

# Tropical Root Crops

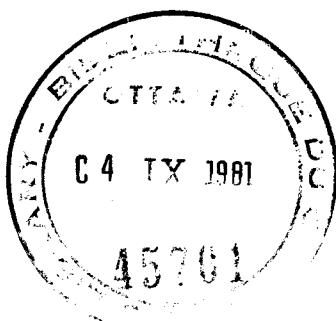
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## **TROPICAL ROOT CROPS: RESEARCH STRATEGIES FOR THE 1980S**

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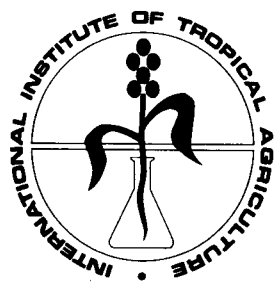
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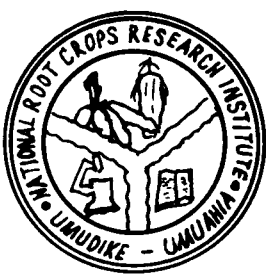
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# CONSUMPTION PATTERNS AND THEIR IMPLICATIONS FOR RESEARCH AND PRODUCTION IN TROPICAL AFRICA

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With the exception of Nigeria, the countries in the African root crops belt are experiencing low growth rates in real income. One of the ways in which this trend is manifested is changes in dietary habits. Average Nigerians seem to be substituting rice and wheat for root crops, in their diet, whereas average consumers in the other countries seem to be substituting root crops for rice and wheat. In future, root crops consumption will likely decline in Nigeria but increase in the other countries. For the whole region, there is likely to be a surplus of production over consumption needs of root crops in general in the future. However, there would be deficits of specific root crops in specific countries. A surplus of one root crop cannot offset a deficit of another because one is not a perfect substitute for the other. Also, a surplus in one country may not offset a deficit in another because trade in the commodities is limited. There is therefore a need to develop trade in the commodities; there is also need to encourage research in and production of the root crops in which deficits of production over consumption are likely to occur in the future.

Le revenu réel des pays compris dans la ceinture de production de plantes-racines, exception faite du Nigeria, progresse lentement. L'un des effets de cette augmentation est l'évolution des habitudes alimentaires de la population. Il semble que le Nigérien moyen remplace les tubercules alimentaires par le riz et le blé alors que dans d'autres pays le consommateur moyen substitue les tubercules au riz et au blé. La consommation de plantes-racines diminuera probablement au Nigeria mais elle augmentera dans les autres pays. Il y aura donc probablement un excédent de tubercules. Cependant, il pourrait quand même y avoir un déficit de certaines plantes-racines dans quelques pays, qui ne pourra être compensé par le surplus d'approvisionnement d'autres espèces, les substituts parfaits étant souvent rares. De même, l'excédent de plantes-racines dans un pays ne pourra compenser la disette prévalant dans un autre, le commerce des biens étant très limité dans ces régions. Il faut donc encourager la recherche sur l'augmentation de la production des cultures susceptibles d'être déficitaires.

During 1970–75, Africa produced 42% of the world production of cassava and 18% of yams and cocoyams combined (FAO 1971–76). Cassava, yam, cocoyam, and perhaps sweet potato are the staples of many people of tropical Africa just as millet, sorghum, or maize is a staple of other low-income peoples of the world. Because of the present world economic situation of high energy prices, inflation, and unemployment, most of the countries in tropical Africa are experiencing low rates of growth or declining real income. Under such a situation, root crops are likely to assume greater importance in the diets of the people.

My objective in this paper is to reappraise the relative importance of cassava, yams, cocoyams, and sweet potato in tropical Africa in the light of changing economic conditions and suggest research and production strategies through which the importance of the root crops can be most efficiently realized. The paper is based partly on time-series data generated by the International Bank for Recon-

struction and Development (IBRD), the Food and Agriculture Organization of the United Nations (FAO), and the United States Department of Agriculture (USDA) and partly on farm-management studies carried out in Nigeria, Ghana, and Zaïre.

## AFRICAN ROOT CROPS BELT

The African production of cassava, yam, cocoyam, and sweet potato is concentrated in the countries lying within 15° of both sides of the equator — the African root crops belt; production in other African countries is relatively unimportant (FAO 1971–76). From 1970 to 1975, most of the countries within the belt cultivated an average of between 0.04 hectares and 0.15 hectares per person annually. This was 28% of the per-person area of arable lands cultivated in the belt annually. The area is also the belt of production of such tropical



industrial crops as cocoa, rubber, oil palm, and timber.

