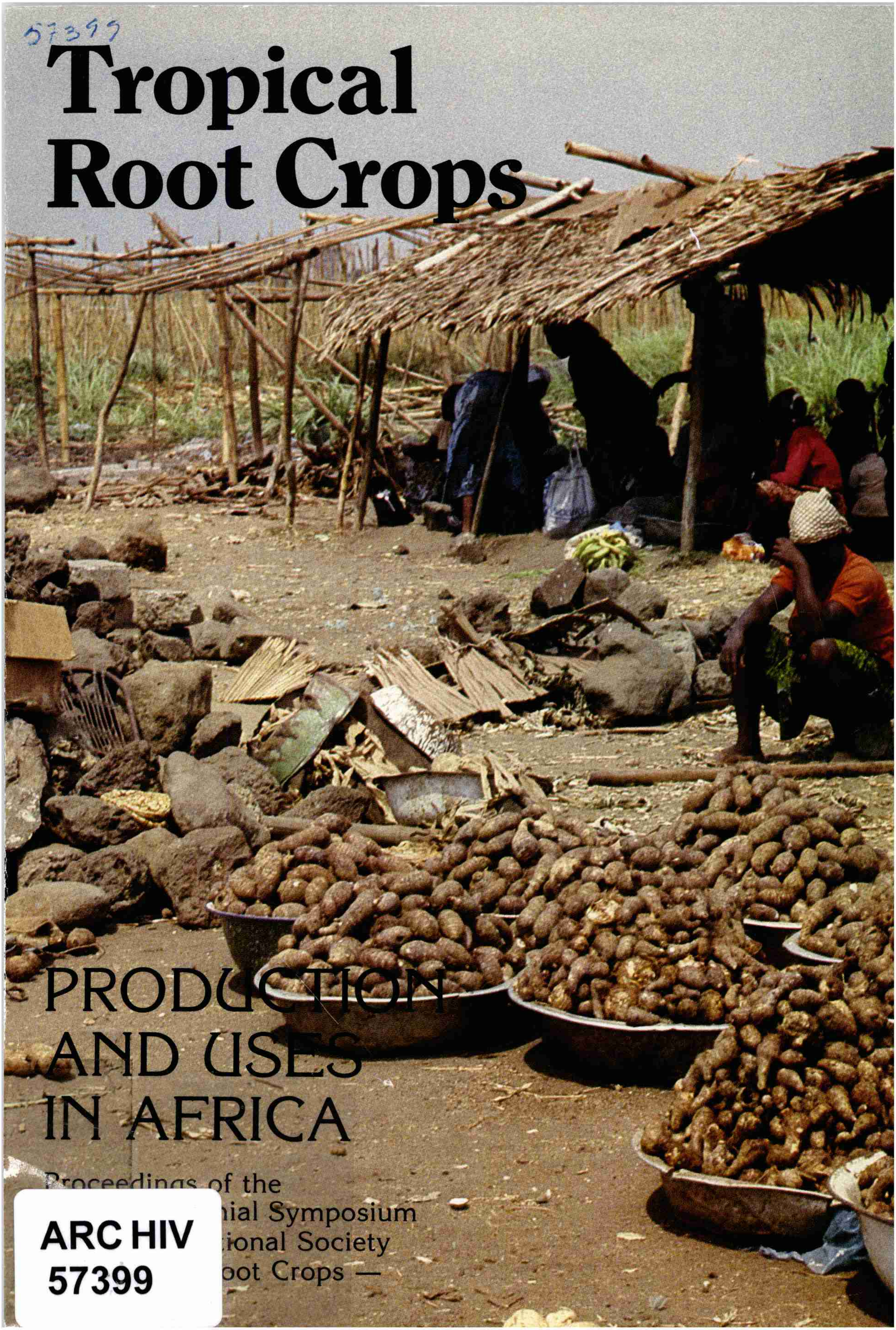
Tropical Root Crops



PRODUCTION AND USES IN AFRICA

Proceedings of the
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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 are 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.

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TROPICAL ROOT CROPS: PRODUCTION AND USES IN AFRICA

Abstract

A mixture of original research, updates on procedures, literature reviews, and survey reports, this document resulted from the second symposium of the International Society for Tropical Root Crops — Africa Branch, with 77 participants from 16 countries. The focus was cassava, yams, cocoyams, and sweet potatoes, from the perspectives of breeders, agronomists, soil specialists, plant pathologists, entomologists, nutritionists, food technologists, etc. Learning from past successes and failures, many of the researchers directed their efforts toward problems obstructing progress in reaching improved production and use of root crops and attempted to view, realistically, the context in which their results would be applied.

