Kingdom of Tonga

PROGRESS REPORT

PERFORMANCE OF NEW SWEET POTATO VARIETIES INTRODUCED TO THE KINGDOM OF TONGA

June 01, 2019.
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Introduction

Mainstreaming of Rural Development Initiatives Tonga Trust (MORDI TT) was established in 2007. Much of our focus is on major cross-cutting issues, such as climate change, disaster risk management, food security, gender equality, human rights, non-communicable diseases and youth employment. Using a multi-sector approach in responding to our members’ development priorities, we draw upon skills and capabilities from around the region and internationally, and support the empowerment of Pacific communities and sharing of expertise and skills between countries and territories.

The purpose of this sweet potato trial is to improve the livelihoods and resilience of Tongan smallholder farmers, particularly with regard to the effects of climate change. Projections for climate change point to increased ambient temperatures and more extreme weather events, and in recent years there have been both severe droughts and cyclones. The impact of these weather events and their impact on food security are most apparent among the smallholder farming communities with which MORDI TT works.

Different crops have different strengths and weaknesses with regards to climatic resilience and hence food security. Some withstand cyclones relatively well, some tolerate drought conditions better than others and some tolerate saline soil conditions better than others. For smallholder farmers one of the ways to food security is by growing a range of crops, in the hope that at least one of them will flourish in the conditions prevailing during the current cropping cycle. The odds of this occurring can be increased through careful cultivar selection.

Sweet potato is a widely grown staple food for the people of Tonga. The crop grows relatively easily and produces well in normal growing years. It suffers few ill effects from cyclones due to the fact the plant is low growing and does not blow over, but it performs poorly during drought conditions.

The object of this project is to select varieties that demonstrate good production and pest and disease resilience along with superior climatic resilience characteristics than are present in locally grown cultivars. The sweet potato cultivars selected for this trial have by and large been selected for their improved drought tolerance characteristics.

Seven different clones were imported from SPC and one was supplied by Tokyo University of Agriculture (TUA) for the trial. The SPC plants were planted out in the MORDI nursery in Haveluloto on 4 September 2018 and the plants from TUA were planted in the nursery about two weeks prior to this date. These original plants were largely used as a source of propagation material to establish two further trial plots at MORDI TT. One of these has been harvested and both of them used to provide propagation material to establish a further trial plot at MORDI, one at Vaini and one in Vava’u.

Future trials will be benchmarked against the locally important sweetpotato varieties, *Ipomaea batatas* ‘Setaita’ and *Ipomaea batatas* ‘Hawaii Kolosi’, to ascertain if the imported clones have superior characteristics in terms of productivity, pest and disease resistance, and in particular superior drought resilience characteristics. The clones will not be widely distributed until it is clear that a clone has superior characteristics to the varieties currently being grown.
This report details the performance of plants from the harvest trial plot and provides an update of the subsequent plantings propagated from the original plants. It also provides recommendations for the future of the trial.
Trial Sweet Potato Plants

Tissue cultured plants for this trial were provided by SPC – CePaCT (seven clones) under the Pacific Seeds for Life Initiative, and one cultivar from Tokyo University of Agriculture (TUA) in Japan.

A total of 74 plants were planted into the field and form the basis of this project.

<table>
<thead>
<tr>
<th>No.</th>
<th>Crop</th>
<th>CePaCT Acc. Code</th>
<th>Variety Name</th>
<th>No. Supplied</th>
<th>No. Planted Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sweet Potato</td>
<td>IB/BOL/001</td>
<td>Aguela Manuchia</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Sweet Potato</td>
<td>IB/PER/002</td>
<td>Nacional (NN)</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>Sweet Potato</td>
<td>IB/PER/013</td>
<td>Blanco de Chilca</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Sweet Potato</td>
<td>IB/PER/016</td>
<td>Costanero</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Sweet Potato</td>
<td>IB/PER/035</td>
<td>NA</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Sweet Potato</td>
<td>IB/PER/038</td>
<td>NA</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Sweet Potato</td>
<td>IB/PER/042</td>
<td>NA</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Sweet Potato</td>
<td>Beni-imo</td>
<td>Beni-imo</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td>76</td>
<td>74</td>
</tr>
</tbody>
</table>
**Timeline**

**Growing**

**04/09/2018** – The plants were received from SPC, removed from the flasks and planted into individual pots. Subsequently they were cared for and grown in the nursery until large enough for field planting. The plants from TUAg were planted out a couple of weeks prior to this time.

**24/10/2018** – All trial plants were hardened off in an area outside the nursery in preparation for field planting.

**15/11/2018** – All clones were planted in the field at a spacing of 0.5 m between the plants and 1 m between the different varieties. Watering was done as required. No disease problems were observed between planting and harvesting.