Of the countries in the belt, Central African Republic, Togo, People's Republic of Congo, Liberia, Gabon, Comoros, Equatorial Guinea, and Guinea-Bissau had populations of 2.5 million or less in mid-1976 (IBRD 1978) and, thus, are not included in this analysis. Up-to-date, time-series data are unavailable for Mozambique, Uganda, Burundi, Rwanda, and Benin, so they are also excluded from the analysis even though their total populations are greater than 2.5 million. My analysis is therefore based on Nigeria, Zaire, Tanzania, Ghana, Madagascar, Cameroon, and Ivory Coast. It is hoped that the conclusions reached are applicable to the entire belt. The seven countries account for nearly 80% of the mid-1976 population (IBRD 1978) and also nearly 80% of 1970–76 annual average area under root crops in the entire belt (FAO 1971–76).

Nigeria alone accounts for more than 50% of the mid-1976 population and more than 40% of the 1970–76 annual average areas under root crops.

## RELATIVE IMPORTANCE OF INDIVIDUAL ROOT CROPS

Cassava accounted for about 65% of the total area cultivated with root crops, yam accounted for about 15%, and cocoyam and sweet potato accounted for about 10% each in 1970–75 (FAO 1971–76). Cassava production and consumption are evenly distributed throughout the belt, but yam and cocoyam production and consumption are concentrated in the countries of West Africa (Nigeria, Ghana, Cameroon, and Ivory Coast), and sweet potato production and consumption are concentrated in the countries of East Africa (Tanzania, Madagascar, and Zaire).

In 1970–75, root crops (cassava, yam, cocoyam, and sweet potato) contributed 38% of the average person's daily energy intake in the root crops production belt. Of the 38%, 22% was from cassava, 10% from yam, 4% from cocoyam, and only 2% from sweet potato. In comparison, 43% came from grains, 8% from bananas and plantains, 7% from pulses, and 3% from meat, dairy products, etc.<sup>1</sup> Hence, root crops, especially cassava, are major sources of dietary energy in tropical Africa at present.

Although in the western half of the belt cassava and yam are of about equal popularity, cassava is

by far the most popular of all the root crops when the whole belt is considered. Nevertheless, the popularity of a root crop in tropical Africa cannot be determined on the basis of area or contribution to dietary consumption because some root crops have cultural values in certain areas within the belt.

## IMPORTANCE OF ROOT CROPS IN THE FUTURE

The importance of root crops as a source of dietary energy in future will depend on what happens to real income in the belt. In developing countries, rice and wheat are eaten primarily by high-income consumers, whereas root crops, maize, millet, and sorghum are low-income consumers' staples — root crops in root crop-production regions and maize or millets and sorghum in grain-production regions.

Although individuals may not increase the quantity of root crops that they consume in a year as incomes decline, annual average per-person consumption increases because more people begin to substitute root crops for grains in their diets.

With the exception of Nigeria, major countries in the African root crops belt experienced little growth or even declining real income in 1970–76. Zaire, Tanzania, Cameroon, and Ivory Coast experienced low rates of growth of real income, whereas Ghana and Madagascar experienced declining real income in the period (Table 1). Available consumption figures show that an average Nigerian has started to substitute grains, especially rice and wheat, for root crops in his or her diet, whereas in countries with low rates of growth or declines in real income an average consumer is substituting root crops for grains, especially rice and wheat, between 1968–72 and 1973–77 (Fig. 1 and 2). In Nigeria, the annual average per-person consumption of root crops declined from 524 kg in 1968–72 to 518 kg in 1973–77 at an average annual compound rate of 0.2%; the annual average per-person consumption of rice and wheat increased from 10 kg in 1968–72 to 17 kg in 1973–77 at an annual average compound rate of 11.2%. In the countries with low rates of growth or declines in real income, the weighted (with population) annual average per-person consumption of root crops increased from 332 kg in 1968–72 to 336 kg in 1973–77 at an annual average compound rate of 0.3%, the weighted annual average per-person consumption of rice and wheat declining from 37 kg in 1968–72 to 34 kg in 1973–77 at an annual average compound rate of 0.3%.