Résumé

Résultats de recherches récentes, mises à jour sur les méthodes de recherche, revues de publications et rapports de sondages sont contenus dans ce document issu du Deuxième symposium de la Société internationale pour les plantes-racines tropicales — Direction Afrique, qui a réuni 77 participants de 16 pays. Des communications sur le manioc, le taro, le yam et la patate douce ont été présentées par des phytosélectionneurs, des agronomes, des pédologues, des phytopathologistes, des entomologistes et des spécialistes de la nutrition et des aliments, entre autres. Tirant leçon de leurs succès et de leurs échecs, beaucoup de ces chercheurs ont dirigé leurs efforts vers la solution des problèmes qui entravent l'augmentation de la production et de la consommation des plantes-racines et ont tenté de considérer d'un œil réaliste le contexte qui sera celui de l'application de leurs recherches.

Resumen

Una mezcla de investigaciones originales, actualizaciones de procedimientos, reseñas de literatura e informes de encuestas, este documento es el resultado del segundo simposio de la Sociedad Internacional de Raíces Tropicales, Filial Africana, que contó con 77 participantes de 16 países. El simposio se centró en la yuca, el ñame, el cocoñame y las batatas, desde la perspectiva de los fitomejoradores, los agrónomos, los especialistas en suelos, los patólogos vegetales, los entomólogos, los nutricionistas, los tecnólogos alimenticios, etc. A partir de los éxitos y fracasos anteriores, muchos de los investigadores encaminaron sus esfuerzos hacia los problemas que obstaculizan el avance para lograr una producción y un uso mejorados de las raíces y trataron de obtener una visión realista del contexto en que los resultados pueden ser aplicados.

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Tropical Root Crops:
Production and Uses in Africa

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Yams

ECONOMIC INDICES FOR CLONAL SELECTION AND BREEDING OF YAMS

O.O. OKOLI, J.U. NWOKOYE, AND C.C. UDUGWU[1]

Edible yams are widely grown under mixed-cropping systems in Nigeria. Sizable portions of food tubers are planted to produce new crops, the yields of which are greatly influenced by the numbers and sizes of seeds planted. Currently, yield data are not reported in such a way as to take this variation into account. Thus, we have developed a system of reporting that will enable a better comparison of results. We also have detailed other indices that make for objective selection of clones in a breeding program and, to exemplify the approach, we have used these indices and other conventional descriptors to describe cultivars belonging to two yam species.

Now that yams, especially the *Dioscorea rotundata–D. cayenensis* complex, *D. dumetorum*, and *D. alata*, have been successfully grown from true seeds (Okoli 1975; Sadik and Okereke 1975), breeders will be perfecting the operation so that they can select and improve the varieties. This means that the traits to be transferred or eliminated must be clearly defined not only taxonomically (Waitt 1961; Ukoha and Ikediobi 1983) but also economically. We have empirically defined phenotypic expression of economic attributes in an attempt to provide indices for use by breeders to rank selective value among yam cultivars.

More than 4000 clones of six species of *Dioscorea* were collected during surveys in Nigeria. The clones are being maintained in the germplasm plots at the National Root Crops Research Institute (NRCRI); from records of vegetative, floral, and tuber characteristics over a 6-year period, we evaluated four clones of white yams (*D. rotundata*) and one of water yam (*D. alata*) for descriptive characteristics that may be used as standards for selection in yam breeding.

CHARACTERIZATION

Some of the characters that lend themselves to improvement by breeders are yield, shape, flowering, time to maturity, dormancy, storability, and food quality.

Yield is usually the weight of fresh or dry tubers. However, the yield is influenced by the number and weight of the tubers used as seeds (the setts). Up to 4 t/ha may be used, and, generally, the larger the seed tuber, the larger the yield expected. Comparison of yields from different locations and times is difficult because the amount of seed material used is neither standard nor stated. Also, the yield data do not show what fraction (yield minus seeds for the next planting) is available to the farmer for sale or for food. Yield data can be made comparable by the use of a seed-yield factor — W_h/W_p — where W_h is weight of tubers harvested and W_p is weight planted. The result is the number of times the amount of yams used in planting ("seed") is multiplied in the harvest. Thus, if a farmer uses 3 t/ha and harvests 12 t, the seed-yield factor is 4. The amount of yield available to the farmer is not 12 t; if he or she needs 3 t for establishing next year's crop, then the available harvest (for sale or eating) is 12 − 3 − 3 t or 6 t. To determine what fraction of the yield is available to the farmer, we express the available harvest as a percentage of the total yield. Thus, available yield (%) = $(W_h - 2W_p)/W_h \times 100$.

This means that only 50% of the total harvest of 12 t/ha would be available to the farmer. Seed-yield factor takes into account the (genetic) yield potential of the variety as well as the relationship between the amount of seed tubers planted and the yield obtained — a relationship that varies among varieties and between species. Available yield percentage indicates the profitability (or otherwise) of growing a particular yam cultivar.