These plants were used as stock plants to provide propagation material.

**17/12/2018** – Cuttings were taken from the original clonal material for propagation purposes. A total of 280 cuttings were taken (see quantities per variety below) and a new trial plot was established on plot 011 from this planting material. Three cuttings were planted per mound.

**The plants from this block were harvested on 18/4/2019 and reported on below.**

**18/01/2019** – cuttings were taken from the original clones for propagation purposes. A total of 1273 cuttings were taken (see quantities per variety below) and a new trial plot was established in block 017 and 018 from this planting material. As at the date of this report the plants remain in the field. Three cuttings were planted per mound.

**23/02/2019** - cuttings were taken from plants growing in plots 017 and 018 and planted in plot X. A total of 3099 cuttings were taken (see quantities below) and a new trial plot was established in plot X using this planting material. As at the date of this report the plants remain in the field. Three cuttings were planted per mound.

<table>
<thead>
<tr>
<th>Date</th>
<th>Beni-imo</th>
<th>IB/PER/013</th>
<th>IB/PER/038</th>
<th>IB/PER016</th>
<th>IB/PER035</th>
<th>IB/PER042</th>
<th>IB/PER/002</th>
<th>IB/BOL/001</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>17/12/2018</td>
<td></td>
<td>40</td>
<td>55</td>
<td>49</td>
<td>55</td>
<td>30</td>
<td>35</td>
<td>16</td>
<td>280</td>
</tr>
<tr>
<td>18/01/2019</td>
<td></td>
<td>102</td>
<td>166</td>
<td>269</td>
<td>276</td>
<td>113</td>
<td>129</td>
<td>218</td>
<td>1273</td>
</tr>
<tr>
<td>23/02/2019</td>
<td></td>
<td>510</td>
<td>486</td>
<td>528</td>
<td>525</td>
<td>438</td>
<td>300</td>
<td>312</td>
<td>3099</td>
</tr>
</tbody>
</table>

**Cultivation of the harvested crop**

Cuttings were planted in mounds (three per mound) in pre-prepared soil. No fertilizer was applied to the crop and the cuttings were not watered following planting because of rainfall levels provided adequate moisture. The plants were weeded twice before canopy cove. Some damage from sweet potato tortoise beetle (*Cassida* and *Aspidimorpha species*) was observed but not enough to warrant chemical usage. No other pests or diseases were observed on this crop over the growing period.
**Harvesting**

18/4/2019 – The plants in plot 011 (planted 17/12/2018) were harvested 123 days after planting. All plants were harvested on the same day. The plants were harvested by cutting the tops off and digging up the tubers by hand. Tubers were not weighed because scales were not available. Three average looking plants per variety were sampled (see results below).

<table>
<thead>
<tr>
<th>Variety</th>
<th>Skin Colour</th>
<th>Flesh Colour</th>
<th>Tuber Shape</th>
<th>Tuber Size</th>
<th>Ave. Tuber Weight</th>
<th>Ave. No. Tubers per Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB/PER/013</td>
<td>Light Yellow</td>
<td>Orange</td>
<td>Rounded tapering to a point at the bottom</td>
<td>Small to Medium</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>IB/PER/038</td>
<td>Light Purple</td>
<td>Orange</td>
<td>Oval/round tapering to a point at the bottom</td>
<td>Medium</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>IB/PER016</td>
<td>Purple Yellow</td>
<td>Orange</td>
<td>Oval tapering to a point at the bottom</td>
<td>Large</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>IB/PER035</td>
<td>Light Purple</td>
<td>Orange</td>
<td>Oval/round tapering to a point at the bottom</td>
<td>Medium</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>IB/PER/042</td>
<td>Purple</td>
<td>Orange</td>
<td>Round/oval tapering to a point at the bottom</td>
<td>Large</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>IB/PER/002</td>
<td>Light Yellow</td>
<td>Yellow</td>
<td>Elongated tapering to a slight point at the bottom</td>
<td>Large</td>
<td>-</td>
<td>11</td>
</tr>
<tr>
<td>IB/BOL/001</td>
<td>Purple</td>
<td>Yellow</td>
<td>Long, wider in the middle tapering to a point at the end</td>
<td>Small</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Beni-imo</td>
<td>Light Yellow</td>
<td>Yellow</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cooking Trial**