An average annual compound rate of decline of

<sup>1</sup> Figures are calculated from production (USDA 1971–76) and trade (UN 1971–76) records.

Table 1. Population, totals (1976) and growth rates (1970–76), and GNPs per capita (1976) and growth rates (1970–76) for major countries in the African root crops belt.

| Country     | Population          |                             | GNP per capita            |                             |
|-------------|---------------------|-----------------------------|---------------------------|-----------------------------|
|             | Mid-1976<br>('000s) | Growth rate,<br>1970–76 (%) | 1976<br>(U.S. \$ million) | Growth rate,<br>1970–76 (%) |
| Nigeria     | 77056               | 2.6                         | 400                       | 5.4                         |
| Zaire       | 25389               | 2.7                         | 130                       | 0.4                         |
| Tanzania    | 15136               | 2.7                         | 180                       | 1.7                         |
| Ghana       | 10310               | 2.9                         | 370                       | –0.7                        |
| Madagascar  | 9112                | 3.1                         | 200                       | –2.3                        |
| Cameroon    | 7606                | 2.0                         | 310                       | 1.0                         |
| Ivory Coast | 7025                | 3.8                         | 650                       | 1.9                         |

0.2% in per-person consumption of root crops associated with annual compound rate of growth in real income of 5.4% in Nigeria shows that the effect of increases in real income on reduction in consumption of root crops is slow. It cannot be relied upon to offset the decline in root crops production, especially in a country where the level of annual per-person consumption is high. On the other hand, an increase of 4 kg, from 332 kg to 336 kg, in countries with low rates of growth or of declines in real income could be significant in total demand in countries where the population is large and increasing.

IBRD estimates show that, of the 43 tropical African countries for which data were available, 25 experienced annual compound growth rate in gross national product (GNP) of 1.0% or less and of these 25, 13 had negative growth in 1970–76 (IBRD 1978). Of the 25 countries with low rates of growth or declining real income, 13 are in the root-crops production belt. The only countries of the African root crops belt with GNP compound growth of 2.0% or more in 1970–76 were Nigeria, People's

Republic of the Congo, and Gabon. People's Republic of the Congo and Gabon together had less than 2 million people in 1976 (IBRD 1978).

The current world economic situation, especially with respect to petroleum shortages and inflation, suggests that the downward trend in real income in tropical Africa, except in oil-producing countries, will continue for some time and that root crops will likely assume greater importance in the diets of the people in the region.

To determine the future importance of root crops in the region, I projected the annual total production and consumption of root crops in the major countries of the African root crops belt to the year 1995. In projecting production, I assumed that the 1961–77 production trend would be maintained. In projecting consumption, I assumed the 1970–76 annual compound rates of growth of GNP per person and of population as estimated for each country by IBRD (1978) and income elasticity of demand for each root crop as estimated by FAO (1971).