The shape of the tubers, although sometimes affected by environment (soil density, presence

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or absence of rocks, roots, etc. in the soil), is primarily specific to the variety. The commonest shapes include wedge-like (large head and thin tail); cylindrical (fairly uniform from head to bottom); and fan-like (flat and spreading bottom). We defined the shape index as the ratio of the length to the girth of the tuber, with the average girth being used in calculations. Shape index reflects the eye appeal and acceptability of the tuber. An index of 1–2 is most acceptable to consumers in Nigeria; yams with a shape index of 1 or less are likely to be suitable for mechanized harvesting.

In the germ-plasm plots at NRCRI, the plants are observed for appearance of flowers over a number of years. Records are also kept of the type of flowers seen — staminate (male) or pistillate (female) or both — and of how soon (days) after planting the flowers appear. Fewer than 60 days from planting to flowering is classified as early; 61–90 days, medium; and more than 90 days, late.

This record is important for clones to be used in a hybridization program, as the flowering times of the staminate and pistillate plants need to be synchronized. The pistillate flowers remain open for 1 day only.

In yams, the plants are mature when the foliage and vines begin to die naturally (as opposed to death caused by diseases, pests, environmental changes, etc.). For practical application, maturity is the time from planting to normal dieback. Cultivars that mature 5–7 months after planting are rated as early; 8–9 months, medium; and longer than 9 months, late.

Yam growth is a continuum whether in the field or in storage (Okoli 1980). However, in practice, the period from harvest to sprouting is usually regarded as dormancy. Dormancy for fewer than 30 days is regarded as short; 31–45 days, medium; and more than 45 days, long.

Storability is the keeping quality of healthy, uninjured yam tubers under normal storage conditions (open, well-ventilated racks under heavy shade). Many factors affect the storability of yam tubers. For instance, the presence of rotting tubers near healthy ones may shorten storability of the healthy ones. Similarly, storage temperature and humidity may affect such physiologic activities as respiration and sprouting, and these in turn will affect storability. Storability as assessed here for the time being is subjective, as storage conditions are fairly difficult to replicate.

Assessments of food quality include cooking time, colour, appearance, texture, and taste. The time (in minutes) it takes a 1-cm-thick slice taken from the middle of the tuber and immersed in boiling water to cook — the cooking time — varies from 5 minutes in some cultivars of *D. rotundata* to 360 minutes in some cultivars of *D. dumetorum*. White flesh and a smooth appearance are preferred to a yellowish-white and grainy appearance. Yams that turn brown when cut and exposed to air are considered poor. The texture and elasticity of pounded yam is particularly important in Nigeria. Yams that can be pounded into a smooth, elastic dough are judged to be good, whereas those with a rough, brittle dough are poor. The texture and taste of boiled yams may be friable and sweet or starchy and bland. In other words, consumer preferences and local practices are a guide to appropriate food quality. At NRCRI, food quality is rated on a scale of 1–5.

EXAMPLES

Within the species of the genus *Dioscorea*, there are groups of cultivars whose differences are not enough to make them separate varieties. Thus, we have described four such groups for *D. rotundata* and one for *D. alata* to exemplify the use of criteria for selection.

D. ROTUNDATA

Nwapoko tubers are generally large, long, and often mildly pointed at one end. The shape is often spindular, with a shape index between 2 and 3. Tuber branching or indentation is not common. Skin is firm and light-coloured with a few roots on the surface that give it a rough texture. Few lenticels are visible, and the roots on the head are spiky. The cortex is greenish, and the flesh milky white. Nwapoko rarely flowers under Umudike conditions; when it does, only staminate flowers are produced. Its yield is relatively low to moderate. A mean yield of 0.7 kg/plant and 1.7 tubers/stand is normal. The seed-yield factor is about 1.33 for ware yams and 2.56 for seed yams. Available yield % is about −50 for ware yams and 22 for seed yams. It stores well in cool, airy rooms. Cooking time is 6 minutes, and Nwapoko can be pounded into good fufu. Food quality rates 4.5 out of 5. It is susceptible to wilt, leaf spot, anthracnose, and shoestring virus. Termite and beetle damage depends on where the yam is planted, and both root knot and crack-forming nematodes may attack the tubers. Rotting in the field is rare. Other local names include Adaka, Agba, Ig-

By defining the characters of existing cultivars carefully, breeders can focus on selecting the most socioeconomically desirable ones.

uma, Igum, Aga, Akuru, Agbakuru (Igbo), Agboja (Ugep), Nkara, Mkpidot, Okot (Efik), Akpochi, Ogbagu, Gbangu (Tiv), and Ebo (Ogoja).

