TROPICAL ROOT CROPS:
RESEARCH STRATEGIES FOR THE 1980s

PROCEEDINGS OF THE FIRST TRIENNIAL ROOT CROPS SYMPOSIUM OF THE INTERNATIONAL SOCIETY FOR TROPICAL ROOT CROPS — AFRICA BRANCH, 8—12 SEPTEMBER 1980, IBADAN, NIGERIA

EDITORS: E.R. TERRY, K.A. ODURO, AND F. CAVENESS

Although the editorial chores for these proceedings were the sole responsibility of the editors, the International Society for Tropical Root Crops — Africa Branch has a full Editorial Board comprising E.R. Terry, O.B. Arene, E.V. Doku, K.A. Oduro, W.N. Ezeilo, J. Mabanza, and F. Nweke. This Board serves the Society in various editorial capacities at all times.
The International Development Research Centre is a public corporation created by the Parliament of Canada in 1970 to support research designed to adapt science and technology to the needs of developing countries. The Centre's activity is concentrated in five sectors: agriculture, food and nutrition sciences; health sciences; information sciences; social sciences; and communications. IDRC is financed solely by the Parliament of Canada; its policies, however, are set by an international Board of Governors. The Centre's headquarters are in Ottawa, Canada. Regional offices are located in Africa, Asia, Latin America, and the Middle East.

The International Society for Tropical Root Crops — Africa Branch was created in 1978 to stimulate research, production, and utilization of root and tuber crops in Africa and the adjacent islands. The activities include encouragement of training and extension, organization of workshops and symposia, exchange of genetic materials, and facilitation of contacts between personnel working with root and tuber crops. The Society's headquarters is at the International Institute of Tropical Agriculture in Ibadan, Nigeria, but its executive council comprises eminent root and tuber researchers from national programs throughout the continent.

©1981 International Development Research Centre
Postal Address: Box 8500, Ottawa, Canada K1G 3H9
Head Office: 60 Queen Street, Ottawa

Terry, E.R.
Oduro, K.A.
Caveness, F.

International Society for Tropical Root Crops. Africa Branch, Ibadan NG


UDC: 633.4 (213) ISBN: 0 88936 285 8

Microfiche edition available
Cooperating institutions
## CONTENTS

**Foreword**  E.R. Terry ................................................................. 7

**Participants** ................................................................. 9

**Welcoming Addresses**
- **Bede N. Okigho**, President, International Society for Tropical Root Crops — Africa Branch ................................................................. 15
- **Alhaji Ibrahim Gusau**, Minister of Agriculture, Nigeria ......... 17
- **S. Olajuwon Olayide**, Vice-Chancellor, University of Ibadan, Nigeria .... 19
- **E. Hartmans**, Director-General, International Institute of Tropical Agriculture, Nigeria ................................................................. 22

**Cassava**
- Cassava Improvement in the Programme National Manioc in Zaire: Objectives and Achievements up to 1978  **H.C. Ezumah** ................................................................. 29
- Assessment of Cassava Cultivars for Extension Work  **C. Oyolu** ......... 35
- Breeding Cassava Resistant to Pests and Diseases in Zaire  **T.P. Singh** ......... 37
- Selection of Cassava for Disease and Pest Resistance in the Congo  **Joseph Mabanza** ................................................................. 40
- Some Characteristics of Yellow-Pigmented Cassava  **K.A. Oduro** ......... 42
- Field Screening of Cassava Clones for Resistance to *Cercospora henningsii*  **J.B.K. Kasirivu, O.F. Esuruoso, and E.R. Terry** ................................................................. 49
- Properties of a Severe Strain of Cassava Latent Virus Isolated from Field-Grown Tobacco in Nigeria  **E.C.K. Igwegbe** ................................................................. 58
- Cassava Bacterial Blight Disease in Uganda  **G.W. Otim-Nape and T. Sengooba** ................................................................. 61
- Insect Dissemination of *Xanthomonas manihotis* to Cassava in the People’s Republic of Congo  **J.F. Daniel, B. Boher, and N. Nkouka** ................................................................. 66
- Cassava Root Rot due to *Armillariella tabescens* in the People’s Republic of Congo  **Casimir Makambila** ................................................................. 69
- Screening for Resistance Against the Green Spider Mite  **K. Leuschner** ................................................................. 75
- Biological Control of the Cassava Mealybug  **Hans R. Herren** ................................................................. 79
- Entomophagous Insects Associated with the Cassava Mealybug in the People’s Republic of Congo  **G. Fabres** ................................................................. 81
- Dynamics of Cassava Mealybug Populations in the People’s Republic of Congo  **G. Fabres** ................................................................. 84
- Consumption Patterns and Their Implications for Research and Production in Tropical Africa  **Felix I. Nweke** ................................................................. 88
### Problems of Cassava Production in Malawi
R.F. Nembozanga Sauti

