | 1000        |
| Chemicals                        | 189                       | 755                  | 1050                             | 255                    | 255         | 278                    | 278         |
| Cultivation                      | 486                       | 1232                 | 1280                             | 1088                   | 1088        | 1088                   | 1088        |
| <b>Total Growing Costs</b>       | <b>1902</b>               | <b>4277</b>          | <b>2830</b>                      | <b>2766</b>            | <b>2766</b> | <b>2789</b>            | <b>2789</b> |
| Harvest                          | 452                       | 380                  |                                  | 350                    | 350         | 350                    | 350         |
| Processing/ Drying/Losses        | 559                       | 1985                 |                                  | 533                    | 639         | 1050                   | 1156        |
| Freight                          | 199                       | 174                  |                                  | 170                    | 170         | 85                     | 85          |
| <b>Total Harvesting Costs</b>    | <b>1210</b>               | <b>2539</b>          |                                  | <b>1053</b>            | <b>1159</b> | <b>1485</b>            | <b>1591</b> |
| <b>Total Costs</b>               | <b>2305</b>               | <b>6816</b>          | <b>2830</b>                      | <b>3819</b>            | <b>3925</b> | <b>4274</b>            | <b>4380</b> |
| <b>Gross Revenue</b>             | <b>5434</b>               | <b>4746</b>          | <b>5350</b>                      | <b>4131</b>            | <b>5202</b> | <b>4131</b>            | <b>5202</b> |
| <b>Gross Margin</b>              |                           |                      |                                  |                        |             |                        |             |
| <b>Total</b>                     | <b>3128</b>               | <b>(2070)</b><br>(1) | <b>2520</b>                      | <b>313</b>             | <b>1277</b> | <b>(143)</b>           | <b>822</b>  |
| <b>TOP/tonne</b>                 | <b>272</b>                | <b>(295)</b>         | <b>202</b>                       | <b>37</b>              | <b>150</b>  | <b>(17)</b>            | <b>97</b>   |

(1) Excluding cost recovery levy of TOP 0.10 per kg

At a average yield of 8.5 tonnes per hectare

- The dry season harvested crop would be marginally profitable at the contract price
- The wet season harvested crop would remain unprofitable at the contract price suggesting that even at the higher yield all year round maize production at the contract price is not a viable option
- At the spot price the return from the dry season harvested maize crop would equate with the traditional root crops
- At the spot price the return from the wet season harvested maize crop would make a positive contribution to household incomes be it at a lower level than the traditional root crops

The following issues need to be recognised

- To be recognised as a viable option in the cropping rotation maize needs to achieve an average yield of 8.5 tonnes per hectare at an fob price of US\$340 per tonne
- The lower return attributed to the wet season harvested crop is due to higher drying costs and increased crop losses.
- At the higher yield and a US\$340 per tonne fob price then the wet season crop would breakeven provide no more than 40 percent of the crop was lost to high winds and or cyclones
- If the entire wet season crop had to be dried then the Gross Margin per hectare would fall by 20 percent to just under TOP 670 per hectare (approx TOP 79 per tonne)
- At the higher yield and fob prices a 10 percent increase in the farm gate price of fertiliser would result in an 8 percent decline in dry season maize gross margin and a 12 percent decline in wet season maize gross margin per hectare

Should the reduced area of Tongan squash result in an increase in the unit price for squash then

- A 59 percent increase in the fob price to TOP1075 (US\$597) per tonne would allow squash to break even
- A 86 percent increase in the fob price to TOP1260 (US\$700) per tonne would result in the gross margin for squash equating to the indicative gross margin for dry season maize production at 8.5 tonnes per hectare..

### **Household Analysis**

The indicative assessment of maize production at the small holder household level assumes

- Squash is no longer grown. Half the area previously allocated to squash is sown to maize in any one season.
- Under small holder production a yield of 7.5 tonnes per hectare is assumed at a price of US\$340 per tonne or ex farm gate of TOP 520 for the dry season harvested crop and TOP 460 per tonne for the wet season crop
- Cassava and taro are considered as cash crops contributing to household disposable incomes
- Yams are considered as being indicative of a traditional crop consumed by the household
- All labour is considered to be family labour and has not been costed

Three scenarios have been considered

- Maize production with no livestock
- Maize production with 2 sows under improved management ie farrowing sows sheltered plus maize
- Maize production with 20 layers under semi extensive management

The analysis is detailed in Annex II Tables 12 to 14 and summarised below (TOP per household)

|   | Maize Only |       | Maize plus Pigs | Maize plus Poultry |
|---|------------|-------|-----------------|--------------------|
| Yield (t/ha)                                  | 7.5        | 8.5   | 7.5             | 7.5                |
| Incremental Net Revenue Before Debt Servicing | 2753       | 5203  | 4221            | 4470               |
| IRR   | 4.9%       | 27.6% | 29.7%           | 24.2%              |
| NPV at 12%                                    | -2602      | 5203  | 5723            | 4658               |

The household analysis would indicate

- At 7.5 tonnes per hectare maize production without the added benefits from incremental livestock production is not profitable
- Given that the deposit rate at the Tonga Development Bank is 12 percent then it would appear that maize/ livestock households could justify an investment of between TOP 4,600 and TOP 5,700 per hectare in the clearing of scattered coconuts.
- For a household with no interest in livestock improvement to justify this level of investment a yield of at least 8.5 tonnes of maize per hectare must be achieved
- The analysis also indicates that it is in the small holders “best interest” to divert maize from the sale of maize as an export crop into incremental