19/04/2019 - Samples of each sweet potato variety were cooked and assessed by project staff as set out below.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Tuber Colour Uncooked</th>
<th>Tuber Colour Cooked</th>
<th>Suitability of shape for Processing</th>
<th>Texture When Cooked</th>
<th>Taste</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB/PER/013</td>
<td>orange</td>
<td>orange</td>
<td>yes</td>
<td>Soft/mushy</td>
<td>poor</td>
</tr>
<tr>
<td>IB/PER/038</td>
<td>orange</td>
<td>orange/yellow</td>
<td>yes</td>
<td>firm</td>
<td>good</td>
</tr>
<tr>
<td>IB/PER016</td>
<td>orange</td>
<td>Orange/yellow</td>
<td>yes</td>
<td>firm</td>
<td>average</td>
</tr>
<tr>
<td>IB/PER035</td>
<td>orange</td>
<td>orange</td>
<td>yes</td>
<td>firm</td>
<td>good</td>
</tr>
<tr>
<td>IB/PER/042</td>
<td>orange</td>
<td>orange</td>
<td>yes</td>
<td>firm</td>
<td>average</td>
</tr>
<tr>
<td>IB/PER/002</td>
<td>yellow</td>
<td>yellow</td>
<td>yes</td>
<td>firm</td>
<td>good</td>
</tr>
<tr>
<td>IB/BOL/001</td>
<td>yellow</td>
<td>yellow</td>
<td>no</td>
<td>Soft/mushy</td>
<td>average</td>
</tr>
<tr>
<td>Beni-imo</td>
<td>purple</td>
<td>purple</td>
<td>yes</td>
<td>firm</td>
<td>good</td>
</tr>
</tbody>
</table>
Weather Data

Weather data for Tongatapu sourced from Tonga Climate Service for Agriculture\(^1\) has been analyzed and averaged for the period from field planting (17 Dec 2018) until harvest (18 April 2019).

<table>
<thead>
<tr>
<th>Date</th>
<th>Month</th>
<th>Temp</th>
<th>Min Temp (°C)</th>
<th>Max Temp (°C)</th>
<th>Humidity (%)</th>
<th>Days of Precipitation</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-31</td>
<td>Dec</td>
<td>26.62</td>
<td>24.47</td>
<td>29.6</td>
<td>85.95</td>
<td>7</td>
<td>10.05</td>
</tr>
<tr>
<td>01-31</td>
<td>Jan</td>
<td>26.36</td>
<td>24.12</td>
<td>29.19</td>
<td>86.29</td>
<td>17</td>
<td>6.59</td>
</tr>
<tr>
<td>01-28</td>
<td>Feb</td>
<td>27.17</td>
<td>24.75</td>
<td>30.05</td>
<td>87.23</td>
<td>18</td>
<td>5.05</td>
</tr>
<tr>
<td>01-31</td>
<td>Mar</td>
<td>26.14</td>
<td>23.72</td>
<td>29.19</td>
<td>87.6</td>
<td>17</td>
<td>11.16</td>
</tr>
<tr>
<td>01-18</td>
<td>April</td>
<td>25.47</td>
<td>22.94</td>
<td>28.72</td>
<td>88.9</td>
<td>11</td>
<td>8.77</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>70</strong></td>
<td><strong>41.62</strong></td>
</tr>
</tbody>
</table>

Date: September 04, 2018
Tissue cultures materials arrive to Tonga
Date: September 04, 2018
Transferring/planting to pot plants
Date: September 04, 2018
Pot mix – body mix with styro-foam
Date: September 05, 2018
Pots transferred into nursery
Transferring/planting to pot plants

Date: September 25, 2018
IB/PER/013
Date: October 24, 2018
IB/PER/013 – hardening inside nursery
Date: November 15, 2018
Transplanting to the field (removing from the pot)
Date: November 15, 2018
Transplanting to the field (planting to the ground)
Date: November 15, 2018
Transplanting to the field complete
**Aguela Manuchia**

**Crop**  
Sweet potato

**Scientific Name**  
*Ipomoea batatas*

**CePaCT Acc. Code**  
IB/BOL/001

**Variety Name**  
Aguela Manuchia

**Origin**  
Bolivia

**Characteristics**  
Drought tolerant

**Plant Description**

- **Leaf shape** - halberd
- **Average leaf size** - length 11 cm, width 10 cm
- **Stem colour** - purple
- **Average vine intermodal length** - 7 cm
- **Average nu. Of tubers/plant** – 3
- **Tuber size** -
- **Tuber shape** - long, wider in the middle tapering to a point at the end
- **Tuber colour** - Purple
- **Flesh colour** - Yellow

**Field observations**

Compared to other trial varieties this variety had weaker growth, the smallest tubers and lowest yield per plant.

