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CONTENTS

Foreword 5
Society Council, 1976–79 6
Welcoming addresses 7
Participants 11

Section 1: Origin, dispersal, and evolution 19
   Papers by: Léon 20; Plucknett 36; Sadik 40; Martin 44; Mendoza 50;
   Kobayashi and Miyazaki 53; Degras 58; and Warid et al. 62
   Summary of discussions 65

Section 2: Basic productivity 69
   Papers by: Loomis and Rapoport 70; Holmes and Wilson 84; Ferguson and
   Gumbs 89; Dharmaputra and de Bruijn 94; Nitis and Suarna 98;
   Obighesan et al. 104; Ngongi et al. 107; Howeler et al. 113;
   Rendle and Kang 117; Mohan Kumar et al. 122;
   Edwards et al. 124; Wahab 131; Umanah 137; Montaldo and
   Montilla 142; Montilla et al. 143; Wilson et al. 146; Tanaka and
   Sekioka 150; and Sykes 151
   Summary of discussions 152

Section 3: Preharvest and postharvest losses 155
   Papers by: Lozano and Terry 156; Bock et al. 160; Mukibi 163;
   Mukibi 169; Terry 170; Ninan et al. 173; Leu 175; Terry 179;
   Obighesan and Matuluko 185; Bellotti and van Schoonhoven 188;
   Nyiira 193; Yaseen and Bennett 197; Pillai 202;
   Thompson et al. 203; and Albuquerque 207
   Summary of discussions 208

Section 4: Utilization 211
   Papers by: Christiansen and Thompson 212; McCann 215; Chandra and
   De Boer 221; Valdes Sanchez 226; Phillips 228; Oke 232;
   Delange et al. 237; Hew and Hutagalung 242; Khajarern and
   Khajarern 246; Varghese et al. 250; Hutagalung and Tan 255;
   Gomez et al. 262; Gregory et al. 267; Narrey 270;
   Nakayama et al. 274; and Jeffers 275
   Summary of discussions 277
terial did not form noodles with the capacity to retain their shape upon boiling for 10 min. However, upon the addition of 10–20% soy flour, noodles that retained their shape were obtained. The addition is at the interface of processing and distribution. Such additions may be considered to be preventive measures to ensure against malnutrition induced by a convenient and inexpensive food staple.

Conclusions

The production of stable convenience foods from root crops involves several steps that may be taken in diverse orders. For taro, it is possible to separate the acridity factors by gravitational means, stabilize the material by dehydration, and utilize it as the main component in a noodle like food that can be prepared by simple cooking. These steps are part of a larger study aimed at the entire system of delivering food calories from root crops.


Mechanization of Yam and Sweet Potato Production in Barbados

J. P. W. Jeffers

A locally constructed planter and an imported transplanter were used to plant yam and sweet potatoes respectively on a field scale. Harvesting was carried out using a locally constructed harvesting-aid and an imported digger-elevator. The digger-elevator was successful in sweet potatoes, but will have to be modified to work on yams.

Yams (Dioscorea alata) and sweet potatoes (Ipomoea batatas) have long been cultivated in Barbados. Traditionally, they have been planted with sugar cane in either “thrown-out” or in preparation land. In recent years, due to the increasing labour shortage and to the physical effort involved, attempts have been made to mechanize the production of these crops. Mechanized production of sweet potatoes is very advanced, however mechanized planting of yams has been attempted but not yet perfected.

Preparation land may be cultivated with ridges 168 or 84 cm apart in keeping with the practice of planting sugar cane on ridges 168 cm apart. It is now recommended that the 84-cm ridges be used for yams and sweet potatoes rather than the previously used 168 cm. This recommendation is based on earlier work where we showed that larger yields and better sized and shaped tubers were obtained from the smaller ridges.

Mechanized Production of Sweet Potatoes

Sweet potato slips are normally planted by hand and after one or two hand weedings are harvested with a garden fork. This production method is labour intensive, time consuming, and physically laborious.

