AfricaYam: Enhancing Yam breeding for increased productivity and improved quality in West Africa

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Overview

More than 54 million tons of yam (*Dioscorea* spp.) are produced in Sub-Saharan Africa annually on 4.6 M Ha. Over 95% of this production lies in a five-country "yam belt" that includes Nigeria, Benin, Togo, Ghana, and Côte d'Ivoire.

Yam is the preferred staple food in West Africa and supply is constrained by inadequate production and losses in storage. The most important biotic constraints are nematodes, viruses, and anthracnose. Genetic improvement can contribute significantly to addressing these challenges and seizing opportunities for expanding the markets for the commodity.

Yam cultivation has significant impact on the environment. Yam is usually planted into recently cleared land and requires staking with branches/small trees, especially in the forest areas. Yam productivity is negatively impacted by declining soil fertility and diseases and pests associated with intensive cropping systems.

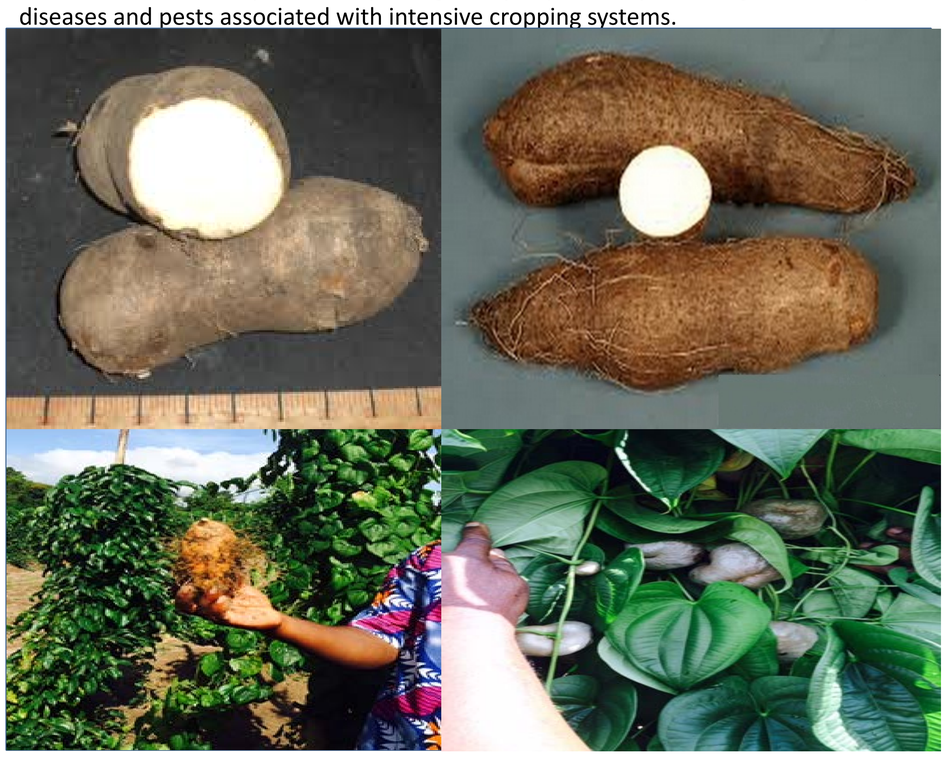

Figure 1. Showing (L-R) *D. rotundata, D. alata, D. esculenta, D. bulbifera*

The major cultivated yam species which are the focus for genetic improvement are white yam (*D. rotundata*), which is indigenous to West Africa, and water yam (*D. alata*) which originated from the Asia/Pacific region.

Important traits for breeding include tuber yield, tuber quality, resistance/tolerance to diseases (yam mosaic virus and anthracnose) and nematodes.

Figure 2. Showing (L-R) Female yam flower, male yam flower, yam seedlings growing in carbonized rice husk at various stages of growth

Key Objectives

The key objectives for achieving the vision of the AfricaYam project are:

- Breeding for high yield, good quality of tubers, and resistance to diseases (anthracnose, yam mosaic virus and nematodes)
- Establishing a breeders' community of practice for participating countries with a focus on upgrading skills in breeding, phenotyping, and management of a breeding program, including national and international trials
- Regional testing of promising breeder's lines that are currently available and additional ones that will be generated during the project and identification of superior clones for pre-release trials in each country
- Phenotyping and genotyping of bi-parental populations and conducting genome-wide association studies for key agronomic and quality traits
- Additional re-sequencing, sequence analysis for generation of genomic tools for genotyping populations, genome-wide association studies, and testing feasibility of genomic selection
- Constructing and using a database for curation and integration of yam research data
- Training and capacity building

Expected Outcomes

Output 1.0

Active yam breeding programs in four countries in West Africa (Ghana, Nigeria, Côte d'Ivoire and Benin).

Intermediate outcome 1.1 Strengthened Yam breeding programs at IITA and national institutes in Ghana, Nigeria, Cote d'Ivoire and Benin

Output 2.0

Improved efficiency of yam breeding programs through use of faster and more precise tools and methods

Intermediate Outcome 2.1

Genetic basis of important agronomic and quality traits (starch content, YMV and anthracnose resistance) in *D. rotundata* and *D. alata* understood and utilized in breeding

Intermediate Outcome 2.2

Rapid and accurate phenotyping protocols adopted and utilized in breeding programs for agronomic and quality traits

Intermediate Outcome 2.3

Effective integration of data in yam breeding programs

Output 3.0

Improved yam genotypes adapted to production systems and suited to market preferences nominated for release

Intermediate Outcome 3.1

Genotypes superior in key traits to existing cultivars selected from multi-site pre-release trials in each country

Intermediate Outcome 3.2

D. alata and *D. rotundata* genotypes with desired traits evaluated in multi-site trials and used in breeding

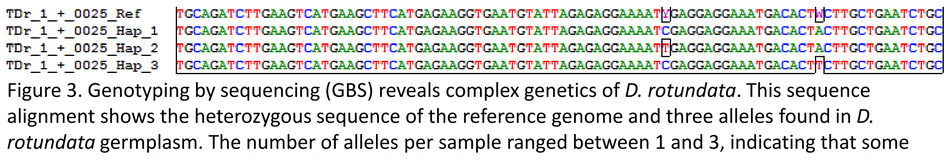

Figure 3. Genotyping by sequencing (GBS) reveals complex genetics of *D. rotundata*. This sequence alignment shows the heterozygous sequence of the reference genome and three alleles found in *D. rotundata* germplasm. The number of alleles per sample ranged between 1 and 3, indicating that some clones are polyploids. Knowledge of ploidy level will improve hybridization success and parental selection.

Figure 4. Showing hands-on training of yam breeders and technicians and facility upgrades in national institutions

Constraints and Recommendations

Challenges in yam breeding mainly arise due to the lengthy crop cycle, poor seed multiplication ratio, poor understanding of genetic diversity and limited breeding enabling technologies.

The AfricaYam project is focused on upgrading the existing equipment and facilities at national institutions in the four target countries.

Capacity development of existing yam breeders and technicians as well as training of younger breeders is integral for the long term sustainability of yam breeding.

It is necessary to review and develop a fast-tracked, effective and efficient varietal release program in each country.

New technology, such as genomics, combined with improved breeding methods will increase the understanding of yam genetics and improve the efficiency and effectiveness of yam breeding.

AfricaYam: building better yams …faster

This five-year project has brought together researchers in West Africa to meet the challenge of improving yam breeding and to strengthen the capacity of this region to develop improved varieties.

Collaborators

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