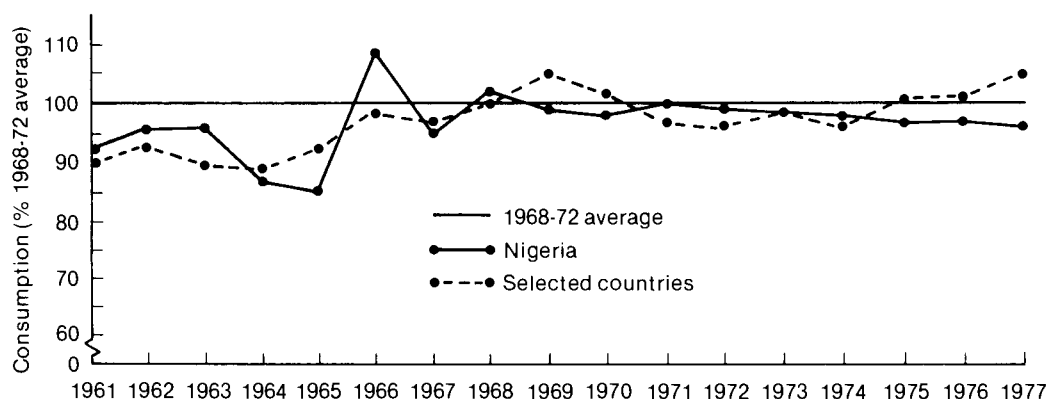
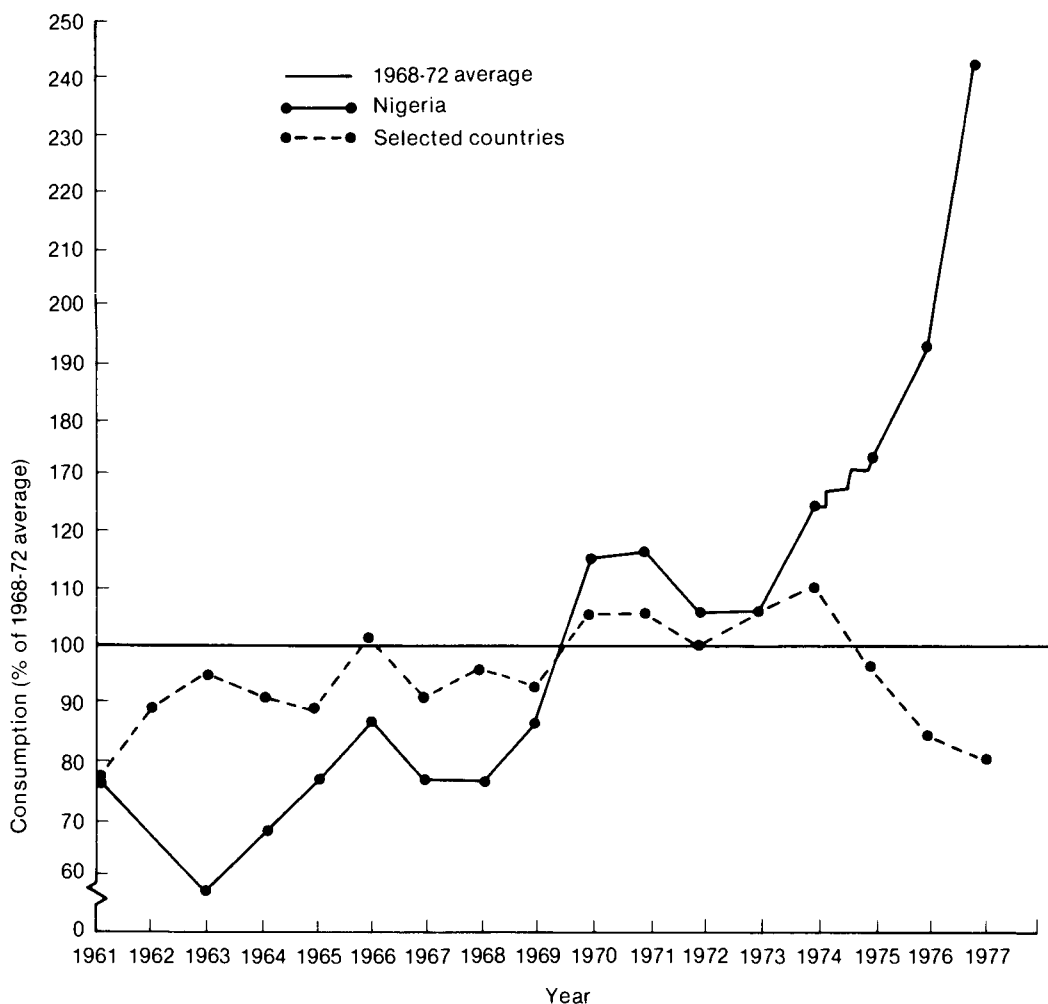


Fig. 1. Indices (1968–72 average = 100%) of per-person consumption of root crops in Nigeria and in selected countries in the African root crops belt, 1961–1977.



**Fig. 2.** Indices (1968–72 average = 100%) of per-person consumption of rice and wheat in Nigeria and in selected countries in the African root crops belt, 1961–77.

On the basis of these assumptions, the production of root crop (R) in country (N) in year  $t$ ,  $P_{R,N}(t)$ , is estimated as  $P_{R,N}(1977)(1 + G_{R,N})^T$  where  $P_{R,N}(1977)$  = 1977 production trend estimate for root crop R for country N (tonnes);  $G_{R,N}$  = annual compound rate of growth of production of R in N during 1961–77 (%); and  $T$  = time interval between 1977 and  $t$  (years).  $P_{R,N}(1977)$  is estimated as  $\log P_{R,N}(1977) = a + bT$  where  $T$  = time interval (16 years) between 1961 and 1977. The consumption of root crop R in country N in year  $t$ ,  $C_{R,N}(t)$ , is estimated as  $C_{R,N}(1977)[1 + (L_N + I_N E_{R,N})]^T$  where  $C_{R,N}(1977)$  = 1977 consumption trend estimate for root crop R for country N (tonnes);  $L_N$  = annual compound rate of growth of population in country N for 1970–76 (%);  $I_N$  = annual compound rate of growth of GNP per person