Abi includes cultivars that produce long tubers (shape index between 2 and 3, e.g., Abi Ogologo) and squat tubers (with a shape index less than 1, e.g., Abi Ito). Branching or flattening of the tail of the tuber is common, and the bottom is mildly pointed. Unlike Nwapoko, the roots on the head of Abi are not usually spiky. The skin of the tuber is light-coloured and smooth (usually no roots are found on the body) and often peels in storage. Lenticels are not easily visible. The cortex is greenish, and the flesh is greenish-white. Abi usually flowers early, producing staminates, and is early maturing. Tuber yield is moderate to high, even on poor, sandy soils. Average yield/stand is 0.75 kg; tubers/plant, 1.43; and average tuber weight, 0.5 kg. Seed-yield factor is about 2.96 for seed yams and 1.75 for ware yams. Available yield % is about 32 for seed yams and −14 for ware yams. Abi keeps well in open airy places, although its dormancy is short. Its food quality rates 3, but it improves with storage. Pounded Abi is regarded as poor because it is sticky. The cultivars within this group are fairly resistant to most foliage and tuber diseases: not affected by anthracnose, wilt, or virus, although they are susceptible to nematode attack. Other local names include Ngarada, Orume, Nkoroto (Igbo), Nkorito, and Okperekpere (Efik).

The Okwocha group produces medium to large tubers that are blocky, with shape index less than 1. The bottom is often rounded, and the head, flat or square with unspiked roots. Indentations are common on the tubers. The skin is firm, light-coloured, but very rough because of the many roots on it. Few lenticels can be seen. The cortex is greenish, and the flesh is milky white. Okwocha flowers easily, although late, producing only staminate flowers. Its tuber yield is moderate to high. Yield/plant is 0.79 kg, tubers/plant 1.67, and average tuber weight 0.47 kg, with available yield % being 41 for seed yams and 3 for ware yams. The seed-yield factor is 3.39 for seed yams and 2.07 for ware yams. It is medium to late maturing and does not store well, rotting fairly quickly in high humidity. Nevertheless, its dormancy is moderately long. It rates well in food quality, having a score of 4. It does not pound well, as it tends to be friable, but its taste offsets this drawback. It is susceptible to leaf spot, wilt, anthracnose, and shoestring virus as well as to rots in the field and in storage. Damage by termites, beetles, and nematodes is also almost always present. Other local names include Awudu, Omashi, Evo (Igbo), Adasu, Ntume, and Dan anacha (Tiv).

Obiaoturugo produces large cylindrical tubers with a shape index between 1 and 2. The bottom end is often rounded, and the head flat or square with roots that have no spikes on them. The skin is firm, light-coloured, and smooth (no roots on the body). Few lenticels can be seen. The cortex is greenish, and the flesh is milky white. Obiaoturugo flowers sparsely or profusely depending probably on weather conditions. It flowers late and produces mostly pistillate inflorescences, although it may produce both pistillate and staminate florets on the same spike. The ovary later develops into a 3-sided capsule containing 2–6 winged seeds. Its tuber yield is low to moderate: average yield/stand 0.76 kg, tubers/plant 1.23, and tuber weight 0.62 kg. Seed-yield factor is about 3.14 for seed yams and 1.37 for ware yams; available yield % is about 36 for seed yams and −46 for ware yams. It is medium to late maturing and keeps moderately well in cool, dry, airy rooms. Its food quality is 4.5. Cooking time is 6 minutes, and the tuber can be pounded into good fufu. It is susceptible to anthracnose and leaf spot and is sometimes liable to beetle and termite attack. Nematode attack is rare, but preharvest rot is usually present, especially if harvesting is delayed. Other local names for Obiaoturugo are Iyawo (Yoruba), Oyoyo (Idoma), Ewesu, Elewusu (Kwara), Igoyo, Tameneyo, Yatoho Tsatoho (Tiv), Unegbe (Igbo).

D. ALATA

Tubers of *D. alata* variety UM680 are usually large, long, and pointed at the bottom. They are spindular, with a shape index between 2 and 3. Their body has shallow grooves and a few roots, which make it rough to the touch. The skin is firm, and light brown. The cortex is reddish, and the flesh purplish-white. No flowering has been observed for this cultivar in Umudike. It is late to mature, with a moderately high yield: 1.39 kg/plant, 1.52 tubers/plant, and 0.92 kg/tuber. Seed-yield factor is about 5.72 for seed yams and 2.61 for ware yams, with the available yield % being about 65 for seed yams and 23 for ware yams. It stores very well in cool, airy rooms. Its cooking time is 7 minutes, but it is not well accepted by consumers. Pounded, it is considered poor, and the food quality rating is 3. It is tolerant to anthracnose–blotch, leaf spot, and shoestring virus.