Planting

A mechanical two-row transplanter was obtained in 1973 for use mainly with vegetable crops. We decided to plant potato cuttings or “slips” with the transplanter, and changed only the seating arrangement to seat four persons. The land was ploughed and harrowed to obtain a well cultivated flat seedbed. The transplanter was then used to plant the slip burying the butt end at least 10.6 cm in the soil. In operation, the planters work in pairs, one pair a row.

1Ministry of Agriculture, Science and Technology, Bridgetown, Barbados.
The individuals in a pair work alternately putting the slips in the planting pockets, resulting in an output of 1.5 ha/h.

**Intercultivation**

After the slips have rooted and started growing it is necessary to ridge them up to create an area for the formation of tubers and to control weed growth. The ridges should be 84 cm, obtained by using rotary cultivators. Two operations are normally used for ridging up.

**Harvesting**

Earlier work identified two implements that could be used for harvesting sweet potatoes. A locally constructed “harvesting aid” has been successfully used. It consists of a 10.1 x 15.2 cm mounted tool bar fitted with two subsoiling tines placed 102 cm apart. The shoes are joined by a straight blade 102 x 20.3 cm made of 1-cm thick steel. On the trailing edge of the blade five 2.5-cm diameter rods were welded 16.5 cm apart and protruding backwards 38 cm to assist in separating the soil from the tubers. This implement is relatively inexpensive and efficient. The vines must be removed to prevent clogging, and a simple device has been devised to cut the potato vines. This consists of two pairs of angled discs set 102 cm apart to cut and clear the vines from the path of the subsoil standards.

The second harvester is an imported digger-elevator. This is a PTO operated digger consisting of an under-cutting blade and shaker chains that elevate the tubers and sift out most of the soil, dropping tubers and remaining debris from the rear of the elevator.

**Results**

The harvesting aid can bring an 84-cm row of sweet potatoes 100 m long in about 7 min. The collection, grading, bagging, and loading take appreciably longer. In 3.5 h the digger-elevator harvested 27 000 kg of potatoes by one operator. The incidence of damaged tubers in each case was less than 5% by weight.

**Mechanized Production of Yams**

There are certain prerequisites to successful mechanization of yam production: (1) yams must be grown in pure stands because it is impractical to harvest mechanically from between young sugar cane; and (2) land must be prepared and tubers planted to suit the harvester. Good land preparation is essential and positioning of the seed pieces is critical if the mature tubers are to be conveniently located for harvesting (Chandler 1973).

### Table 1. Comparison of harvesting methods on damage to yams.

<table>
<thead>
<tr>
<th>Method</th>
<th>Ridge spacing (cm)</th>
<th>Wt. of whole yams/row (kg)</th>
<th>Total/row</th>
<th>% breakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual (fork)</td>
<td>168</td>
<td>185</td>
<td>370</td>
<td>50</td>
</tr>
<tr>
<td>Harvesting aid</td>
<td>168</td>
<td>285</td>
<td>346</td>
<td>19</td>
</tr>
<tr>
<td>Manual (fork)</td>
<td>84</td>
<td>314</td>
<td>466</td>
<td>33</td>
</tr>
<tr>
<td>Harvesting aid</td>
<td>84</td>
<td>259</td>
<td>340</td>
<td>24</td>
</tr>
</tbody>
</table>

**Planting**

Mechanical planting has been tried only on the ridges spaced 168 cm apart. The planter is simple, consisting of a double tool-bar with conventional three-point mounting to which is attached subsoil tine moulding discs, boxes for seed pieces, and the operator's seat. A 15.2 cm diameter tube is attached behind the tine through which seed pieces are dropped into the furrow opened by the tine.

In operation, the tine and tube travel 10–15 cm below the apex of a previously prepared ridge. Yams are deposited at this depth and are covered when the ridge is reformed by the moulding discs. This planter has a working rate of 1–2 ha/day depending on operating conditions, and requires one driver and a planter operator.