in country N for 1970–76 (%);  $E_{R,N}$  = income elasticity of demand for root crop R in country N; and  $T$  = time interval between 1977 and  $t$  (years);  $C_{R,N}(1977)$  is estimated as  $\log C_{R,N}(1977) = a + bT$  where  $T$  = time interval (16 years) between 1961 and 1977 (Table 2, Fig. 3).

Without population projections, it is not possible to estimate future consumption on a per-person basis. Yet the low rates of growth or declines in real income and income elasticities of demand of less than zero suggest that per-person consumption of the root crops will be higher in 1995 than in 1977 in countries other than Nigeria. Despite this, at 1961–77 rates of growth of production and at 1970–76 rates of growth in real income and population, by 1995 the belt as a whole would generate a surplus of production over consumption

needs of more than 4 Mt of root crops. Most of the surplus would be generated in Nigeria where per-person consumption is expected to decline.

The assumption of continuation of 1961–77 rate of production to 1995 is perhaps the most subjective of all the assumptions behind the projections. It implies that substitutions in resource allocation will not take place. However, in Nigeria where a high rate of increase in GNP is expected it is likely that resources will be shifted from root-crop to grain production because demand for grains will be higher than for root crops. In the other countries resources will likely be shifted from high-cost grains to root crops. Then, the deficits for those countries would be lower and the surpluses higher than projected.

In analyses of actual data on root crops in tropical Africa, production is generally equated with consumption because recorded trade on the commodities between nations is insignificant. Nevertheless, surpluses and deficits occur from year to year, absorbed as fluctuations in returns to producers. The available data on market prices for root crops show not only seasonal and locational differences but also major fluctuations in annual averages (FAO 1971), reflecting year to year differences in supply and demand.

## IMPLICATIONS

A surplus of 4 Mt for the area as a whole would mean that there would be no shortage of root crops if the commodities moved freely across national boundaries and if one root crop were a perfect substitute for another. Zaire, Tanzania, and Madagascar (all of the eastern belt countries) and Nigeria would generate surpluses; Ghana, Ivory Coast, and Cameroon (all of the western belt

countries) would generate deficits of production over consumption by 1995. However, recorded trade in root crops between countries, especially among tropical African countries, is insignificant. This means that surpluses in one country do not offset deficits in another. Hence, producers in countries with a surplus of production over consumption, especially in Nigeria where income is expected to grow rapidly, would suffer capital losses and may divert their land and labour. This shift would not be adverse if the resources were diverted to tree crops such as oil palm, cocoa, rubber, etc. for which an export market exists. If, however, the resources were diverted to grains, in the production of which tropical African resources may be relatively inefficient, the effect would be adverse.

Although average yield rates for both root crops and grains are lower in tropical Africa than in the rest of the world, the difference is smaller for root crops than for grains. For example, in 1971–75, the weighted (with area harvested) annual average yield of root crops in Africa was 64% of the world average and the weighted annual average yield of cereals in Africa was 57% of the world average (FAO 1971–76). Rather than divert their resources from root-crop production to grain production, tropical African farmers would be better off if encouraged to produce root crops for export. This means that efforts should be made to establish such export markets.

Although all the root crops have more or less the same nutritive value, mainly carbohydrate, they are not perfect substitutes for each other because of local consumption habits. In most parts of south-eastern Nigeria, for instance, yam is the food security crop, and it is by far more important than any other root crop not because of its nutritional but because of its cultural value. In the area, yam is

Table 2. Estimates of production, consumption, and surplus or deficit of various root crops in major countries of the African root crops belt, 1995.