### Evaluation of Some Major Soils from Southern Nigeria for Cassava Production
J.E. Okeke and B.T. Kang

### Effects of Soil Moisture and Bulk Density on Growth and Development of Two Cassava Cultivars
R. Lal

### Performance of Cassava in Relation to Time of Planting and Harvesting
F.O.C. Ezedinma, D.G. Ibe, and A.I. Onwuchuruba

### The Effects of Previous Cropping on Yields of Yam, Cassava, and Maize
S.O. Odurukwe and U.I. Oji

### Intercropping of Plantains, Cocoyams, and Cassava
S.K. Karikari

### Effect of Maize Plant Population and Nitrogen Application on Maize-Cassava Intercrop
B.T. Kang and G.F. Wilson

### Cassava Leaf Harvesting in Zaire
N.B. Lutaladio and H.C. Ezumah

### Effects of Leaf Harvests and Detopping on the Yield of Leaves and Roots of Cassava and Sweet Potato
M.T. Dahniya

### Metabolism, Synthetic Site, and Translocation of Cyanogenic Glycosides in Cassava
M.K.B. Bediako, B.A. Tapper, and G.G. Pritchard

### Loss of Hydrocyanic Acid and Its Derivatives During Sun Drying of Cassava
Emmanuel N. Maduagwu and Aderemi F. Adewale

### The Role of Palm Oil in Cassava-Based Rations
Ruby T. Fomunyam, A.A. Adegbola, and O.L. Oke

### Comparison of Pressed and Unpressed Cassava Pulp for Gari Making
M.A.N. Ejiofor and N. Okafor

### Gari Yield from Cassava: Is it a Function of Root Yield?
D.G. Ibe and F.O.C. Ezedinma

### Yams

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameters for Selecting Parents for Yam Hybridization</td>
<td>Obinani O. Okoli</td>
<td>163</td>
</tr>
<tr>
<td>Anthracnose of Water Yam in Nigeria</td>
<td>Okechukwu Alphonso Nwankiti and E.U. Okpala</td>
<td>166</td>
</tr>
<tr>
<td>Strategies for Progress in Yam Research in Africa</td>
<td>I.C. Onwueme</td>
<td>173</td>
</tr>
<tr>
<td>Study of the Variability Created by the Characteristics of the Organ of Vegetative Multiplication in <em>Dioscorea alata</em></td>
<td>N. Ahoussou and B. Toure</td>
<td>177</td>
</tr>
<tr>
<td>Growth Pattern and Growth Analysis of the White Guinea Yam Raised from Seed</td>
<td>C.E. Okezie, S.N.C. Okonkwo, and F.I. Nwke</td>
<td>180</td>
</tr>
<tr>
<td>Artificial Pollination, Pollen Viability, and Storage in White Yam</td>
<td>M.O. Akoroda, J.E. Wilson, and H.R. Chheda</td>
<td>189</td>
</tr>
<tr>
<td>Improving the In-Situ Stem Support System for Yams</td>
<td>G.F. Wilson and K. Akapa</td>
<td>195</td>
</tr>
<tr>
<td>Yield and Shelf-Life of White Yam as Influenced by Fertilizer</td>
<td>K.D. Kpeglo, G.O. Obigbesan, and J.E. Wilson</td>
<td>198</td>
</tr>
<tr>
<td>Weed Interference in White Yam</td>
<td>R.P.A Unamma, I.O. Akobundu, and A.A.A. Fayemi</td>
<td>203</td>
</tr>
<tr>
<td>The Economics of Yam Cultivation in Cameroon</td>
<td>S.N. Lyonga</td>
<td>208</td>
</tr>
<tr>
<td>Effect of Traditional Food Processing Methods on the Nutritional Value of Yams in Cameroon</td>
<td>Alice Bell and Jean-Claude Favier</td>
<td>214</td>
</tr>
</tbody>
</table>