In subsequent trials it has proved susceptible to sweet potato scab (*Elsinoe batatas*).
**Nacional (NN)**

**Crop**  
Sweet potato

**Scientific Name**  
*Ipomoea batatas*

**CePaCT Acc. Code**  
IB/PER/002

**Variety Name**  
Nacional (NN)

**Origin**  
Peru

**Characteristics**  
Megaclones new variety / Drought tolerant

**Plant Description**

- **Leaf shape** – variable heart/halberd
- **Average leaf size** - length 9 cm, width 12 cm
- **Stem colour** - green
- **Average vine intermodal length** – 7 cm
- **Average nu. Of tubers/plant** – 11
- **Tuber size** -
- **Tuber shape** - Elongated tapering to a slight point at the bottom
- **Tuber colour** – Light yellow
- **Flesh colour** - yellow

**Field observations**

This variety grew very well and had fewer weeds in the trial rows due to its growth rate. It had the most and largest tubers of the plants in this trial. It showed very good resistance to pests and diseases.
**Blanco de Chilca**

**Crop**  
Sweet potato

**Scientific Name**  
*Ipomoea batatas*

**CePaCT Acc. Code**  
IB/PER/013

**Variety Name**  
Blanco de Chilca

**Origin**  
Peru

**Characteristics**  
Drought tolerant

**Plant Description**

- **Leaf shape** – variable heart/halberd
- **Average leaf size** - length 9 cm, width 10 cm
- **Stem colour** - purple
- **Average vine intermodal length** – 3 cm
- **Average nu. Of tubers/plant** – 9
- **Tuber size** – small to medium
- **Tuber shape** - Rounded tapering to a point at the bottom
- **Tuber colour** – Light yellow
- **Flesh colour** - orange

**Field observations**

These plants exhibited good growth characteristics and disease resistance, though a small amount of leaf miner (*Bedellia somnulentella*) was observed in the leaves.
Costanero

Crop: Sweet potato

Scientific Name: Ipomoea batatas

CePaCT Acc. Code: IB/PER/016

Variety Name: Costanero

Origin: Peru

Characteristics: Orange flesh & Drought tolerant

Plant Description:

- Leaf shape - heart
- Average leaf size - length 14 cm, width 12 cm
- Petiole length -
- Stem colour – dark purple
- Average vine intermodal length – 3 cm
- Average nu. Of tubers/plant – 4
- Tuber size -
- Tuber shape -
- Tuber colour – purple/yellow
- Flesh colour - orange

Field observations:

Although the plants of this variety grew vigorously they were very susceptible to sweet potato scab (Elsinoe batatas). Some leaf miner (Bedellia somnulentella) was present on the leaves also.
**IB/PER/035**

**Crop**  
Sweet potato

**Scientific Name**  
*Ipomoea batatas*

**CePaCT Acc. Code**  
IB/PER/035

**Variety Name**  
NA

**Origin**  
Peru

**Characteristics**  
Orange flesh

**Plant Description**
- **Leaf shape** - halberd
- **Average leaf size** - length
- **Average petiole length** – length 12 cm, width 6 cm
- **Stem colour** - green
- **Average vine intermodal length** – 8 cm
- **Average nu. Of tubers/plant** – 5
- **Tuber size** - medium
- **Tuber shape** – oval/round tapering to a point at the bottom
- **Tuber colour** - purple
- **Flesh colour** - orange

**Field observations**
These plants grew well and demonstrated good pest and disease resistance characteristics, though a small amount of leaf miner (*Bedellia somnuletella*) was seen in the leaves.
IB/PER/038

Crop: Sweet potato

Scientific Name: Ipomoea batatas

CePaCT Acc. Code: IB/PER/038

Variety Name: NA

Origin: Peru

Characteristics: Orange flesh

Plant Description:
- Leaf lobes - 1
- Average leaf size -
- Average petiole length - 18 cm
- Stem colour – dark purple
- Average vine intermodal length – 6 cm
- Average nu. Of tubers/plant – 9
- Tuber size - medium
- Tuber shape - oval/round tapering to a point at the bottom
- Tuber colour - purple
- Flesh colour - orange

Field observations:
The growth on these plants was very vigorous and the pest and disease characteristic were reasonably good. A small amount of both sweet potato scab (Elsinoe batatas) and leaf minor (Bedellia somnulentella) was observed on the plants.
**IB/PER/042**

**Crop**  
Sweet potato

**Scientific Name**  
*Ipomoea batatas*

**CePaCT Acc. Code**  
IB/PER/042

**Variety Name**  
NA

**Origin**  
Peru

**Comments**  
Orange flesh

---

**Plant Description**

- **Leaf shape** - halberd
- **Average leaf size** - length 13 cm, width 20 cm
- **Stem colour** - green
- **Average vine intermodal length** – 9 cm
- **Average nu. Of tubers/plant** – 9
- **Tuber size** - large
- **Tuber shape** – round/oval tapering to a point at the bottom
- **Tuber colour** - purple
- **Flesh colour** - orange