| Country     | Cassava                          |                                   |                                      | Yam                              |                                   |                                      | Cocoyam                          |                                   |                                      | Sweet potato                     |                                   |                                      |
|-------------|----------------------------------|-----------------------------------|--------------------------------------|----------------------------------|-----------------------------------|--------------------------------------|----------------------------------|-----------------------------------|--------------------------------------|----------------------------------|-----------------------------------|--------------------------------------|
|             | Pro-<br>duc-<br>tion<br>(‘000 t) | Con-<br>sump-<br>tion<br>(‘000 t) | Sur-<br>plus/<br>deficit<br>(‘000 t) | Pro-<br>duc-<br>tion<br>(‘000 t) | Con-<br>sump-<br>tion<br>(‘000 t) | Sur-<br>plus/<br>deficit<br>(‘000 t) | Pro-<br>duc-<br>tion<br>(‘000 t) | Con-<br>sump-<br>tion<br>(‘000 t) | Sur-<br>plus/<br>deficit<br>(‘000 t) | Pro-<br>duc-<br>tion<br>(‘000 t) | Con-<br>sump-<br>tion<br>(‘000 t) | Sur-<br>plus/<br>deficit<br>(‘000 t) |
| Nigeria     | 24179                            | 23211                             | 968                                  | 34287                            | 29989                             | 4298                                 | 2496                             | 2803                              | -307                                 | —                                | —                                 | —                                    |
| Cameroon    | 1329                             | 1388                              | -59                                  | —                                | —                                 | —                                    | 1069                             | 1129                              | -60                                  | 429                              | 407                               | 22                                   |
| Ghana       | 963                              | 1802                              | -839                                 | 1556                             | 2713                              | -1157                                | 2294                             | 2226                              | 68                                   | —                                | —                                 | —                                    |
| Ivory Coast | 2485                             | 2074                              | 411                                  | 3671                             | 4170                              | -499                                 | —                                | —                                 | —                                    | 18                               | 35                                | -17                                  |
| Zaire       | 17445                            | 16832                             | 613                                  | —                                | —                                 | —                                    | —                                | —                                 | —                                    | 665                              | 652                               | 13                                   |
| Tanzania    | 3700                             | 3007                              | 693                                  | 399                              | 495                               | -96                                  | —                                | —                                 | —                                    | —                                | —                                 | —                                    |
| Madagascar  | 2907                             | 2580                              | 327                                  | —                                | —                                 | —                                    | —                                | —                                 | —                                    | 342                              | 558                               | -216                                 |

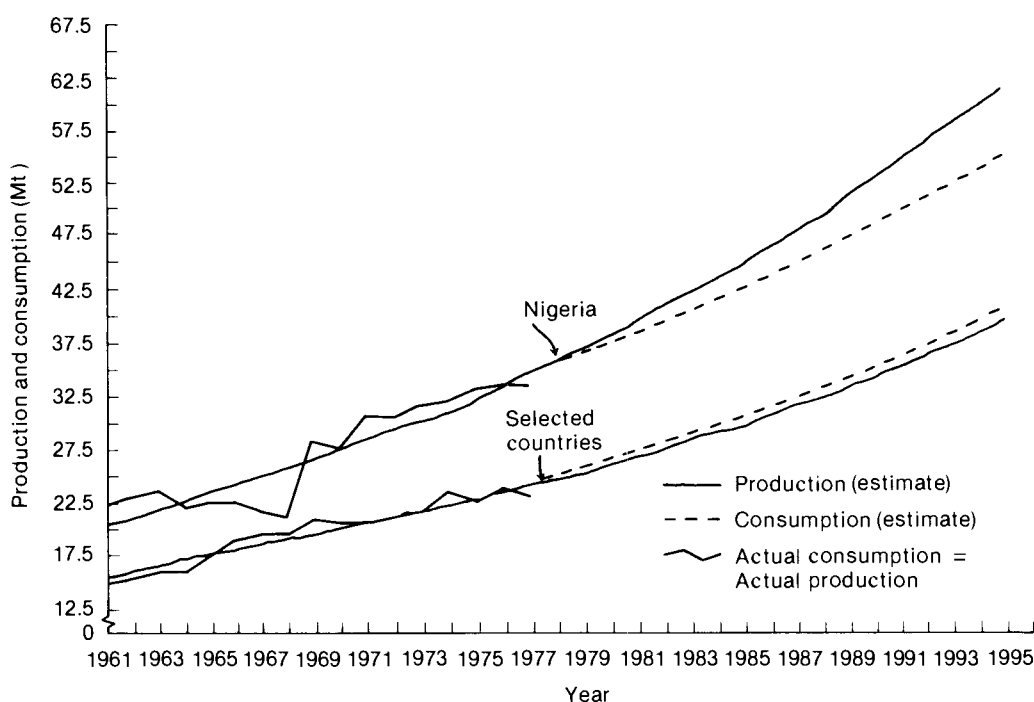


Fig. 3. Total production and consumption of root crops in Nigeria and in selected countries in the African root crops belt: actual (1961–77) and estimated (1961–95).