### Cocoyams

<table>
<thead>
<tr>
<th>Title</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies for Progress in Cocoyam Research</td>
<td>E.V. Doku</td>
<td>227</td>
</tr>
<tr>
<td>Root and Storage-Rot Disease of Cocoyam in Nigeria</td>
<td>G.C. Okeke</td>
<td>231</td>
</tr>
</tbody>
</table>
Fungal Rotting of Cocoyams in Storage in Nigeria    J.N.C. Maduewesi and Rose C.I. Onyike .................................................. 235
A Disease of Cocoyam in Nigeria Caused by Corticium rolfsii    O.B. Arene and E.U. Okpala .................................................. 239
Cocoyam Farming Systems in Nigeria    H.C. Knipscheer and J.E. Wilson ... 247
Yield and Nitrogen Uptake by Cocoyam as Affected by Nitrogen Application and Spacing    M.C. Igbokwe and J.C. Ogbannaya ......................... 255

Abstracts
Cassava Research Program in Liberia    Mallik A-As-Saqui ................. 259
Effects of Cassava Mosaic on Yield of Cassava    Godfrey Chapola .......... 259
Effects of Green Manure on Cassava Yield    James S. Squire .......... 260
Alleviating the Labour Problem in Yam Production: Cultivation without Stakes or Manual Weeding    I.C. Onwueme ......................... 260

Discussion Summary
Strategies for the 1980s .......................................................... 263

References .................................................................................. 265
STRATEGIES FOR PROGRESS IN YAM RESEARCH IN AFRICA

I.C. ONWUEME

PLANT SCIENCE DEPARTMENT, UNIVERSITY OF IFE, ILE-IFE, NIGERIA

The various problems confronting yam production in Africa are highlighted, and research strategies are suggested for solving these problems. The problems of laborious planting and harvesting can be solved through mechanization. Staking, with its high labour consumption, should be discontinued and agronomic research done to make yam yield well without staking. Researchers can tackle the weed problem by developing a herbicide package that requires no supplemental weeding. The research strategy for yam breeding should aim at types with ovoid tubers, thick tuber periderm, high yield, good disease resistance, a high multiplication ratio, and the ability to yield well without stakes. The strategy for reducing storage losses should include selections of cultivars that have thick periderms and store well at temperatures of 0–10°C. Also the development of economic processed forms of yam will lessen the need to store the fresh tuber. Certain social phenomena peculiar to yam in Africa now threaten the implementation of the research strategies suggested. The most crucial of these phenomena is the lack of will on the part of governments and research agencies to execute yam research. Since the problems associated with yam will remain, unless tackled, this lack of will must be reversed.

Mise en évidence de divers problèmes limitant la production d’ignames en Afrique et stratégie de recherche proposée pour leur solution. Les travaux pénibles requis pour la plantation et la récolte peuvent être allégers par la mécanisation. Le tuteurage si exigant en main-d’oeuvre devrait être supprimé et des recherches agronomiques effectuées dans ce but. A cause de sa sensibilité aux mauvaises herbes, un traitement global herbicide devrait être déterminé afin d’éliminer les saclages; la stratégie de recherche pour la sélection d’ignames devrait être orientée sur des types à tubercules ovoïdes, à périermer épais, à rendement optimal, à taux de reproduction élevé et possédant une bonne résistance à la maladie et la propriété de croître sans tuteur. La stratégie de réduction de perte en cours d’entreposage devrait porter sur la sélection de cultivars à périermer épais qui se conservent bien à des températures de 0 à 10 °C. De même, de nouveaux traitements économiques devraient être mis au point afin de réduire le stockage de tubercules verts. Cependant, la mise en oeuvre des stratégies de recherche proposées ci-dessus pour l’Afrique est compromise par diverses attitudes sociales vis-à-vis de l’igname dont la plus grave est le refus de la part des gouvernements et des agences de recherche de poursuivre des études sur cette plante. Il faut donc corriger cette situation pour solutionner les problèmes relatifs à la culture de l’igname.