---

**Field observations**

Plants of this variety had vigorous growth and large leaves but proved susceptible to *(Elsinoe batatas)*. Leaf minor (*Bedellia somnulentella*) was also present on the leaves.
Beni-imo

Crop Sweet potato
Scientific Name Ipomoea batatas
CePaCT Acc. Code N/A
Variety Name Beni-imo
Origin Japan (Okinawa)
Comments Purple sweet potato

Plant Description
▪ Leaf shape - halberd
▪ Average leaf size - length 10 cm, width 12 cm
▪ Average petiole length – 17 cm
▪ Stem colour – light purple
▪ Average vine intermodal length – 6 cm
▪ Average nu. Of tubers/plant – 5
▪ Tuber size – small to medium
▪ Tuber shape – oval, tapering at both ends
▪ Tuber colour – dark red
▪ Flesh colour – dark purple

Field observations
The growth of this variety was slower in relation to the other trial plants, but it exhibited very good pest and disease resistance characteristics.
**Subsequent trial plantings**

MORDI TT has multiplied planting material from the original plants, continuing and extending the trial. Two plots of 1.24 acre have been planted, one on plot 17 & 18 (please refer map) and the other on plot X. Both plots are at Haveluloto, close to the MORDI TT office. A small amount of planting material has been distributed to a farmer in Vaini and some to farmer in Va’u to ascertain performance in differing geographical locations.

Initially all plants in these new trial plots performed well but sweet potato scab (*Elsinoe batatas*) symptoms became visible on new growth about eight weeks after planting (see details of sprays applied below).

Sweetpotato scab is a serious fungal disease of sweetpotato. An epidemic of the disease swept through Tonga in the 1980’s decimating the crop. As a result farmers stopped growing sweetpotato until new resistant varieties were bred using seed from the Solomon Islands. It is mainly these new varieties that are grown in Tonga today.

The disease damages the new shoots, slowing growth and reducing yields. It spreads from spores in wind driven rain and although it is possible that infection occurs from crop debris the main source of infection comes from using infected planting material.

Given that the propagation material in the MORDI TT trial was free of the disease at the time of planting, and the trials are being conducted on previously fallow land, it is surprising to see such a high incidence of the disease. In some varieties, notably IB/PER/016 and IB/PER/042 virtually 100 per cent of the new growing tips are severely affected. Because the disease was not present in the initial growth stage of the trial the older leaves on the plants are free of the disease and a reasonable canopy remains. For this reason the yield from these plants is likely to be ok, however if the infection had occurred at an earlier stage it is likely that the crops productivity would be significantly reduced.

Leaf damage from sweet potato tortoise beetle (*Cassida* and *Aspidimorpha species*) has warranted spraying also. Although there is also some leaf minor (*Bedellia somnulenta*) present in the crops at current levels it is not of economic significance.

Two applications of chemicals have been applied to control sweet potato scab and sweet potato tortoise beetle in the current trial plots. The following chemicals were combined in the tank and applied:

- **April 05, 2019**
  - Benomol 15 gms/15l
  - Decis 10 mls/15l
- **April 23, 2019**
  - Benomol 15 gms/15l
  - Decis 10 mls/15l
Recommendations for the trial going forward

- The trial is integrated into TRIP II and continued over the life span of the project.
- Varieties 016 and 042 be dropped from the trial because of their susceptibility to sweetpotato scab (*Elsinoe batatas*). Trials continue on other varieties.
- All further trials are benchmarked against commonly grown varieties (Hawaii and 'Setaita') that are planted at the same time as the trial clones. Growth characteristics, disease susceptibility and productivity etc. of the different clones can then be compared to see if there is any out performance.
- The islands of Tonga are spread over a wide geographical area with differing soil and climatic conditions. Similar plants will perform differently in these different environments therefore small scale trials should be extended to include outer islands and different parts of Tongatapu.
- The project engages with model farmers in each new area to help run the trials and collect data. Mentoring and assistance is provided to the farmers as required to ensure consistency and accuracy of the information collected.
- An economic analysis be conducted compare the benefits of the new clones compared to existing varieties being grown, paying particular attention to return on investment for the farmers and characteristics such as drought tolerance that could help mitigate the effects of climate change on vulnerable communities.
- Trials are conducted on clones that outperform currently grown cultivars to ascertain market suitability of the new clones, based on appearance, taste and suitability for processing etc.