**Harvesting**

The harvesting-aid has been used to harvest both hand and mechanically planted yams. The mechanically planted yams were grown on ridges 168 cm apart while the hand planted crop was grown on 84 cm ridges. Observations were made on the rate of work, the amount of damaged tubers, and comparisons were made with hand harvesting.

From an area of 1.1 ha planted on 168-cm ridges, a yield of 26 283 kg was obtained, whereas 1.03 ha planted in 84 cm ridges yielded 31 034 kg of yams. Table 1 shows the comparison of harvesting methods on damage to yams.
**Discussion**

The yield of yams increases as the size of the ridge decreases. On the larger ridges, the tubers were large and irregularly shaped. On the smaller ridges, the tubers were smaller and more regularly shaped.

Mechanical harvesting of yams and sweet potatoes could save about $100.00 (Bds)/ha. Mechanical planting and intercultivation of sweet potatoes could save about $150.00 (Bds)/ha.

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**Summary of Discussions**

**Utilization**

**Rapporteur: Truman P. Phillips**

**Discussion Leaders: O. L. Oke and Truman P. Phillips**

The discussion centred on three topics: the benefits of potatoes in the tropics; the inadequacies of the data presented; and the benefits of other root crops in the tropics.

Supporters of potatoes in the tropics highlighted the adaptability of the potato to numerous climatic zones, and the importance, or growing importance, of potatoes in the diets of many regions of the tropics. It was also noted that the short growing season of the potato suggests the potential of using it in a multi-cropping sequence.

The data presented by Thompson et al. were criticized for too often being based on temperate country information, and failing to compare potato productivity with other tropical root crops. For example, potatoes are the fourth most important staple at the world level, but in the tropics potato production is only a fifth of cassava production, and is only slightly greater than sweet potato or yam production. Also, given current practices it is unrealistic to suggest that in the tropics potatoes can provide the 'complete protein value' for 23.5 persons/ha (although this may now be possible in temperate countries).

The nutrient potential of other tropical root crops was best summarized by Oke. He noted that in the tropics cassava is the cheapest source of calories and is the most widely grown tropical root crop. It is the most productive farm crop, yielding edible nutrient equivalent to an average of over 13 million Kcal/acre compared with 9 million for yam and 1 million each for guinea corn and maize. Over 8 million tons of cassava are produced annually in Nigeria, contributing about 16% of the total caloric and 5% of the protein intake. FAO estimated cassava intake in 14 tropical countries to be between 269 and 1193 calories/day, representing 10–58% of requirements.

Yam is a more nutritious root crop, with an annual production of over 12 million tons, contributing 13% of the total caloric intake and 11% of the protein. Like cassava it is deficient in the sulfur amino acids. Cocoyam and potato (sweet and Irish) are not utilized to as great an extent as yam or cassava, seemingly because they grow wild.

It is, however, not the individual nutrient value of foods that is important, but the total nutrient value of the diet. Basic foods in the African diet are: (1) cassava fermented to give fufu or served and fried to give gari. This is usually eaten with vegetable stew and meat; (2) yam boiled and pounded to give a pudding, iyan, or alternatively, sliced, dried in the sun, and powdered. The fine powder is made into a thick paste with hot water, a mala. In both cases the product is eaten with vegetable stew and meat; and (3) cocoyam grated, wrapped in banana leaves, and steamed. Again, this is eaten with vegetable stew and meat. Obviously, the nutritive value of each of these will depend on the quantity used and the nutritive value of the meat or fish.

But it has been noted by numerous researchers that sulfur amino acids are the first limiting factors in diets based on roots and tubers. Nevertheless, these foods, in addition to providing large percentages of caloric requirements, account for substantial proportions of protein, calcium, iron, and vitamin C.

In conclusion it is difficult, if not impossible, to visualize how tropical diets can be maintained without the traditional root and tuber crops. The potato, however, becomes important when considered to be complementary rather than competitive with other root and tuber crops.