The yam is the agricultural economist’s nightmare. The most critical problems in yam production today are those concerned with the economics of production. Broadly stated, these problems are high-labour input, the low yield per unit of input, and inadequate preservation facilities for the harvest. Research strategies for yam must, inevitably, have the objective of solving these problems so that, ultimately, a greater quantity and better quality of yam can be available to the consumer at a lower price.

The main labour-consuming aspects of yam production are planting, weeding, staking, and harvesting (Onwueme 1978a). The laboriousness of planting arises from the fact that in the traditional setting, both the land preparation and the planting are done by hand or with hand tools. The research strategy with respect to planting should therefore be to intensify efforts toward the complete mechanization of planting. The shift from hand-made mounds to machine-made ridges for yam production in many parts of Africa has already resulted in some labour savings. Research is going on in various locations to devise machinery that will ridge, place the sett, and cover up all in one operation.

Yam harvesting in Africa today is done almost entirely with hand tools. It is not only labour-consuming but also tedious. This is so for several reasons. First, the yam tuber is usually stored for several months. To avoid bruising the tuber and, hence, to maximize shelf-life, the farmers must exercise special care when lifting and handling the tuber. Second, the preference for large tubers
among African yam farmers and consumers implies that the mean depth from which the tuber must be extracted is great, with attendant increases in the time needed for harvesting. Third, most yams tend to respond to improved cultural practices by increasing the mean size (weight) per tuber rather than the number of tubers. Thus, modest improvements that have been made in cultural practices at the farmer's level have, paradoxically, increased the depth of tuber penetration and, therefore, increased the difficulty of harvesting. Fourth, some farmers practice double harvesting in which each plant is harvested twice, first about 3 months before senescence and then again after senescence. It has been amply demonstrated (Onwueme 1977a,b) that this practice does not result in a higher total tuber yield for the season; yet it demands more than double the time and effort needed for single harvesting.

The research strategy for yam harvesting, as that for planting, should be toward development of a mechanical yam harvester. Progress in this direction will probably depend on selection of cultivars with ovoid shape and thick skin, the breakdown of the preference for large tubers so that small mechanically harvested tubers can be economic, and the discontinuation of double harvesting.

Staking in yams has been shown to be beneficial (Waitt 1960; Chapman 1965; Lyonga et al. 1973), particularly in the humid tropics where insolation is low. However, staking is costly, laborious, and difficult to mechanize (Onwueme 1978). Moreover, with increasing deforestation, wooden stakes are becoming scarce. One approach is to improve the system of staking (Campbell 1967; Fiji, Department of Agriculture 1979) — for example, the introduction of a trellis system. A second approach (Onwueme 1978a, b) is based on the belief that even the trellis system is expensive (40% of total production costs in Fiji) and that the ultimate solution to the staking problem is to eliminate staking from yam production. Once the decision has been taken that staking must go, all that is left is to determine, through agronomic experimentation, how to obtain the maximum possible yields from unstaked yams. It is important, of course, that the amount saved by the elimination of stakes exceeds any reductions in yield.

The obvious research strategy with respect to weed control in yams is the search for appropriate herbicides. This search has been rendered unusually difficult by certain peculiarities of the yam crop. First is the long period from planting time to emergence. This period can range from 1 to 4 months and means that a herbicide applied at planting may have lost much of its effectiveness by the time the yam emerges, whereas a herbicide applied just before emergence must be able to cope with the weeds that emerged since planting was done. Second, for normal commercial plantings (utilizing heads, middles, tails, and wholes), emergence is extremely staggered, and there is a wide time gap between the early and late emergers. It is impossible to pinpoint a time of emergence for the plot (except in a mathematical sense) so that one cannot easily plan a herbicide application to occur just before emergence. Third, yam cultivars are characteristically slow in producing leaves after emergence, and the ability of the crop to cover the ground is limited, the herbicide effect often wearing off before good groundcover is attained. Fourth, yam is a long-season crop, and there are few herbicides whose effect can persist for the duration of the yam-cropping season.