“man’s crop,” whereas cassava and cocoyam are “woman’s crops,” and all production, marketing, and consumption decisions with respect to yam are made by the male head of a household. Similar decisions with respect to cassava, cocoyam, etc. are made by female members of the household (Nweke et al. 1980). In such a situation a surplus of production over consumption in cassava would not offset an equal amount of deficit of production over consumption in yam.

The African root crop belt would generate 2.1 Mt of cassava and 2.6 Mt of yam as surpluses and only marginal deficits in cocoyam and sweet potato by 1995. The marginal deficit in sweet potato is important, because it is mainly in one country, namely Madagascar. The surplus of production over consumption of cassava would be generated in Nigeria and in eastern belt countries; countries in the western belt would generate deficits of cassava production over consumption. The surplus of production over consumption of yam would be generated only in Nigeria; the surplus in that country would be large enough to offset major deficits in Ghana, Ivory Coast, and Tanzania if trade in the commodity were developed among these countries.

The surplus of more than 4 Mt of yams in Nigeria would be at a high cost because compared with

production of other food crops, yam production is very labour-intensive (Table 3).

Producing 1 Mcal from yam takes nearly three and a half times the amount of labour required to produce the same amount of calories from cassava. In most places yam is grown on huge mounds and also staked. The tasks involved are labour-intensive; mounding is necessary to enhance drainage in yam plots because the yam tuber is susceptible to rot under waterlogged conditions.

In addition, surplus yam output would be more difficult than surplus cassava output to dispose of without major capital losses to the producers. Its high production costs are not offset by potential uses; apart from its cultural value the utility of yam is limited to human consumption. In contrast, cassava has uses in livestock feed, industrial starch,

Table 3. Labour requirements for production of various root crops in Nigeria

| Crop    | Mandays/ha | Mandays/Mt | Mandays/Mcal |
|---------|------------|------------|--------------|
| Yam     | 325        | 45         | 69.31        |
| Cassava | 183        | 21         | 20.57        |
| Maize   | 90         | 121        | 35.51        |
| Rice    | 215        | 145        | 59.92        |

etc. There is, therefore, a major need for new technology that would reduce yam production costs. Such technology could be mechanical methods of mounding and staking for yam or, preferably, breeding of yam varieties that are resistant to waterlogged conditions. Such efforts should be in addition to attempts now under way at the National Root Crops Research Institute, Umudike, Nigeria, and at the International Institute of Tropical Agriculture, Ibadan, Nigeria, to develop yam planting materials from seeds and stem rather than from the tuber, which is the edible part.

## **RESEARCH AND PRODUCTION STRATEGIES**

Given the 1961–77 production trend for various root crops, 1970–76 annual compound rates of growth of GNP per person and population, and income elasticities of demand for various root crops, one may assume that the African belt will generate a surplus of root crops in general in future. However, there would be major deficits in specific countries and in specific root crops. It is necessary to encourage trade in root crops among the countries of the African root crop belt so that surplus in one country offsets deficits in another. In the absence of such trade, producers in countries with surpluses will suffer capital losses and could divert their resources to less-efficient uses; consumers in

countries with deficits would pay high prices for root crops.

Surpluses generated in yam would be at high costs because of the high production costs. In areas where yam does not have a high cultural value, resources are more efficiently used in cassava production than in yam production because a unit of calorie is cheaper to produce from cassava than from yam and because cassava has uses other than for human consumption and, hence, surplus production of cassava is more easily disposed of without capital losses to the producers than is surplus production of yam.

Where yam must be produced, probably because of its high cultural value, there is need for development of cost reduction technologies, including planting materials from seed and stems as well as yam varieties with tubers and foliage resistant to rot under waterlogged conditions. Such varieties would be grown on flat beds rather than on mounds and would not need staking. These developments would significantly reduce yam production labour directly by eliminating mounding and staking and indirectly by facilitating mechanization of yam cultivation. One of the major bottlenecks to mechanization of yam production where the soil and sociologic factors such as land tenure are conducive to mechanization is the heavy power that would be needed to make huge yam mounds.

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