Herbicides that have been recommended for yam include diuron, linuron, and ametryne (Kasasian and Seeayve 1967; Renault and Merlier 1973; Akobundu 1977), but most workers recommend a supplementary hand weeding late in the season when the herbicide effect has declined. This situation is not satisfactory. The ultimate strategy should be to develop a herbicide package that constitutes a single herbicide application that is effective for the season. Considerable progress has been made at the University of Ife, Nigeria, in combining such a herbicide package with yam production without staking (Onwueme and Fadayomi 1980; Oriuwa and Onwueme 1980).

Some of the problems of yam that cannot be solved through cultural manipulation must be solved through plant breeding and selection. The overall strategy for a crop improvement program for yam should be to provide cultivars that embody the maximum number of desirable traits. As with most other crops, such traits would include high yield, disease resistance, and good culinary quality of the harvested product. For yam, specifically, such traits should also include a tuber that is ovoid and has a thick periderm to minimize harvesting injury and improve storability; a relatively high protein content; and ability to yield well even from small sets (i.e., a high multiplication ratio). The ability of the yam to yield well without support for its vines varies with cultivar and should be one of the objects of selection. In addition, attempts should be made to identify cultivars with a short growing season. This character would allow the farmer to grow another short-season crop (e.g., cowpea, maize) before or after the yam within the same cropping season; at present yam occupies the field for the entire cropping season.

One of the fundamental problems in yam
improvement is the degenerate sexuality of the plant. Flowering is irregular, hybridization is difficult, and seed production is sparse. Some species, such as Dioscorea cayenensis, usually produce only male flowers, and some cultivars never flower at all. With such species and cultivars, conventional breeding techniques break down, and the breeder is forced into the more esoteric realms of mutation breeding and pollen culture. Very few laboratories in Africa are capable of these techniques. Fortunately, however, a large pool of natural variability still exists for yams in Africa so that significant progress in yam improvement can yet be made on the basis of judicious selection alone.

In the area of crop protection, the African yam farmer has hitherto been fortunate in that most of the common yam diseases have not been debilitating. The situation seems to be changing, however, and a few diseases that can completely destroy the crop have been identified. The yam anthracnose or "scorch" is a good example. This disease has become quite prominent in D. alata in West Africa in recent years. Field resistance has been identified in some cultivars, and research is going on at various centres into methods of controlling the disease. For such a serious disease, control is essential; for less serious diseases, researchers should work to determine the extent of yield reduction due to the disease and to decide whether control measures would be economic.

Most yam producers store their yams fresh. A significant proportion of the harvest is invariably lost during storage. The main source of loss is through the attack of diseases and pests; other sources include sprouting, respiration, and dehydration.

The problem of storage losses in yams calls for an integrated research strategy starting from the field and ending on the dining table. In the field, the yam must be harvested with as little bruising as possible. Mechanical harvesting, if practiced, must be preceded by selection of cultivars with appropriate tuber characteristics such as a thick periderm and ovoid shape. Prestorage treatments, such as curing or pesticidal dips, for the tubers have had some success (Adesuyi 1973) and could be further explored. The use of gamma irradiation of the tubers to prolong storage life has been reported (Adesuyi 1973, 1976) and holds much promise for the future.

Investigations into the best environmental conditions for prolonged yam storage have been hampered by the fact that at temperatures lower than about 10°C, stored yams degenerate and turn brown. Yet at 10°C, microbial activity, tuber respiration, and sprouting are still high enough to threaten storability. Perhaps the strategy here should be to look for cultivars that can store at just above 0°C without turning brown. At such a temperature, the main factors leading to storage loss will be effectively contained.

Still another strategy for reducing storage losses in yam is to develop storable processed forms so that only a small fraction of the harvest need be stored fresh. Such processed forms are not only less prone to spoilage but also less bulky and, therefore, easier to store and to transport. Various kinds of yam flour that reconstitute into a paste similar to pounded yam have been tested in African markets. Most of them are certainly more convenient than making pounded yam from fresh tubers, but their production cost has been rather high. Efforts in this direction should be encouraged so that consumers can have dry, storable products that reconstitute, with minimal effort, into any of the whole array of yam dishes that can be prepared from the fresh tubers.

Progress in yam research and production in Africa will depend on an integration of the various strategies that have already been suggested. However, there are three social phenomena associated with yam that tend to override the foregoing considerations, and, indeed, threaten the implementation of rational research and production strategies. A higher group of strategies must, therefore, be fashioned to overcome these social constraints.

The first of these social phenomena is that, in most parts of Africa, there is a marked consumer preference for large tubers. This preference affects various facets of yam production to a degree not generally realized. Indeed it casts a long, lingering shadow over the entire production process:

- Large tubers only can be grown from large setts, which have lower multiplication ratios than do small setts (Onwueme 1978b). Thus, the prevailing problem of low multiplication ratio in yams generally is further exacerbated.
- Large setts planted to produce large tubers produce plants with extensive shoot systems (Onwueme 1972). Such shoot systems tend to need vine support for optimum leaf display, otherwise the leaves shade one another.
- Large tubers tend to heave and be exposed when produced on the flat or on low ridges. Mounds, which can be made as high as needed, are the ideal land preparation for producing large tubers. Thus many traditional farmers, with an eye for large tubers, have continued to grow their yams on unmechanizable mounds, despite the availability of mechanized ridge making.
- Large tubers penetrate the soil to a greater
mean depth than do small tubers. Harvesting is, therefore, more tedious, and the chances of the tubers being bruised are much greater. The bruises render the tuber prone to rotting during storage.

- The prospects for mechanical harvesters for yam are diminished if the production target is the large tuber. It is much easier to design a harvester for the shallower, less-fragile, small tubers than for the large tubers that now command the market premium.

Thus, the consumer preference for large tubers has repercussions from planting through storage. The strategy for dealing with this social phenomenon lies in prosecuting yam research vigorously because the preference for large tubers will probably break down in the face of advances in yam research. When the production (including harvesting) of smaller tubers is fully mechanized and made less laborious, such tubers will be so much cheaper than large tubers that consumers will be forced by economics to reconsider their preferences. Also if consumers get most of their yams as processed material, the size of the tuber from which the material originated will be irrelevant.

The second social phenomenon associated with yam in Africa is that even where research strategies have led to new methods, farmers resist innovations. True, there is farmer resistance to innovation in any crop, but, for yam in Africa, this resistance attains a level bordering on hostility. The main reason for this seems to be that many yam species are indigenous to Africa, and yam cultivation has more or less evolved here through the generations. Thus, traditional yam farmers consider themselves, not the researchers, to be the experts in yam production. For nonindigenous crops like cocoa or rice, farmers are willing to listen to researchers and adopt innovations, but, for yam, African farmers think it should be the other way round. With persistence, and demonstrably better methods, researchers should eventually be able to overcome this problem.

The third and potentially most damaging social problem confronting yam research and production is that many research agencies increasingly lack the will to undertake yam research. This is true in Africa as well as elsewhere. This situation arises mainly because yam is an extremely difficult crop to work on. Institutions and governments are more inclined to spend their money on crops where quick results can be had. Even individual researchers prefer to work on crops that are less intractable. The continent of Africa, for example, is replete with maize, rice, tomato, and cowpea breeders who can grow two or three experimental generations each year and, furthermore, can benefit from large pools of information collected on these crops in the developed countries. In comparison, how many yam breeders are there in Africa, which produces 98% of the world’s yams? Very few. Very few, indeed, have ventured to burn their fingers on a crop with a long-growing season, irregular sexuality, and for which there is a dearth of information. The irony of the present situation, however, is that yam will continue to remain intractable unless somebody devotes enough research attention to it. The problems will not go away unless they are tackled. The ultimate strategy for progress in yam research in Africa, therefore, is to have the will to do yam research. Without this strategy, all the other strategies are inconsequential.